# Report of the President's Advisory Panel on Timber and the Environment

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PRESIDENT'S ADVISORY PANEL
ON TIMBER AND THE ENVIRONMENT

ARLINGTON, VIRGINIA 22209

April 30, 1973

MEMORANDUM FOR THE PRESIDENT

SUBJECT: Final Report of the President's Advisory Panel on Timber and the Environment

Attached herewith is the final report prepared by your timber panel.

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Member

Stephen H. Spurr
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Marion Clawson
Member

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Member

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# THE PRESIDENT'S ADVISORY PANEL
# ON
# TIMBER AND THE ENVIRONMENT

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# Part I (A): Major Recommendations[1]

*The Advisory Panel on Timber and the Environment recommends to the President that:*

1. The President issue a statement or proclamation to the Nation, emphasizing the unique renewability of the timber resource, and the opportunities to improve substantially the productivity and the value of the Nation's forest resources to meet the multiple demands now being made and likely to be made in the future on these forests; and emphasizing that forest resources are to be cherished, nurtured, and used.

2. The President require the Federal agencies concerned with forests to prepare a comprehensive nationwide program of forest development and timber supply covering the periods 1973–85, 1986–2000, and 2001–20, which will convert into specific programmatic terms the general proposals of this report. Such comprehensive programs should include: Expansion of recreation and wilderness areas where appropriate; protection of water supplies; protection of fragile soils and erodable steep slopes by their withdrawal from timber harvest; protection of wildlife including rare and endangered species of plants, animals, and birds; improved utilization of wood fiber for all its varied uses; assistance to owners of private forest lands in the management of their forests for increased output; and harvesting of timber from the national forests on a schedule commensurate with their productive capacity and sufficient to make their proportionate contribution to national timber needs. This comprehensive program should be carefully monitored by the Forest Policy Board, proposed later.

3. The Federal land-administering agencies and the Congress accelerate their efforts to complete the National Wilderness Preservation System as rapidly as possible. The Federal land-managing agencies and the Congress should develop a system of quasi-wilderness areas in the Eastern United States, in which low-intensity outdoor recreation will be possible under natural forest conditions.

4. The commercial forest lands not withdrawn for wilderness or other specific uses should be designated for commercial timber production and other compatible uses and be managed in accordance with appropriate national policies.

5. The Federal agencies continue to reserve from timber cutting all lands under their jurisdictions where sites cannot now be logged without causing unacceptable environmental damage; such reservation to continue until the means of timber management and harvest have improved so that such lands can be safely harvested.

6. The Forest Service, the Bureau of Land Management, and all other pertinent Federal agencies, improve the environment on forest lands under their jurisdictions by establishing road building standards and logging practices that minimize site disturbances, while at the same time retaining all proven and efficient methods of timber harvest, including clearcutting, under appropriate conditions. These agencies should skillfully apply the best silvicultural and conservation measures in forest management, particularly in timber harvest and forest regeneration. The need to economically and intensively manage the new forest crop as well as manage the existing timber crop shall receive due consideration.

7. In order to help dampen short-term fluctuations in softwood lumber and plywood supply, interested public agencies and private industry rep-

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[1] Fuller statements of these recommendations and of reasons for them are found throughout the Panel report, as are other recommendations on a number of pertinent subjects.

resentatives should make periodic (perhaps monthly) reviews or analyses of the prospective demand and supply situation for the various wood products, in order to discover possible imbalances and warn against them. Such reviews would be similar to those now made in the Department of Agriculture for agricultural commodities, but should involve both suppliers and users of wood products to a major degree for the knowledge such groups can contribute and also as a means of making the projections more widely known and more effectively used.

8. The annual harvest on lands available for commercial timber production on western national forests can be increased substantially. Analyses based upon nationwide forest inventory data indicate possibilities for increasing the old growth cutting rate in the range of 50 to 100 percent. The Panel's consultant believes that on four forests analyzed in his report, the annual harvest rate should average 39 percent more, than is now proposed in recently prepared Forest Service plans. The Panel recommends that the Forest Service promptly review and revise policies for allowable cut determinations including rotation period determinations, stocking objectives, and old growth management policies for the western national forests. The precise revised level of harvest must be worked out for appropriate geographical areas and must consider, for each area, condition of existing timber stands, road accessibility, market demands, impact on non-Federal forests, and future timber supplies and do so within the limits of sustained yield. The Panel recognizes that an accelerated harvest of old growth timber in national forests should be undertaken only provided that adequate provision is made for financing whatever intensified timber management is needed to support the new level of harvest. If harvest on national forests during the 1970's is accelerated, it will tend to reduce pressure for harvest of timber from private forests, thereby tending to increase their growth of timber in this and later decades.

9. The Forest Service carry out an accelerated program of timber growing, stressing immediate regeneration, on national forests, in accordance with the foregoing recommendations and with the funds proposed in later recommendations. The objective of this accelerated program is to increase the growth of wood on national forests for harvest in later decades.

10. The Federal Government maintain incentive programs to encourage private landowners to follow forest management programs which protect the environment and to increase future timber supplies from their forests. Such programs should maintain Federal income tax incentives; should include advice and services to forest owners and their associations; and should include cost-sharing for intensive forest management practices, including provision of seedlings. New programs should be developed on a trial basis by providing financial assistance to lessees of land whose forests are combined by lessors of appropriate types into efficient forest management units.

11. Government and industry should conduct and support research to promote technological innovation in forest management and in wood utilization and help develop less destructive logging equipment. Particular attention should be given to methods of timber harvest on fragile sites and to commercial thinnings.

12. The President require all the Federal agencies having responsibility for management of wilderness areas to develop, in cooperation with wilderness users, democratic and equitable systems of managing use of wilderness areas within their carrying capacities, considering the nature of the wilderness experience as well as the wilderness ecosystem.

13. The President require Federal land managing agencies, especially the Forest Service, to undertake management practices to direct and control all nontimber uses made of the lands; to recognize that the day of unlimited public use of Federal recreation areas is over, and that recreation and other nontimber uses will have to be controlled and managed just as management has been applied over many years to timber growing and harvest and to grazing use.

14. The President require the Federal agencies concerned with the administration of outdoor recreation on Federal lands to devise and apply systems of charges or fees for recreation activity which are administratively feasible, equitable to users, reflect the value of the recreation opportunity, and reflect the costs of providing the recreation area and its facilities.

15. The United States continue to import and export forest products of all kinds when it is in the best long-term interests of the Nation to do so; but that, until some of the recommendations herein for increasing timber supplies can be im-

plemented, the executive branch negotiate with Japan to reduce the disruptive log buying activities in the Northwest.

16. The President consider, as one solution, the creation of a permanent national board or council on forest policy to report to the President or other appropriate offices in the White House, with a small group of citizen (not Federal employee) members appointed by the President. The council should examine all aspects of forest policy, on lands of all ownerships, and annually or more frequently recommend action to the President, the Congress, and the Nation, as appropriate.

17. A better method of more adequate and more timely financing of forest management programs on all Federal forest lands is essential. Such a method must recognize the long-term nature of forestry and be based upon sound economic concepts of intensive forest management; programed expenditures and investments must be related to anticipated returns. It is recommended that the President direct the Office of Management and Budget, with solicited help of the General Accounting Office and independent consultants, to devise a management and financial plan that will best meet the special needs of good resource management and at the same time conform to the established requirements of good government.

18. An amendment to the fiscal year 1974 budget be processed to provide sufficient funds for the offering of the full allowable cut on every national forest where there is that volume of market demand.

19. The President propose an increased annual Federal expenditure for forest development of the general order of $200 million. This is desirable and necessary inasmuch as implementation of the preceding recommendations will, at best, take some time and the forestry programs, especially the accelerated harvest of mature timber from national forests, proposed by the Panel merit such critical support. The President should make it clear that this is an investment, not merely an outlay, which should return to the Treasury more than it costs; and he should find ways of establishing an investment account for public forestry programs.

20. Finally, the President provide a suitable forum or means of enlisting review and discussion of this report, especially the policy recommendations, by responsible and informed persons inside and outside of government. The Panel members are prepared to participate.

# Part I (B): Abstract of the Report

## THE PANEL'S ASSIGNMENT

The President's Advisory Panel on Timber and the Environment was appointed to carry out the following activities:

> * * * to study the entire range of management problems. The Panel will advise the President on matters associated with increasing the Nation's supply of timber to meet the growing housing needs while protecting and enhancing the quality of our environment.
>
> The Panel will make recommendations on such matters as the desirable level of timber harvest on Federal lands and methods of accomplishing the harvest while assuring adequate protection of the environment; the costs and benefits of alternative forest programs; timber sales procedures; and the possibilities of increasing timber productivity on non-Federal lands.

The Panel has interpreted its charge broadly. Its report considers the entire forest resources of the United States, public and private, and their contribution to national well-being. The report examines the relationship of imports and exports to the national timber supply and the role that the U.S. forest resources have played and can continue to play in the world forest economy.

## THE TIMBER CONTROVERSY

The Panel's appointment was the direct result of public concern over two issues: The national housing program, and growing awareness of need for protection of the environment.

The Congress set a goal of 26 million new housing units to be built during the decade beginning with 1968. If fully achieved, this program would result in much needed housing for people of all income levels. Funding and initiating the program required builders to place large orders for lumber and plywood. Yard and mill stocks were quickly reduced and prices advanced sharply. For a time it seemed that the entire housing goal was threatened.

At the same time citizen groups in the Bitterroot Valley in Montana, near the Bridger National Forest in Wyoming and near the Monongahela National Forest in West Virginia were vigorously objecting to clearcutting timber from these forests. They found a sympathetic forum for their protests in the Congress; also many conservation and preservation organizations quickly reinforced their ranks. Public concern over management practices and perceived priorities on Forest Service lands also involved, of course, the executive branch. If the housing program were not to stop, large quantities of timber were required. A major portion of it would have to come from the national forests as these contained 51 percent of the Nation's softwood inventory. Moreover, the fact that production and use of alternative building materials would impose greater environmental disturbance than does production and use of wood argued for its continued preferential use. Other essential uses for wood continued, hence the total volume of wood demanded increased faster than logs could be cut and processed. This set off a sharp price rise which recurred in 1972, and is still underway.

Builders blamed the lumber and plywood industry and demanded price controls; the industry blamed the Forest Service for not selling more timber; the Forest Service was unable to respond to the increased demand but responded to environmental pressures by increasing its attention to details of timber sale planning and all multiple use objectives thereby making its road and timber activities rapidly escalate in cost. Actual and threatened court injunctions instituted by the Sierra Club, the Environmental Defense Fund, and other groups against timber sales further slowed the sales program. Preservationists insisted that the National Environmental Protection Act required the Forest Service to file environmental impact statements before opening additional forest lands to harvest. This and other constraints to preserve a balanced program vastly increased the work required to prepare timber sales, while Service manpower ceilings remained constant and then were reduced under rulings of the Office of Management and Budget. Consequently, instead of increasing, sales offerings declined. As frustrations mounted, awakened emotions heated rapidly. Impatient citizens seeking improved housing were ultimately penalized by the conflicts as lumber and plywood prices soared.

Late in 1972, Japan stepped up her log buying on the west coast to support her new housing program planned to match that of the United States. Prices of logs have been bid up to double and triple past levels. Such is the fast-moving situation as the Panel submits its report.

## SIGNIFICANCE OF FORESTS

Forests are dominated by trees; yet, forests are much more than land with trees; they are the complex entities resulting from the interactions of physical, chemical, and biological forces on some unit of land. Climate, soil, and water determine which grasses, herbs, shrubs, and trees will develop; the vegetation, in turn, determines which micro-animal and macro-animal forms will exist. Animals feeding on the vegetation further modify ecological relationships as the dynamics of forest life progress.

Throughout history, forests have provided a multitude of products and services; in industrialized societies the major outputs are: Wood for construction and paper products, a site for various forms of recreation, and water. The major consumable product is wood, just as farms produce consumable crops and livestock. Unlike substitute products used in construction, such as clay products, cement, steel, and aluminum, wood is renewable. Also its conversion from logs into finished products takes but a fraction of the energy that is required for refining and processing substitute materials. When its usefulness as a product is over, it is biodegradable to the basic elements of which it was made. Timber is a highly versatile construction material, unmatched in many technical properties. To dispense with it would be costly in money and environmental degradation.

Forests also provide water, fish, wildlife, and forage, in the commodity sense. Equally or more important are their services in building and protecting soil, safeguarding watersheds, cooling and filtering air, and providing innumerable opportunities for outdoor recreation of diverse character.

While only timber and forage among forest outputs usually generate significant financial returns for forest owners, all products and services benefit society in general and therefore are of public concern. Their perpetuation with unimpaired productivity is a solemn obligation of all forest users and government.

## CRITICAL FEATURES OF AMERICAN FORESTS

No nation on earth is so richly endowed with the variety and wealth of its forests as is the United States. This has been recognized in both the legal and moral obligations which society asserts to assure the Nation that its forest resource not be profligately used. Forests have always been an important natural resource, the use of which is deeply ingrained in American experience and history. Such use is expected to become increasingly important to quality living of the future.

### Hardwoods and Softwoods

The total forest area of the United States is 754 million acres of which 500 million acres are classified as commercial forest land. From about 1910, when clearing for agriculture ceased to exceed reversion of farmland to forest, until 1970 the area of forests increased; apparently the timber growth rate also increased as slow growing old timber was harvested and replaced by rapidly growing young stands (table I–1). Between 1952 and 1970, both total timber harvest and timber growth rate increased.

**TABLE I-1.—Total Commercial Forest Resource of the United States: 1952, 1962, and 1970**

| Year | Area (million acres) | In billion board feet | | |
|---|---|---|---|---|
| | | Inventory | Growth | Removals |
| 1952 | 495 | 2,412 | 45.1 | 52.5 |
| 1962 | 508 | 2,430 | 52.3 | 50.3 |
| 1970 | 500 | 2,421 | 60.0 | 62.8 |

The annual growth of hardwood as of 1970 was 19.7 billion board feet and the annual removal was 15 billion board feet. Hardwood timber is used extensively for flooring, pallets, furniture manufacture, athletic equipment and for paper manufacture. As of 1970, these and other uses totaled substantially less than the annual growth. The Panel does not dismiss the possibility that hardwoods may be in short supply in the decades ahead, as choice walnut, maple, ash, and oak are today. Nor is it unaware that hardwoods may be and in fact are now being used for many structural purposes for which softwoods are preferred. However, it is to the critical softwood timber supply that the Panel was charged to direct its attention.

Softwoods are used not only for lumber and plywood but also are favored for paper and paperboard where high strength and long fiber are requisites. Both softwood growth and softwood harvests on American forest lands have increased during the past 18 years but removals have exceeded growth with consequent reduction in inventory. During 1970 softwood harvest exceeded growth by 7.8 billion board feet. These aggregate national relationships differ between the East and the West and among ownership classes. Eastern forests are predominantly privately owned by farmers and other private owners and forest industry. The trees are young and grow rapidly, and growth exceeds removals for all ownership classes. The situation in the West on forest industry and public forests is the opposite. Most of the western forest are old growth forests where natural mortality offsets all or most of the gross growth. As a result, when harvests on these lands are compared with net growth, there is a current net growth deficit, even though the growth potential of these lands is sufficient to sustain current removal rates. With successful regeneration and continued good management following harvests, net growth on public ownerships will eventually equal or exceed the current rate of removals. On forest industry lands, this will be more difficult to achieve at current removal rates. On farm and other private ownerships, the forests are generally younger, and growth exceeds removals.

## Ownership, Inventories, and Growth

There are four major groups of commercial forest ownerships: National forests, other public, private industrial, and miscellaneous private which is composed of farmers, other individuals, and private groups (table I–2). The differences between these ownerships are many, but the primary functional differences are the quality of the lands for timber growing and the level of investment in timber growing each group is willing and able to make.

The industrial group owns about 13 percent of the commercial land. Their growth rates are substantially above the others and their lands on the average are receiving the most intensive management.

Over half of the total softwood sawtimber inventory stands on the national forests; in general, these lands are overstocked with mature and overmature timber resulting in an average annual growth-per-acre less than half that on industrial lands. National forests, because of less productive soils, use constraints, and remoteness from markets, may never match industrial forests in growth rate but the gap between the two can be drastically lessened as stagnant stands are replaced by thrifty, young timber.

**TABLE I–2.—Area and Volume Statistics by Ownership Classes, 1970**

| Ownership classes | Commercial[1] area held (million acres) | In billion board feet: Total softwood sawtimber volume | | | Total hardwood sawtimber volume | | |
|---|---|---|---|---|---|---|---|
| | | Inventory | Growth | Removals | Inventory | Growth | Removals |
| National forests | 91. 9 | 982 | 8. 6 | 12. 7 | 39 | 1. 3 | . 4 |
| Other public | 44. 2 | 223 | 4. 0 | 4. 3 | 40 | 1. 7 | . 6 |
| Forest industry | 67. 3 | 318 | 10. 0 | 16. 3 | 68 | 2. 4 | 1. 9 |
| Other private | 296. 2 | 382 | 17. 7 | 14. 4 | 368 | 14. 3 | 12. 1 |
| National total | 499. 6 | 1, 905 | 40. 3 | 47. 7 | 515 | 19. 7 | 15. 0 |

[1] Commercial forest land is defined as that forest land capable of producing 20 cubic feet of timber per acre per year and which has neither been reserved nor deferred.

Source of table: "Forest Statistics, 1970," FS–USDA.

Nonindustrial private lands have the smallest inventory per acre—too low in fact for optimum growth. In contrast to the other ownership classes, very close to half of the inventory on small private holdings is hardwood. These "other private" lands are the only ownership class on which softwood sawtimber growth exceeds removals. This margin between growth and removals must be expanded substantially to increase the proportion of softwoods and raise the total stocking level. Because of size, quality, and ownership objectives, these lands are unlikely to achieve the productivity levels of industrial forests.

## THE CENTRAL POLICY ISSUE

The central policy issue for meeting the wood needs for the 1970's and 1980's is: at what rate should the old growth inventory on the national forests be converted to well-managed new stands to meet both current and future timber needs. The Panel recommends that national forest timber sales be brought up to and maintained at allowable harvest levels on all forests where there is sufficient volume of market demand. It further recommends review and revision of allowable cut determination policies to make the timber output from the national forests more responsive to national timber supply needs. Rotation period determinations, stocking objectives, and old growth management policies can be adjusted for this purpose within established sustained yield principles.

While sustainable annual harvest determinations should be made for each geographic or economic area of national forest lands, the Panel disavows any need for a strict "even flow" harvest policy at the national forest level. This recommendation is contingent on adequate provisions for financing whatever intensified timber management is needed to support the higher rate of cutting.

The remainder of the 1970's is a crucial time for action to insure future timber supply. The harvesting of presently standing timber, both old growth and second growth, will continue to be important for a few decades; but, increasingly, harvest will consist of wood grown after 1972. For the truly long run, 2020 and beyond, it is timber growth which is all important; and available timber volume in those decades depends upon measures to increase growth taken in the 1970's and 1980's. It is only confidence in a future supply of new timber that makes defensible a recommendation to accelerate harvest of present old growth.

## OPPORTUNITIES FOR IMPROVING PRODUCTIVITY OF AMERICAN FORESTS

The output of all products and services of the forests of the United States can be increased materially in the next decades at costs commensurate with benefits. Greater investments of capital, labor, and materials will be needed, but the most important need is for bold, improved quality management. Nontimber values of the forest can be thus increased while at the same time timber growth and harvest are increased. Not every acre can be made to produce more of everything at an economical cost, but total productivity of American forests can be increased greatly for all purposes and at reasonable cost.

Timber growth per acre can be increased in a number of ways. After harvest, fire, windthrow, disease or insect kill, the salvagable timber should be promptly removed and the area regenerated by natural or artificial means. Where available and appropriate, genetically improved seedlings should be planted. If such seedlings are to be used, both economics and silviculture normally dictate thinnings and intermediate selective cutting and final harvest by clearcutting. Precommercial and commercial thinnings, application of fertilizers, and control of insect pests and diseases are all well-tested measures for increasing the growth and development of trees suitable for sawtimber and veneer. Prompt harvesting at maturity, together with immediate regeneration with a new stand before weed trees or shrubs take over the site, is always desirable and often essential for success. A proper balance between harvesting and inventory is essential for maintaining optimum growth rate.

The only source of lumber and plywood during the 1970's will be from trees of merchantable size now standing, whether grown here or abroad. Growth of additional wood on these trees, growth of wood on smaller trees now standing, and growth of trees to be seeded or planted in the future, may all add to the annual timber growth rate and therefore increase the current allowable timber cut even though none of the above trees be cut during the 1970's. Measures to increase growth on these lands are extremely important for the period 1980–2020.



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## National Forests

The Panel makes several recommendations designed to help the Forest Service meet the legitimate interests of citizen groups and to facilitate the more efficient management of the national forests. The Panel is convinced that the present annual budgeting and appropriation practices handicap efficient Federal land management. Too little money is provided to prepare forests for present and future multiple-use requirements. Response to urgent needs for protection, salvage, and regeneration is too slow; they also provide inadequately for capital investment inherent in proper forest management. A better arrangement would be one in which national forest revenues and expenditures could be brought into some reasonable relationships and in which an adequate level of long-term funding for national forest programs, including higher levels of harvest, could be assured. The problem in achieving such an arrangement is great, because special programs for national forest administration, even though they be efficient, could create precedents for other aspects of government where they are not justified. Nevertheless, the Panel urges that continued study be given to this problem and that a long-term funding arrangement be instituted.

An immediate pressing problem is that national forest timber output is now declining at a time of unprecedented sustained demand for increased lumber and plywood production. The first step to increasing timber supply is to get national forest timber sales up to present allowable cut levels wherever there is that volume of market demand. Federal timber sales should be financed with accompanying manpower authorizations to a level so there is no fiscal restraint to attainment of this objective; otherwise there may be greater loss in receipts to the treasury than there would be savings in expenditures.

For the next decade, a greatly expanded program of quality forest management on national forests and elsewhere is recommended. The Panel is mindful that these are times of budgetary stringency and that this proposal requires large initial outlays of Federal funds in order to be effective However, well-planned and executed timber growing programs characteristically produce more income than expenses, thus producing net revenue to the Federal treasury. Such annual appropriations need not be treated as if they were current outlays. An apparent net cost outlay often results from transactions which, under any reasonable accounting procedures, produce a net income. The Panel recommends that public land management, particularly where wood is a major end product, be carried on under accounting and financing procedures that reflect the capital investment nature of forest management.

## Other Public

The Panel has noted the extensive forest lands managed by Federal agencies other than the Forest Service and by non-Federal public agencies. This category of forest land ownership is the smallest of the four in total commercial forest acreage and in sawtimber inventory, growth and removals. Nevertheless, "other public" forest lands rank second among all ownership classes in sawtimber inventory and removals on per acre basis. Many of the findings about management needs and environmental considerations for national forests apply to other Federal lands as well. Opportunities for improved productivity and better use of these public lands are both real and significant.

## Forest Industry

Forest industry lands are of better than average quality for timber production, are generally well managed, and are being brought under intensive management more rapidly than are other classes of forest land. Accordingly, the Panel's chief concern is with the institutional factors in the country which affect the forest industries' role in helping to mold and synchronize growth and harvests of timber on their lands with growth and harvests on the other lands supplying timber for American needs.

A factor that for decades has plagued the lumber industry and added to the risk in timber growing has been the sharp and erratic fluctuations in construction, particularly residential construction. Public programs to stimulate housing have tended to accentuate such fluctuations. Stabilizations of residential construction and other markets, would encourage continued and increased investments of private capital in timber growing and would help to maintain a favorable economic climate for encouraging intensive management of the forest industry lands.

### Other Private

A major goal of national forest policy must be to achieve, during the period 1990–2020, a relatively high timber harvest from nonindustrial private woodlands. Whether or not this goal will be attained depends largely on measures initiated in the 1970's and 1980's.

The immense area, low stocking, modest growth, and modest rate of harvest of the "other private" lands makes them the listless giant of forestry. If the growth rate of these woodlands could be increased to match that of the timber industry forests, the effect would be an increase of one-fourth in the average annual growth of all American forests. Part of the problem of getting more output from these lands is technical, part is economic, and part is motivational. Taking into account the present quality and stocking of timber on "other private" lands, one can only conclude that the current growing stock must be improved to serve as an effective "factory" to produce timber for projected future demands. The small area in the typical ownership makes many forestry operations unduly costly per acre, or provides only limited incentive to the owner to apply his resources to forest management. Many such owners are more interested in other benefits and values of their forest than growing wood for harvest.

A variety of public programs have been developed for these small private forests. Though they have aided some owners in practicing better forestry, it is clear that the overall performance of the "other private" forests is comparatively low. The possibility of a more effective type of program that involves aggregating small ownerships into larger operating units is explored in the Panel's report. Such a program would offer the economies inherent in large-scale operations while preserving for the forest owner most of the advantages of individual ownership.

Major hazards to investment in timber growing are ad valorem and other taxes. Forestry investment, because it must be made decades in advance of yield, is highly vulnerable to rapid increase in ad valorem taxes that may take as much as 40–60 percent of the gross revenue. This is especially likely to occur where land developments inflate values before the timber crop is ready for harvest.

The Panel believes that according capital gains tax treatment to timber crops has greatly stimulated investment in forestry by both industries and individuals. It further believes that without this tax provision the timber supply problem would be much more severe than now forecast.

## INCREASING THE EFFICIENCY OF WOOD USE

The Panel is aware that loss in potential timber supply occurs through present methods of harvesting, processing, and use. Economic factors all along the line have acted to delay fuller use of the wood that is grown. Where forests are accessible by roads, dead and dying timber can be salvaged; if pulpmills are nearby, defective logs, tops, and limbwood that otherwise would be left on the logging site can be converted to chips for papermaking. Average sawmills convert but 40 percent of the log into usable lumber, yet the more efficient mills convert up to 60 percent. Lack of an assured future timber supply is often advanced as a reason for not investing in modern machinery to attain such high yields. Competent experts have found that improved management alone can often meet the same standard. Construction designs and techniques are known that make possible savings up to 25 percent in the total timber required for house construction, but their use requires new labor skills, updated building codes, close inspection, quality control, and improved management of construction operations on the building site.

Steps are being taken by a number of firms to realize such savings in wood use. As lumber prices increase many others will be induced to do so. Government can hasten the process by granting small business loans, investment credit, and depreciation allowances for equipment, and taking such other measures as will encourage adoption of efficiencies in processing, distribution, and use.

## TIMBER IMPORTS AND EXPORTS

The United States has always imported some wood products, and in recent years has become an increasingly important exporter of wood products as well. Trade in wood products is relatively free; import tariffs are low, and exports are uncontrolled except for logs originating from Federal lands. Wood is heavy in relation to its value, and transportation costs, except by water, often prohibit long-distance movement of logs and lumber. Yet, the United States has a substantial comparative advantage as a producer of softwood; its logs (and to a lesser extent, its lumber) are being avidly sought by the Japanese who are large net importers of wood. Japan's pressing housing needs are leading to a sharply increased demand for logs and lumber. Most wood exports to Japan originate in the States of Washington and Alaska.

The United States imports lumber from Canada equivalent to more than twice the volume of our log and lumber exports. The Nation also imports newsprint from Canada and is likely to continue to do so; paper is exported to Western Europe and to Japan. Our imports of pulpwood, paper, and related products were 10 percent of our 1971 consumption. Our exports of similar materials were nearly half of our imports. Exports may be expected to increase in the near future.

Numerous proposals have been made to reduce, eliminate, or otherwise control log exports, particularly to Japan. Conservation and preservation groups opposed to increased timber harvest, timber processors interested in log supply for their mills, and consumers of lumber and plywood have all supported such restrictions. The Panel is concerned about the upsurge in log buying by the Japanese in late 1972 and early 1973 and urges the executive branch to negotiate a reduction to past levels.

There are substantial advantages, however, in retaining relatively free trade in forest products for the long term. Such trade brings in needed foreign exchange, provides more market stability for certain species and affords increased incentive for timber growing through increased prices for logs resulting from increased competition.

## ENVIRONMENTAL CONCERNS

Many citizens, conscious of the demands modern society places on our environment, criticize operations and management objectives on the national forests. They have found much that upsets them—erosion from logging roads, streams clogged with logging debris, spawning beds silted over, huge quantities of slash and defective material left on logging sites, and large areas clearcut thus offending their esthetic sensibilities. Some question if long-term forest management can be practiced without soil depletion.

The Panel has made a thorough inquiry into these and related matters. A careful review of scientific findings together with on site inspection revealed that most of such damage caused by logging can be avoided or minimized. Many of the fears that have been expressed are unfounded, misleading, or exaggerated, often due to extrapolation from an isolated case to forest lands in general. For example, Norway spruce, when grown in pure dense stands in Saxony, did produce an acid soil condition that reduced growth. This was corrected by mixed planting with alder, or more quickly by application of lime. A meticulous study of published evidence of soil depletion from forest management reveals no case in the United States, or in Europe where records extend over a period of 300 years, in which the removal of timber crops, as opposed to annual litter removal, has led to soil impoverishment. The average annual removal of plant nutrients due to harvested timber is in the order of 1 to 3 pounds per acre for phosphorus, up to 10 pounds for nitrogen and potassium, and somewhat higher for calcium. Such amounts are readily restored by decomposition of soil minerals, nitrogen fixation and additions from rainwater and dust. The accelerated nutrient release caused by direct sunlight following clearcutting is generally small in total amount and subsides quickly as new vegetation springs up. Erosion and plant nutrient losses from well-managed forests are therefore inconsequential compared with those that occur on comparably well-managed, and long cultivated agricultural lands.

Properly executed logging operations do not destroy wildlife habitat, though they may temporarily alter it. For ground-dwelling species such as deer and other large herbivores, timber cutting stimulates the growth of nutritious herbs, shrubs, and tree seedlings at levels reachable by ground feeding animals. Clearcutting does destroy feeding and nesting habitat of some insectivorous birds and may cause them to vacate cutover areas. Meanwhile, seed eaters move in to occupy the site. Within 3 to 5 years in the case of hardwood clearcuts, the tree canopy is restored and insect feeders return. The net effect of forest management, therefore, is to increase diversity in age-classes of timber which in turn favors diversity in species of birds and other wildlife.

Weather hazards during the construction process preclude the possibility of assurance there will be no soil erosion from roadbuilding, but constant care and vigilance can keep undesirable soil movement to tolerable and correctable proportions. Means of reducing and eliminating such damage are known and need to be applied. Revision of the contractual relationship so that the logger is per-forming contractual services to the Government and can be denied payment for substandard work will help. Most logging damage on national forests has occurred because of a lack of sufficient competent manpower to effectively plan, coordinate, and supervise field operations.

Large amounts of defective timber and logging slash are inevitably left when old growth timber is cut. In fact much debris is already on the ground in old growth timber but remains unnoticed until revealed by harvesting. Fortunately, as mentioned above, it is becoming feasible to remove much of this material for pulp chips whenever mills are nearby or the chips can be loaded on ships for export, primarily to Japan. Unsightliness for a brief period until the new stand reaches 6 to 10 feet in height can scarcely be avoided following harvest of old growth timber.

The Panel finds that the Nation faces neither scarcity of forest land, nor standing timber; neither scarcity of forest wildlife, nor recreational opportunities, nor existing and potential wilderness areas. It finds further that timber harvesting, where properly planned and supervised, does not cause floods, significant soil erosion nor impoverishment of wildlife habitat. However, the potential for modern logging machinery, when improperly used, to cause significant damage should not be dismissed, nor should the need for careful supervision of logging operations be disregarded.

## FOREST POLICY BOARD

There is no single agency or group whose sole or primary concern is national forest policy, and none that brings total forest policy issues to a focus or, better, avoids or resolves crisis problems. Forest policy in the United States is made by a multiplicity of Federal agencies, private groups and individuals. The very existence of this Panel is evidence that a different approach is needed at the Federal level. A Presidential forest policy advisory board or council, reporting to the President or other appropriate offices in the White House and with members appointed by the President and serving at his pleasure, will provide a satisfactory device for achieving a desirable focus of forest policy. Decisions on forest policy would still have to be made by the President and the Congress, and ultimately by the whole electorate, but issues could be more sharply defined, extraneous matters more quickly disposed of, and alternatives for the future more clearly drawn, by such a board than in any other way.

## CONCLUSION

The forests of the United States present opportunities for better service to the American people. To be sure, there are many problems in the best management of forests of different ownerships and of diverse physical characteristics; but problems are also opportunities.

The Panel's considered judgment is that growth on all forests of the Nation, considered as a whole, might well be doubled by 2020 by a reasonable increase in management input.

Forests are not merely growing in the physical sense; they are growing in importance, in economic output, and in social possibilities as well. The challenge to the Nation and to those directly involved in forest management is to optimize forest multiple-use potential.

The full report provides considerable detail as to how this can be accomplished. The major recommendations address the balanced goals of increasing the productivity of forests for commodity and noncommodity uses in ways which protect and enhance the quality of the forest environment and of American life.

# Part II — REPORT

# Man's Use of the Forest Environment[1]

Forests occupy almost one-third of the land area of the world and support a biomass and have an annual rate of productivity exceeding that of agricultural land and oceans combined.

At the time of the European settlement of America, almost one-half of our land was forest or woodland. Even though this has been reduced by extensive clearing for agriculture, urban areas, highways and other uses, one-third of the Nation remains forested with a pleasantly diverse coniferous and deciduous flora. The wide variety and quality of species and the productive capacity of soil and climate give U.S. forests an unrealized potential for all uses, including additional softwood growth that is unsurpassed in the world.

## IMPORTANCE OF FORESTS TO MAN

Forests have a major role in our daily lives. They are the greatest converters of solar energy to chemical energy of any vegetative type. Moreover, they do so more economically than any solar engines, converters, or heaters man has devised. Because of the possibility of converting wood cellulose and lignin into sugars, pentosans, alcohol, fodder yeast, and other products through various biological and chemical means, the ultimate utility of forests can be greatly increased.

Forests also play an indispensible role in creating and preserving a quality environment. They build and protect soil, filter water, preserve watersheds, and carry on photosynthesis, the basis of every food chain. They improve the quality of the environment by providing sound and wind barriers; help to prevent floods by detaining and then slowly releasing water; act as air-conditioners that filter, cool and humidify the air through transpiration (the release of water into the air through leaves and needles); provide suitable habitat for plants and wildlife including rare and endangered species; and furnish raw material for lumber, plywood, paper, and other wood products.

Forests provide important amenities to life that contribute materially to quality living. Picnicking, hiking, camping, and wildlife study all bring satisfactions we would never want to do without. If forests or wooded corridors extend into an urban area, they can attract some forms of wildlife to the urban doorstep. Forests are also helpful in absorbing carbon dioxide, releasing oxygen, muffling noise, and collecting dust from the air.

Forests supply one of the major natural resources for our domestic and world economy—wood. The variety of uses is almost infinite. Solid wood products are used in residential construction and other buildings, furniture, boats and ships, and in many other products. Wood fiber is the basis of paper and paper products. Wood-based economic activities contribute some 5 percent to our gross national product.

Psychic rewards and forest recreation opportunities also have values that cannot yet be measured. The inherent qualities of strength, resilience, shelter, and beauty of forests inspire emotional ties long celebrated in literature, art, and music. Old growth stands are preserved and guarded by people today because they have esthetic qualities, offer solitude, and are living reminders of our heritage. Trips into the wilderness offer a test of

[1] For detail on the material covered in this chapter see "Appendix C: Softwood Sawtimber Supply and Demand Projections," by Robert Marty; "Appendix L: Maintaining Timber Supply in a Sound Environment," by David Smith; "Appendix M: The Impact of Timber Harvest on Soils and Water," by Earl Stone; "Appendix N: Timber and Wildlife," by William Webb; "Appendix O: Forest Recreation: An Analysis With Special Consideration of the East," by the Panel staff.

physical fitness, resourcefulness, and fortitude. Forests provide opportunity for hunting, fishing, and trapping including opportunity for a participant to experience some of the excitement and satisfaction his ancestors must have felt while pursuing wildlife for sustenance.

## FOREST DYNAMICS

Forest communities and their associated environments function together in the transfer and circulation of energy and matter, thus forming an ecosystem. The parts of the forest ecosystem—climate, soil, water, plant cover, animals, bacteria, and fungi—are intricately interrelated. Soil provides three basic functions for forest vegetation: Root anchorage; essential minerals and nutrients; and retention, release, and filtration of water. Although soil supports life and is permeated by living organisms, it is not itself a living organism. Green plants including trees hold the basic secret of life—it is their capacity by aid of sunlight to convert carbon dioxide and water into sugars, starches, cellulose, proteins, and all other plant products. The leaves, stems, fruits, and roots of the vegetation provide nourishment for all animal life, including herbivores and carnivores, and for the decomposers—the bacteria, fungi, and minute animals—that break down the remains of all plants and animals. The end products of such breakdown are carbon dioxide, water, and the basic chemicals with which the plants started the cycle of life.

In forests the dominant organisms—trees—are long lived and seem to be permanent parts of the environment. Yet forests are dynamic as are all biological communities and change from season to season, from year to year, and from century to century. Even the longest lived tree is only a temporary occupant of a particular space, and even the most stable forest is subject to constant change. Natural forces such as wind, wildfire, storm, disease, and insects cause the longest lived trees to die and be replaced; in turn every forest modifies its own environment by changing soil characteristics and microclimate. As the forest changes, modifications accumulate and make the forest environment less suitable for one type of vegetation and more suitable for another. In this way a predictable sequence of biologic communities occupies an area over time as the dynamic process of ecological succession unfolds.

## MAJOR FOREST USES AND VALUES

The highly diverse forests of the United States are used for numerous purposes. Some uses are competitive with one another; e.g., more wilderness means less land available for intensive recreational development. Other uses are often complementary, so that the management which favors one will favor the other also; e.g., good watershed management is likely to mean good management for fish life. Still other uses are largely independent of one another. Later we will point out that the extent of the various uses of the forest land base is not fixed and can be increased or decreased by an investment of capital, labor, and management. The essence of forest policy is to devise and administer programs which best meet the needs of the entire public with a minimum of sacrifice of one use to another.

Precise information on the annual volume of forest uses is not available; indeed, it is extremely difficult to measure some of these uses in a quantitative way, even though they may be very important. Some data are available, however, for American forests generally, and additional data are available for the national forests. A discussion of some of the major forest uses follows.

### Water Use

Forest lands usually have significant watershed values; tree cover affects the infiltration rate and runoff, and the rate at which soil material enters a water course. Forests in temperate regions can develop only on land that receives 20 or more inches of annual rainfall; they supply 60 percent of the Nation's water for irrigation, industrial and municipal uses. The daily per capita use of water that in 1900 was 527 gallons had risen in 1970 to over 2,000 gallons. In 1969, percentage use for various purposes was: Irrigation, 39 percent, steam utilities, 32 percent, industrial, 21 percent, public water utilities, 6 percent, and rural domestic, 2 percent.

Watershed yield is dependent upon forested area, somewhat dependent upon forest stand, somewhat affected by timber harvest, but largely independent of the rate of forest growth. Harvesting of trees or any other reduction in transpiring surface, temporarily reduces the draft on stored and slowly seeping water, and so increases the amount that remains available for streamflow or ground water. But even the most drastic harvesting procedures likely to be used, if carefully performed, would have slight effects on peak flows from watersheds of any substantial area. The watershed function is thus compatible with other uses of the forest, given reasonable management of the latter.

## Forage Use

Forage from the national forests was very important at one time but is becoming relatively less important compared with total range use in the West. This is due primarily to relatively low forage value of forested range and the difficulties in managing herds in the forest as opposed to open land.

In 1867, there were approximately 2 million head of cattle and 5 million head of sheep grazing on the open range lands of the West. By 1940, the number of sheep on the western range had approached a maximum of 24 million and declined thereafter to a present day level of 11 million head. Cattle numbers, on the other hand, continue to increase. Much of the grazing that occurs on the western range is not on forested land. The national forest, however, in 1968 furnished forage for 1.5 million head of cattle and horses, and for 1.9 million head of sheep and goats. Cattle grazed on the national forests on the average for a period of 4½ months of the year and sheep for 2½ months. Fees are charged for grazing domestic livestock on western public lands. During the last two decades grazing was also increased substantially in the southeastern section of the country where cattle graze in the open grown pine forests and where swine feed on acorns and other nuts, pine seeds, and pine seedlings.

If domestic animal populations are properly managed and are kept off the range during periods in early spring when damage occurs from trampling of soft soil, they may use the forage of the forest with negligible damage to the ecosystem. In some cases their presence may be helpful, because grazing can often promote the establishment and growth of desirable tree species by reducing competing grasses. Sheep feed mostly above the timberline in summer where they find much low-growing vegetation, so in such cases there is no damage to forests. In today's forest these domestic animals perform a role somewhat comparable to that performed in earlier centuries by the wildlife of that time. Cattle have taken the place of buffalo and elk; sheep to some extent have replaced antelope, mountain sheep, and mountain goats; and swine forage on lands formerly used by wild turkeys.

## Wildlife

Growing urbanization during the current century has removed an increasing percentage of our Nation's people to locations too distant from productive wildlife habitat for them to enjoy hunting, fishing, or trapping as a daily or weekly form of wildlife use. Even so, interest as measured by numbers of fishing and hunting licenses issued is intense. In 1971, fishing license holders numbered 25,751,494, an increase of 1,316,814 from 1970. Similarly, hunting license holders numbered 15,977,588, a rise of 607,107 from 1970. If properly regulated so as to maintain a favorable number and balance of game species, hunting, fishing, and trapping cause only limited impact on the forest ecosystem. If these uses are not properly regulated, they can have a serious impact eventually resulting in elimination of a given species.

There is a serious lack of data about wildlife in forests generally, particularly about trends in nongame populations and species composition. Wildlife generally have increased in forests of all types in recent years—though not, of course, every type of wildlife in every local area. On the national forests, estimates of the amounts of forage taken by the larger grazing animals indicates that by 1960 game animals were removing more edible forage than were all domestic livestock.

Nonconsumptive uses of wildlife have little or no adverse impact on forests or on the wildlife itself. Such uses include intensive academic study of wildlife patterns as well as casual observation for personal satisfaction or hobbies such as photography and fine art. If not too intense and concentrated, such uses add meaningful dimension to forest outings without harm to the ecosystem.

Part of forest dynamics is the changing patterns of wildlife populations as forests are changed either naturally or by man. Wildlife is therefore responsive to and affected by forest area, stand characteristics, tree harvest, site quality, and total land management objectives. If use of land is for wilderness, there will be no manipulation of the cover by man which means that wildlife populations and patterns are under less active control, protection, and development than in a managed forest. If a forest area is actively managed for intensive camping, natural wildlife patterns will differ from those in wilderness areas, but will not necessarily be better or worse. These patterns will be different again in a newly harvested forest, a young stand, and an old growth forest. Trouble occurs only if wildlife populations exceed the carrying capacity of the range. In such cases population reduction becomes necessary either by acts of man or by starvation.

## Recreation Use

Forest recreationists are legion and their number is increasing rapidly. They include picnickers, campers, hikers, backpackers, cross-country skiers, snowmobilists, trail riders, hunters, fishermen, nature photographers, and many, many more. According to the U.S. Forest Service, in 1971 America's recreation-seeking public spent 184 million visitor-days [2] of outdoor activities on the lands of the national forest system. This is a 6 percent increase in 1 year.

As use has increased, facilities to provide for public accommodation have been expanded. Between 1956 and 1970, the number of outdoor recreation areas increased by 45 percent. The number of State parks alone increased from 2,100 to 3,200.

The extent of use of Federal outdoor recreation areas and State parks is shown in table 1-1. Three points are especially noteworthy in this table:

1. The very high degree of use of State parks and their relatively modest area. State parks accommodated 48 visits per acre of park land in 1970 whereas national forests accommodated but one visit per acre.

2. The national forests provided about four times as many visitor-days of use as did the national parks.

3. The least intensive use of all, wilderness, still accounted for 5.8 million visitor-days of use or one visitor-day per 1.8 acres of wilderness.

Statistics are unavailable on the extent of recreaction use of private forest land. It is known, however, that a high percentage of lands owned by forest industries are open for public recreation, usually without charge. Similarly, most of the 4 million farmers and other nonindustrial owners of private forest lands permit hunters, fishermen, hikers, and others to use their land for recreation, largely on a nonfee basis. The total use of public and private forests for outdoor recreation is certainly much greater than 625 million visits per year and perhaps is 1 billion visits or more.

[2] Visitor-day: The presence of one or more persons on land or waters, generally regarded as providing outdoor recreation, for continuous, intermittent, or simultaneous periods of time totaling (usually) 12 hours. Thus, one visitor for 7 hours and a second visitor for 5 hours constitute one visitor-day.

**TABLE 1-1.—Large Outdoor Recreation Areas and Their Use, 1970 [1]**

| Type of area | Number | Area (thousand acres) | Number of visits (millions) |
|---|---|---|---|
| National parks [2] | 35 | 14, 464 | 45. 9 |
| National monuments [2] | 85 | 10, 223 | 16. 0 |
| National recreation areas [2] | 13 | 3, 809 | 11. 5 |
| National forests [3] | 154 | 219, 826 | 172. 6 |
| Wilderness areas [4] | 85 | 10, 258 [5] | 5. 8 |
| Wildlife refuges [6] | 320 | 29, 000 | 18. 0 |
| State parks [7] | 3, 202 | 7, 352 | 354. 8 |
| Total | 3, 894 | 284, 674 | 624. 6 |

[1] This table was prepared by Neil Stout of the U.S. Department of Interior, Bureau of Outdoor Recreation, and is used in "Forestry and Its Career Opportunities," 3d edition, by Hardy L. Shirley, McGraw-Hill Book Co., 1973 (in press).
[2] *Source*, National Park Service.
[3] *Source*, Forest Service (visitor-days).
[4] *Source*, Wilderness Society and Forest Service (visitor-days).
[5] *Source*, 9,925,000 acres included in national forests. Remainder in wildlife refuges.
[6] *Source*, Bureau of Sport Fisheries and Wildlife.
[7] *Source*, Bureau of Outdoor Recreation (data as of 1967).

Total recreation visits on national forests rose from less than 30 million in 1950 to about 200 million by 1972. The increase has been paralleled by a similar increase in timber harvesting on these lands. To some extent, the two developments are complementary and mutually supportive in that building additional roads for timber harvest has opened up land for all forms of recreation uses including wilderness lands formerly inaccessible. To some extent, each of these uses is independent of the other because none depends on another for its implementation. Yet the two developments reflect increasing and intense economic and social trends. Clearly, on the basis of this record, one cannot reasonably assert that timber harvest has inhibited or prevented recreation use of the national forests. Outdoor recreation requires that some forest land be devoted to providing parking lots, picnic and camping areas, scenic trails and lookout points, and preservation of scenic features. Recreation thereby becomes the dominant use of such areas. Open woodland is generally preferable to dense high forest for areas of concentrated use. Timber cutting is restricted to that necessary to achieve the desired forest cover during the development of facilities, and to removal of hazardous trees thereafter. Beyond the limits of concentrated use and of an appropriate buffer zone, timber harvesting is permissible if care is taken to minimize unsightliness along access roads and in scenic vistas. Forest management including harvesting old growth timber improves forests for many recreation uses, for in addition to improving access it introduces variety in timber age classes that increases game carrying capacity, diversity of bird species and other animal life, and permits growth of shrubs and herbs that are shaded out by dense high forest cover. In fact, the most intensive type of silviculture and forest management is required to maintain the vigor and health of forest cover on areas subjected to intensive recreational use. In many cases periodic rotation of intensive recreation use from abused forest to rejuvenated forest is essential to perpetuate an attractive forest cover.

The timber productivity of the land is not a significant factor in most recreation use because many forms of outdoor recreation can be as satisfying on sites of low timber productive capacity as on that of high capacity. Some factors, such as relative absence of rain and a less dense cover and understory, that cause a site to be of low timber productivity can also encourage recreation use.

Recreation use of forests has negligible impact on the forest environment except at heavily used areas such as at or near roadsides, parking lots, picnic areas, campgrounds, trails, lookout points and other places of major attraction. People in numbers often compact the soil, disturb animal life, and trample and otherwise threaten some populations of plant species. Recreation impacts on the forest environment are unavoidable from the necessity to provide picnic tables, shelters, fireplaces, toilets and bathhouses, a safe and dependable water supply, trash disposal service, litter cans, and trails to features of interest. Harm can be minimized but not eliminated by nature walks and guided tours led by experienced biologists during which the need for care to avoid misuse of the forest can be explained. Bird lists, flower guides, tree guides, numbered points of interest along a self-guided trail, and other simple devices also may be used by forest managers to stimulate a conservation interest and develop understanding by forest recreationists.

### Wilderness Use

Wilderness use is unique. It requires ecosystems substantially undisturbed by man or which appear to be undisturbed. Consequently, timber harvesting is precluded from these areas.

Protection of this use dates from 1924 when Aldo Leopold, then a Forest Service administrator, was instrumental in getting the 574,000-acre Gila Wilderness set aside from timber use by Secretarial action. By the time the Wilderness Act of 1964 was passed, the Forest Service had reserved a total of some 9 million acres for wilderness use and by 1972, approximately 15 million acres was in official wilderness and primitive areas including some national park and national wildlife refuge areas.

While the numbers of visits to wilderness areas are relatively a small part of the total number of recreational visits to the forests, the use of wilderness areas has risen at least as fast, proportionately, during the last decade as has total recreation use. At the same time, it may be argued plausibly that the opportunity for wilderness experience has declined somewhat, as access roads have opened up national forest areas for timber harvest and for more intensive recreation. Wilderness areas have generally become more accessible—a factor which makes their use greater and their protection against overuse more difficult. The privacy of wilderness areas—a factor critical to their value—is at least as much threatened by heavy recreation use as by timber harvest.

The essence of the wilderness experience is being alone, enjoying solitude, experiencing certain attitudinal reactions to the landscape whether these are well-grounded in fact or not—if one imagines one is alone in a vast wilderness, it may be as satisfying as actually being alone. For at least some wilderness users, encounters with other people reduce the value of the whole experience. The wilderness experience requires relatively very large areas of land. Volume, age, and growth of the timber stand are of secondary importance as long as the fact or the illusion of "naturalness" is maintained; timber harvest is likely to be antithetical to wilderness experience, except at very long intervals; and the wilderness experience is more or less indifferent to the site quality of the forest. Of all the many uses of the forest, the wilderness experience is least tolerant of other uses, least capable of being integrated with other uses, least improved by investments of capital, labor, and management—though some such opportunities exist—and serves fewer people per acre of land.

## Scientific Use

Federal, State, and other agencies have designated over 500 research natural areas which represent individual vegetative types or ecosystems that are to be preserved unmolested for the indefinite future. By making available these areas for study, it is hoped to better our understanding of the relationship of natural vegetation to soil and climate under conditions of minimum human disturbance. This kind of preservation is essential to a scientific understanding of our natural environment and constitutes a restricted use, as does wilderness. For instance, to study the water cycle, particular watersheds must be used by qualified forest hydrologists just as has been done at the Coweta Forest Hydrologic Laboratory, N.C., and at Hubbard Brook, N.H. Some forest areas are set aside for other experimental purposes. In these, various concentrated experiments are conducted where they can be kept free from unregulated logging and other human disturbances. If timber cutting is done, it is almost always carried on with an experimental objective in mind, with the result that these forests can often serve as centers for demonstration and training grounds for other forest officers and for special tours for citizens to acquaint them with the methods and the results of forest research.

## Timber Use

Lumber is the major component used in the framing and general construction of single-family, owner-built homes and low-rise apartments. Wood is the preferred material for the manufacture of household and office furniture and the major source of fiber for manufacture of paper and paper products. The forest products industries make a significant contribution to our national economy accounting for 7.2 percent of all employment in manufacturing, distribute 6.4 percent of all manufacturing payrolls and create 6.5 percent of the value of all manufacturing. Forest-based economic activity as a whole accounts for 5 percent of the gross national product. This major role of wood in the United States is in large part due to its widespread availability and relatively modest cost, the ease with which it can be machined and fabricated, its physical properties of high ratio of stiffness to weight and strength to weight, its favorable insulating properties compared to other materials, and its esthetic appeal for furniture and decorative use.

United States forests have also provided logs, lumber, woodchips, pulp, and paper for export to other nations thereby strengthening our Nation's role in the world economy. The products exported have generally been those surplus to the needs of our own economy. Their export has added to employment and has made possible use of much material that otherwise would have gone to waste or would have been discarded.

The total volume of wood harvested annually from all forests was relatively constant from 1900 until 1966, except during the depression years when a sharp decrease occurred. The uses of wood, however, have changed greatly over the years. The amount of wood used for fuel has declined from more than a fourth of the total to much less than 10 percent. The amount of wood used for other products—poles, posts, pilings, etc.—has also declined somewhat. More than offsetting these declines has been the rapid increase in use of domestically produced wood for veneer, plywood, and for pulp and paper. Today these three uses take nearly half of the total wood harvest; lumber use takes the other half.

It is an interesting paradox that over the long run no more timber can be harvested than is grown, and that no more can be grown on a given land base than is harvested by man or natural mortality. While the forest land base is finite, the ability of man to apply science and technology to increase the growth of the genetically primitive plants—trees—is very great. An objective of forest management is to maintain both growth and harvest at optimum levels for human use.

In a modern society, everyone who reads, buys anything packaged, or lives in a house, is dependent upon wood production. Wood is the chief—often the only—salable product from a forest. Its production provides the only incentive for much private forest land ownership. The relationship of timber growth and harvest to other uses of the forest has already been described and need not be repeated. Under some circumstances and some methods of forest management, timber harvest has had severe adverse effects upon other uses of the forest. Nearly all of these are avoidable, without excessive cost, with reasonable management. Timber production is compatible with most other uses of the forest, is the economic base upon which most forest management must depend, and produces a raw material of great value for the whole societv.

## COMPATIBLE AND INCOMPATIBLE USES

The Multiple Use-Sustained Yield Act of 1960 states:

> It is the policy of the Congress that the national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes.

The act also states that the resources of national forests are to be managed

> * * * so that they are used in the combination that will best meet the needs of the American people.

The act recognizes that not all uses can be exercised on the same area, but on a national forest most major uses can be accommodated. The extent of all forest uses has increased to the point that demands on the limited forest land base can be met only through deliberate allocation of forest uses and management for those uses. Some lands, because of biological or physical characteristics such as steep slopes or fragile soils, must be managed for uses of less impact than wood harvesting. Even with single use management, however, forest lands yield multiple outputs. For example, management of some forest lands for water supplies would not limit the value of the lands as wildlife habitat. Other forest lands have the capacity to be managed for many coexistent uses that are compatible on the same or closely intermingled tracts of land. Watershed protection, recreation use, grazing, and properly regulated timber harvesting may all be compatible uses depending on land capacity and relative demand levels.

Incompatibilities arise when the esthetic or other values of a particular user are not in accord with those of another user. Recognizing the need for segregating incompatible user groups is essential for preserving the enjoyment of users of the forests and for protecting forest outputs. Within the recreational use groups alone, snowmobilers are objected to by cross-country skiers, and off-road vehicle types offend backpackers when on the same trails, and hunters offend some of the birdwatchers. The requirements for wilderness and scientific use also make active management for other uses incompatible.

Use of forests as watersheds is incompatible with uses that might contaminate municipal water supplies; yet often whole forests can be managed for a number of seemingly incompatible uses even though single component areas must be managed for but one or two uses at a particular time. For instance, wilderness use and timber harvesting can be compatible uses within a forest because areas that possess desirable wilderness characteristics tend to be those less suitable for intensive timber management and harvest.

## VALUATION OF FOREST USES

With the exception of timber and forage that can be measured and sold, benefits that forests contribute to people's welfare redound mainly to the populace as a whole and rarely have a price set upon them. Among these are the protection of soil and watersheds, shelter for a host of wild creatures, preservation of seed stock of native plants and animals, and provision of natural beauty of forests and the amenities they add to suburban and rural life. It is equally difficult to attempt to assign dollar values to the enjoyment of wilderness, hunting, fishing, and trapping, to the many other kinds of recreation enjoyed in the forest environment, or the use of forests by scientists to discover new natural laws. As these benefits are neither quantifiable in physical terms nor valued in a marketplace in dollars, people differ widely in opinion as to how much tax money should be expended to protect such intangibles on public forests or how much favorable tax treatment or other inducements should be granted private forest owners for providing such services for the general welfare.

In a way, this lack of quantifiable value is unfortunate for some of these "noncommodity" benefits are of great public significance, perhaps equally or more important to national welfare than is timber. Many individuals, in fact, value the environmental protection and amenities of forests far above their use for timber products. In order for forest management and use allocation to reflect the priorities of the people, intangibles must be given consideration along with measurable forest uses. Until a system of measurement is developed, this is indeed a difficult task which will always involve controversy.

## STEWARDSHIP

Forest stewardship means management without deterioration in quality. It encompasses respect by forest owners and users for the physical and biological integrity of the forest ecosystem, and for optimal, long-term returns therefrom. If we are to enjoy the benefits of forests, they must be constantly managed and used in a way that their multiple yields will be both currently enjoyed and sustained indefinitely.

The Federal Government has several responsibilities with respect to the forests of the Nation. First, it must consider protection and enhancement of the total forest resources on a nationwide scale for much of the wealth of the Nation is based on its natural resources. Second, the Government must manage the forests for the important intangible values as well as for those with monetary and commodity value. Finally, the Government must manage the public forest lands in a way that harm to private lands is also avoided. In this respect, it must take into account the duties of the Government both as sovereign and proprietor. The Forest Service and other agencies in charge of public forests should have a specific concern for financial costs and returns. Investment in programs that do have a measurable return such as investment in timber management should be efficient. The agencies also need to consider the effectiveness of investing in private versus public programs, and the effect of public land management on the sustained yield capacity of private lands.

Although private forest owners and users do not have an assigned public responsibility, they too should act as trustees and stewards as well as proprietors: ideally, the private forest would receive the highest intensity of management to create yields of products and services consistent with economic constraints. The development of a forest is a continuous process that extends over generations and centuries such that a forest cannot really be owned by any one person. Nor can values that forests offer be restricted to any defined area or enjoyed only by one person. A person can modify the forest during his proprietorship and the modifications can have far-reaching effects. Each human generation is privileged to use forests and should feel obligated to pass them on to succeeding generations unimpaired in quality and productivity.

Because of the great importance of the forests to the American people,

The Panel recommends:

> That the President issue a statement or proclamation to the Nation, recognizing the role of forests in our history, their vital contributions to the quality of life, and the need to manage the total forest resource so that future generations can have as much or more of all forest products and amenities as has the present generation.

# Impacts of Timber Harvesting and Production on Environment[1]

One aspect of the currently expanded public concern for environmental preservation is objection to timber harvesting generally and clearcutting in particular. Since the problem of reconciling continued and increased timber production with increasing recreational use of forests led to the creation of the Panel, the impacts of timber harvesting and production on the environment have been matters of prime importance in its deliberations. Fortunately, much scientific knowledge exists about these impacts and the Panel has been able to persuade distinguished scientists to bring together this knowledge.

The Panel has tried to consider the full range of the biotic and social environments that might be affected by timber harvesting and forest management. The biotic environment includes all the plants and animals in the forest as well as those outside that are influenced by the forest or which affect it. The physical influences considered include the physical habitat, the chemical properties of forest soils and water, and the nature of the gases escaping into the atmosphere; the temperature of air and water in the forest, and associated factors. Enough of the factors are measurable in conventional physical and chemical terms to form reasonable judgments of how timber harvesting affects them. The social environment involves the full range of human demands on forests. Thus, economic and political forces influence decisions affecting forests as well as do biotic factors. It is noteworthy that management of forest soils is of keen importance. Allocation of the land base to a particular treatment is made easier and all silvicultural and harvesting practices are easier to agree upon once attention is focused on soils.

The goal of forest management is to maintain an ecosystem which is balanced in terms of natural factors, unimpaired as to productivity, and structured to respond to the requirements that human society may place on the forest. Thus, if it is socially desirable to grow subclimax tree species,[2] silvicultural practices that bring about such stands are carried out. In the management of timber, a sale is viewed as a silvicultural means to harvest the old crop and to start a new one. Thus, long-term and short-term economic, esthetic, environmental and other objectives are thereby integrated directly with timber production.

As will become clear in this chapter, it is not the temporary elimination of trees, but the techniques connected with the removal of the fallen trees, that is the primary cause of environmental harm.

## IMPACTS OF TIMBER HARVESTING ON THE PHYSICAL ENVIRONMENT

### Water Yields

Although cutting trees affects water yields of forest streams by reducing transpiration, the increased yields are rarely detrimental and usually last for only 1 to 4 years except where regrowth of

[1] Detailed information on material covered in this chapter is found in "Appendix L: Maintaining Timber Supply in a Sound Environment," by David M. Smith; "Appendix M: The Impact of Timber Harvest on Soils and Water," by Earl L. Stone; and "Appendix N: Timber and Wildlife," by William L. Webb.

[2] Subclimax tree species—one that, in the absence of fire or other ecological disturbance, eventually will be replaced on the site by some other species (the climax) capable of sustaining itself indefinitely under a given climactic regime.



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vegetation is deliberately prevented. In some watersheds streambank vegetation is cut expressly to increase water yield. Increases in yields are determined by season of the year, amount of cover removed, storage capacity of the soil, and rate at which regeneration occurs. The more canopy removed and area cut, the greater the decrease in transpiring surface, and the greater the immediate increase in water yield.

During the dormant season, storage capacity of uncut stands differs little from that of partially cut or clearcut areas. However, during the growing season vegetation on uncut stands removes ground water and creates a temporary water deficit. This does not occur to the same extent on lands that have been cut, and in this case relatively more water is available for streamflow with the timing of flow somewhat altered from that of uncut forest stands.

Both the type of forest and density of stand affect the amount of snow to reach the forest floor and the buildup of the snowpack over winter. Conifers, which retain their foliage year round, intercept a large percentage of the total snowfall. Much ultimately reaches the ground but substantial amounts are returned to the atmosphere from sublimation and evaporation. Harvesting conifers by strip or group cutting tends to increase snow accumulation and to extend the period over which runoff from snow melting occurs. Hardwood forests intercept less snow and cause less delay in the melting of the snow that does accumulate than do conifers.

In actual harvest operations, the amount and timing of flow is affected by differences in soil storage possibilities, the effects of logging disturbances on soil, and the percentage of the total watershed cut. Harvesting procedures that are carefully managed should have but slight effects on peak flows from any substantial area. Various studies suggest there is no neat prescription to be followed; every watershed must be examined on its own merits. Nevertheless, it may be a wise precaution to avoid clearcutting the entire area of an intermediate size watershed within a brief time period—for example, 5 years—if high peak flows are both probable and detrimental to downstream values.

### Nutrients

Cutting or otherwise killing trees leads to release but not necessarily loss of nutrients. Although trees absorb appreciable amounts of all the essential elements each year, only a fraction is deposited in the stem and larger branch wood, the portions that are removed from the forest for industrial use. The nutrients in foliage, twigs, roots, and fruits are not removed from the forest and so return to the soil for decomposition and subsequent reuse. Thus, increased nutrient release after cutting comes in part from the release of nutrients from decaying tops and roots of cut trees, but mainly from the decomposition of leaf litter and soil organic matter accelerated by solar heating of the exposed forest floor.

Nutrients lost from the forest through the removal of timber, land clearing, cultivating, and erosion are replenished through soil weathering, nitrogen fixation, and atmospheric additions. Many thrifty forests now grow in the Northeast, the South, and in Europe on lands formerly cultivated and eroded. Such forests demonstrate the widespread ability of soils to reaccumulate nutrient capital. Elsewhere in North America, great expanses of even-aged forests can be found growing on old burns and windfall areas, thus demonstrating the capacity of soils to supply nutrients for a new forest after complete destruction of the old forest (often including destruction of the entire surface organic layer).

The Panel concludes that popular concern in some quarters that timber harvest or other professionally acceptable forest management practices may seriously deplete the forest soils of nutrients has no scientific basis. The harvest of trees and even limbs at infrequent intervals removes relatively low amounts of soil nutrients per acre on an annual basis—far less than the suburbanite removes by his annual raking and disposal of leaves. Nutrients are replaced in forests that have been cut by decomposition of material that remains and through other natural processes. Only the most remote likelihood exists that soils of the commercial forest of North America would be significantly depleted by normal levels of timber harvest, possibly excepting sandy soils of the southeastern coastal plains where phosphate fertilizer application is already coming into routine use. Further, numerous scientific observations by soil specialists lend no support to assertions that forest soils may be irrevocably depleted of nutrients by clearcut harvests at reasonable intervals. In such a remote case that soil deficiency did occur, it could readily be corrected by application of fertilizer as is routinely done in modern agriculture.

### Soil and Soil Erosion

It is not the act of cutting trees or their absence from a site that causes harm to soils. Damage is caused through erosion resulting from the removal of the protective organic cover and from the unprotected exposure of mineral soil. In forests, road construction is the primary cause of soil damage. Studies made to date estimate that 90 to 95 percent of soil loss by erosion results from exposed soil in cuts and fills of roads and from concentrated water runoff on poorly drained roads.

Roads on gentle to moderate slopes in stable topography pose few problems except through careless handling of soil moved during construction. Hazards mount when roads are pushed into steep terrain, on erosive soils or unstable soil, or when they encroach on stream channels. The amount of soil and water damage depends on the proportions of surface covered by roads, the care exercised in their construction and maintenance, and their distance from streams. Approaches necessary to reduce or avoid damage from future road systems include giving much greater attention to soil and geological characteristics in planning, avoiding high hazard areas and improving engineering surveys, road design and construction methods. In most forested landscapes, erosion from roads and skid trails can be reduced and the effects on stream quality largely eliminated by applying the knowledge already at hand. The first approach to reduce any impact of timber harvesting demonstrably harmful to the physical environment is to regulate the construction and maintenance of logging roads.

Mass soil movement is usually in the form of slumps, slides, or avalanches. In steep landscapes with fragile soils, tree roots have an important function in reinforcing the soil mass, and in some instances anchoring it by penetration into fissured rock below. In avalanche country, trees tend to anchor snow on the slopes and decrease the rate of snow thaw. Destruction of trees on such sites whether by cutting, fire, or insects, is followed by decay of the old root systems and an increased risk of landslip for 4 or 5 years after the death of the old stand. Damage from mass slides depends mainly on whether they occur in or reach stream channels. Very little of the commercial forest land is on this type of site so that risk from this type of damage from timber harvesting is slight. It may be nonexistent if site selection is reasonably careful.

Heavy logging equipment may cause soil compaction. This varies with the type of logging; it is greatest with tractor logging and least with off-ground methods such as high lead, skyline, and balloon logging. Compaction may make subsequent tree growth difficult; its severity varies with the porosity of the soil and the severity of freezing and thawing that will tend to loosen the soil. This type of harm may be minimized by concentrating transportation on fewer main route roads, avoiding harvest on susceptible soils during wet weather when compaction occurs most readily, choosing favorable logging methods, or low-pressure-bearing equipment, and, when necessary, loosening and revegetating compacted areas.

### Watercourses

The primary causes of damage to watercourses are: Changes in the stream regimen,[8] and silting and turbidity caused by excessive runoff from logging roads, yarding and decking areas, skid trails and other heavily disturbed areas. There is little evidence that changes in total water yield resulting from logging has significant effects on larger streams.

Complete removal of vegetation along streams exposes the water to greater solar heating that may be harmful to fish. Careless logging practices such as dropping or dragging trees into or through watercourses may cause channel blockage, erosion, and oxygen depletion from decomposing organic matter. Such damage is controllable by proper supervision of operations.

### Slash Disposal

Leaving slash and logging residues on a harvested site has the positive effects of contributing to nutrient supply, sheltering soil and protecting seedlings. Unfortunately this practice hinders access for seedbed preparation and planting, is unsightly, and constitutes a source of fuel for potentially dangerous fires. Slash removal can be mechanical, can employ controlled fire, or can be a combination of the two.

In some instances fire is chosen as a means of

[8] Stream regimen: The normal pattern of flow for a stream over the course of 1 year.

slash disposal in order to favor certain species and forest communities. Fire can be used to influence succession, maintain habitat and scenic values, and reduce fuel accumulations.

Slash disposal has little long-term effect on soil if regeneration follows promptly. Adverse effects on productivity may occur when slash disposal methods are applied carelessly to highly erodable or infertile soils, or where movement of equipment with its load bares and harrows the soil, thus encouraging erosion.

Prescribed slash burning has only minor consequences for soil productivity. However, the absorbtive qualities of forest soils can be impaired by excessively hot fires that consume a large percentage of the organic soil cover. In some cases soil erosion that results from prescribed slash burning is sufficient to degrade water quality and impair fish habitat. Leaving buffer zones along streams can protect water quality until revegetating occurs, thereby further diminishing risk of soil loss and stream damage.

## ECOLOGICAL IMPACTS ON THE FOREST COMMUNITIES AND USE

### Wildlife

Timber harvesting changes the forest habitat by altering forest structure and leads to changes in species composition. Every species is a specialist, with its own tolerance to changes in the forest environment. Habitat preferences vary among species that tolerate little disturbance and those that find suitable environment only following the most severe disturbance.

When a three-dimensional forest habitat is reduced to an essentially two-dimensional environment by removal of tall forest trees, the general effect on the total wildlife population is improvement of habitat for those species specialized to live near or on the ground and destruction of habitat for species specialized to live in the canopy. Regrowth of the forest normally restores the three-dimensional character of the forest in a relatively short period of time and thus restores the original habitats. Since low canopy is created as early as the sapling stage, organisms specialized for this kind of habitat are soon reestablished and the community again resembles the one that existed before disturbance.

Forest management operations cannot be judged as good or bad for wildlife—only as good or bad for certain species, at certain times, in certain places.

In general, variety and abundance of wildlife are favored in forests that have a variety of age-classes and timber types and in which silvicultural operations are active and widely dispersed throughout the forests. Rare and endangered species, however, must be treated as separate cases. An example is management of certain jack-pine forests for Kirtland's Warbler. This very rare bird requires a jack-pine thicket with ground level branches as a habitat. This habitat is maintained by repeated burnings. The Forest Service has set aside certain areas on a national forest in Michigan where jack-pine is cut and periodically burned to maintain habitat favorable to the Kirtland's Warbler. Analogous efforts are being made to preserve the California Condor, the Bald Eagle and other endangered species of birds, plants, and animals (see app. N).

Logging may affect fish habitat by altering the composition of water in a stream and by changing the stream channel. Turbid water directly affects the survival of fish species by reducing light penetration which in turn influences the abundance of fishfood organisms. Furthermore, when suspended materials settle out in slack water, they cover the bottom with an unstable, unproductive layer which may smother fishfood organisms and developing fish roe, and may cover gravel deposits used by many fish for spawning.

Severe removal of vegetation along streams can seriously impair valuable fish habitat by changing water temperatures. This is especially true for smaller streams which serve as spawning grounds, where removal of shade can result in significant warming of the small water volumes. Relatively small amounts of vegetation along small streams can usually prevent deleterious variation in temperatures. These strips also protect streambanks from erosion and serve to filter silt from water flowing directly into streams. Logging debris dropped in streams and lakes damages fish habitat. Treetops, branches, and logs left in stream channels may prevent movement of fish, create sediment traps in slack water, add organic matter to water, decrease stability of bottom materials, and increase streambank erosion by deflecting currents. This can and should be eliminated by more careful logging practices.

### Recreation

Use of forests for recreation is influenced by economic affluence, time for leisure, and public policy. For example, an increasingly mobile and urbanized population tends to regard forests as esthetic and recreation resources and to minimize their importance as a source of raw materials, while at the same time it demands a greater supply of lumber, plywood, pulp, and paper. One of the basic tasks of management is to increase wood supply while keeping the ecological, economic, and other social values substantially unimpaired, both for the present and the future.

The forests in the Eastern United States are a case in point. They have been cut over repeatedly yet continue to be used intensively by recreationists. It is noteworthy that most of the delightful and popular State and county parks in the Eastern United States are located on forest lands that were repeatedly cut in the past and have since regrown to impressive new stands.

Use of forests for wood production does not prevent their use for recreation. Both public and many private commercial timberlands are available to the public for many forms of recreation activity, at little or no cost. People are excluded from these lands only during harvesting or a short period thereafter for safety and to assure the successful reestablishment of trees.

Harvesting actually promotes rather than impedes recreational use. Installation of logging roads makes accessible areas which were previously remote, thereby relieving pressure on overcrowded areas. Skidding trails furnish access for berrypickers, hunters, and birdwatchers. In the longer term, harvesting results in forest diversity which attracts a wider variety of wildlife and makes areas more interesting and attractive to people.

### Impact of Timber Harvesting on Esthetics

There seems to be little question that most of the recent public concern about timber cutting practice can be traced to its visual impact. Because it looks bad, people assume that it is bad. The immediate effect of timber harvesting is an unsightly area, particularly so if clearcut. Many visitors see an area only once. The fact that a treated area may, after a few years, again be beautiful may never be visually demonstrated to them, nor are they made aware that long-term timber management can increase the esthetic quality of forests by creating glades and vistas that add variety to the landscape. Fortunately, foresters have become sensitive to the appearance of forests and are modifying harvesting practices to minimize esthetic impact.

## INTENSIVE FOREST MANAGEMENT

In addition to the environmental impacts already discussed, forest management may introduce silvicultural impacts. What is referred to as intensive forest management includes increasing wood yield through proper stocking, spacing, planting with genetically improved stock, control of pests and disease, frequent thinnings with growth, and sometimes fertilization. For economic reasons alone it will be necessary to use the more intensive practices such as use of genetically superior stock, thinnings and fertilization on sites which are easily accessible, high in productivity, and most responsive to treatment. These sites comprise less than one-sixth of the national forest lands but a somewhat higher fraction of the lands in industrial ownership.

There is historic evidence to support the position that intensive forest management practices over several centuries in Western Europe have not resulted in long-term harm to the forest ecosystem. Mistakes have been made and most of them have been corrected. In general, managed forests have proven more productive than natural forests, and the soils that support them have become more, rather than less, productive (see app. M).

### Monocultures and Seed Stock

A concern frequently voiced about planting single-species stands from improved seed developed in seed orchards is that they will be more susceptible to destruction by insects and disease than will naturally seeded stands. This might be true if all trees planted had identical genetic composition. Forest tree seed, however, is produced by cross pollination so that the progeny has a rich and varied genetic makeup. In addition, parent selection for improved seed includes many clones—not a few—so that a broad genetic base is maintained. It cannot be denied that pure stands—monocultures—carry risks that stands of mixed species do not. However, such risks apply to monocultures resulting from natural seeding as much as to those from orchard seed.

Single-species plantations have also been called biological deserts, a statement that is inaccurate scientifically. Actually vast stands of southern pines, Lake States pine and west coast Douglas-fir occurred in the past in which one to three species constituted virtually the complete tree cover. In none of these three regions does the overhead forest exclude all shrubs and herbs from the forest floor nor does this occur in dense redwood forests. Southern pine forests support a rich and varied undergrowth that produces food for ground-dwelling wildlife, and the same is true in other regions. Following timber harvest such subordinate vegetation grows rapidly providing abundant, nutritious wildlife food.

### Fertilization

At the present time fertilizers are applied to forests in America to produce normal growth on naturally deficient soils or on soils depleted through past agricultural practice. No scientific evidence has been presented that indicates nutrient depletion occurs as a result of timber management, so fertilization plays a part in silviculture only in the areas cited. It is too early yet to assess fully the results of applications of fertilizers to tree plantations but experience in the United States and in various European countries, where fertilization of forests has been extensively tried over the past decade, has failed to show significant hazards. Responses, though not always fully predictable, have generally been strongly positive. Optimistic projections predict up to a twofold increase in yield. Physical and economic considerations will limit intensive practices to a small fraction of managed forests. Only in rare instances, should fertilization be required to maintain high rates of productivity.

### Pesticides and Herbicides

In forest management, the use of pesticides is a last resort. Chemical controls are not normally applied until intolerable damage by pests is either underway or imminent. The herbicides that are now being used appear to have low toxicity for animals and soil bacteria. As applied, their impact on soil and stream runoff is less likely to be harmful than are plowing and terracing.

Insecticides that are presently used are limited to a few characterized by low persistence and low toxicity to warm-blooded animals including man. The use of DDT and other chlorinated hydrocarbons which have proven to have widespread effects on the environment was curtailed during the late 1960's. State and Federal restrictions have limited their use in forests to the control of bark beetles and other insects that can be reached by spraying the tree stem. Major questions still exist about the effects of blanketing substantial areas with toxic chemicals by aerial spraying to control defoliators such as the gypsy moth.

Rodenticides and other mammalian poisons have been used in forestry to control animals feeding on seeds or young trees. A 1972 Executive order prohibits routine Federal use of chemical toxicants on Federal lands or in Federal mammal and bird damage control programs where primary or secondary poisoning of nontarget wildlife may occur. One of the basic shortcomings of all pesticides, but particularly insecticides, is their toxicity to nontarget organisms. A wider diversity of effective chemicals that are rapidly degradable and target specific is desirable.

### Future Implications

While it cannot be predicted precisely what may happen 20, 30, or 40 years from now as a result of intensified forest management, it is expected that few difficulties will arise with which foresters will be unable to cope. Continuing research efforts are needed to keep abreast of disease and insect populations and to develop methods for dealing with these and other forest problems.

The research patterns followed by agriculturists have been successful in protecting highly inbred genetic strains under intensive culture. In view of the far more natural and resilient ecosystems with which the forester will be working, techniques to be developed for forest management intensification should be even more successful.

## CLEARCUTTING

The practice of clearcutting forests when mature, in order to harvest standing timber and to create young even-aged second growth stands in the following generation, has come under attack in the United States within the past 5 years. The Panel has endeavored to identify the most knowledgeable and objective consultants (apps. L, M, and N) on the subject.

The issue of whether or not to permit clearcutting has become confused in the minds of many participants on both sides with the issue of whether or not to permit cutting at all. Many of the arguments used against clearcutting on the western national forests are in reality arguments against logging in any form or fashion. The basic decision on a given piece of public land is whether or not it should be devoted to timber production. If not, it should be reserved as a wilderness area or in a marginal land classification that exempts it from any timber cutting at all, either for an indefinite period of time or in perpetuity. Programs now underway to determine whether or not specific areas of land should be withdrawn from timber production should be completed expeditiously and carefully. Commercial forest lands not so reserved should themselves be dedicated to commercial timber production and should be managed for such in accordance with policies established by Congress and the executive branch.

Timber production on western national forests requires a well planned road system and a long-term plan for systematically converting old growth into second growth forests managed for high-level timber production. Such a program must be professionally developed and should be in accord both with basic principles of land stewardship and long-term economic considerations relating to the U.S. economy and to the best methods of maximizing the contribution of timber as a renewable natural resource to that economy. The professional forester must have the discretion to favor the most valuable species that are ecologically adapted to the site. As in agriculture, the vegetation found growing at the present time on a given site is not necessarily either ecologically the best or the best for the satisfaction of man's total needs.

Professional management should be held responsible for carrying out these tasks in such a manner as to minimize erosion and enhance the uses of the land for water production, wildlife production, and recreation. The methodology and availability of management tools should not be limited except as they relate to matters of public health and safety or unless there are other clearly established restraints that should be observed in the national interest.

Clearcutting is a recognized practice for growing timber in even-aged stands. It is a viable alternative in many forest management decisions and an essential one in others. If properly applied, clearcutting does not lead to soil erosion, nutrient depletion, wildlife habitat damage, or stream deterioration. Its use is compatible with long-term sustained yield forest management.

Clearcutting does have a generally adverse esthetic effect and this may be serious enough in specific instances and areas to merit the minimization or elimination of clearcutting. The undesirable esthetic effect of clearcutting, however, can be minimized and restricted to a matter of a very few years if the area of clearcut is small and if reforestation is immediate.

Permanent streams require special protection. Shade should be left to prevent water temperatures lethal to game and other fish; also care should be taken to prevent logging debris or silt from entering the stream channel. Where an adequate shade cover of alders or other small trees is present, it may be preferable to remove all of the old growth timber overstory in the logging operation rather than to leave an uncut strip along the stream margins. Individual trees in such strips may be wind-thrown into the channel, blocking it with debris that hinders fish movement and degrades water quality. Again, it should be noted that road construction along streams does far more damage than clearcutting along streams in a majority of instances.

Another special case consists of extremely steep and fragile sites. In such cases, either no cutting at all should be permitted or else cutting should be deferred until logging techniques are developed which will provide a high degree of safety in site protection. If cutting is feasible on such sites, however, clearcutting followed by immediate reforestation may often be better than repeated partial cuttings and should not be prohibited, either by legislation or by Executive order.

Clearcutting is often the only feasible timber harvesting method for regenerating old growth Douglas-fir on the west side of the Cascades, aspen and jack-pine forests in the Lake States, pine forests in the South, lodgepole pine in the Rockies, and similar valuable subclimax forest types.

In the Douglas-fir type of the Pacific Northwest a sharp distinction must be made between dense old growth stands on the better sites and second growth forests developing following earlier cutting. In the former type there is really no viable alternative to clearcutting under many circumstances. Repeated experiences with partial cutting over the years has demonstrated that, in the case of old growth Douglas-fir on the better sites, partial cutting will so open up the residual trees to ice damage, wind damage, and subsequent deterioration through attack by insects and disease, and from uprooting that the net growth of the residual forest will more often be negative than positive. At the other extreme, large-scale clearcutting is generally undesirable. The most desirable management, therefore, will often be small area clearcuttings in which the margin of the uncut forest is left so as to minimize wind damage to the standing trees and the clearcut area is of the optimal size for natural regeneration from seed from the marginal trees, for deer browse production, and for minimizing the esthetic impact of the cutting operation. In contrast, various partial cutting methods, particularly the shelterwood system, may be entirely practicable and desirable in second growth forests which have been managed and which have been thinned so as to develop over the years windfirm trees that can stand the exposure resulting from partial cutting.

The situation varies greatly from forest type to forest type and from forest site to forest site. For instance, most ponderosa pine forests on the east side of the Sierra-Cascade ranges can best be managed by partial cutting techniques and have indeed long been so managed. Higher elevation stands of lodgepole pine, however, can be harvested successfully only by clearcutting techniques, although the pattern of the clearcutting provides a great many options in management planning.

In the southern pine region, tree farming based on clearcutting and planting is eminently practicable on both economic and ecological bases. Southern pine trees can be managed by techniques analogous to those used for other agricultural crops and for other silvicultural crops such as pecans, apples, peaches, rubber, and bananas. The arguments for growing mixed uneven-aged forests on these sites in contrast to even-aged silvicultural plantations of a single species are analogous to the arguments that agricultural crops should be grown in mixed communities via organic farming rather than as crops of a given horticultural variety in rows in monocultures. Basically, such arguments have limited biological validity and economic feasibility. The fact is that at the present stage of our knowledge, both agricultural and silvicultural, we can grow more and better quality plant products by intensive management procedures. We see no reason that either clearcutting or monocultures should be legislatively restricted on lands devoted to commercial timber production in the southern pine region.

Finally, the eastern hardwood forest is complex, highly varied, and presents no simple silvicultural solution. By and large, timber growth exceeds use and relatively large areas of eastern hardwood forests will probably remain marginal from a commercial timber production standpoint, at least until such time, if ever, that a substantial need for wood as a source of energy, fuel, or chemicals becomes reestablished.

Silviculturally, most eastern hardwood types—and they are many and varied—can be managed either through clearcutting, shelterwood, or other harvesting techniques leading to the development of even-aged forests, or through partial cutting—whether uniformly or by group—leading to the development of uneven-aged forests. Where esthetic considerations are paramount, clearcutting should certainly be minimized or avoided. At the same time, there are other sites and conditions where clearcutting is the best technique of eliminating culled and degraded forests of extremely low quality and of replacing them with vigorous second-growth forests which would be more valuable to mankind in the future. There is no reason to limit the tools available to the forester in eastern hardwood forests, although public policy objectives in this case may well result in only limited application of clearcutting under many eastern hardwood forest conditions.

In summary, forests are varied, complex, and differentially responsive to management methods. Choices of the method to use must be made by experienced professionals on the ground if timber growing and multiple-use objectives are to be efficiently achieved. Clearcutting should neither be universally practiced nor universally banned, but available for use by forest managers wherever it is the most appropriate practice to achieve the purposes for which the forest is to be used. It should not be the subject of Government regulations, legislation, nor Executive order.

## CONCLUSIONS AND RECOMMENDATIONS

Properly executed timber harvesting and other silvicultural procedures need not result in important long-term losses of soil nutrients, deterioration of the soil, nor cause other physical environmental damage. Damage that has occurred resulted primarily from erosion associated with logging road construction and use, skidding of logs downhill or across streams, depositing debris in watercourses, or harvesting on steep slopes where removal of vegetative cover caused slides. With updated methods, such difficulties will become the rare exception. Such damage as has occurred will be corrected through natural processes as the forest grows back.

In general, the impacts of forest management on wildlife and recreation are positive. Management creates diversity which favors a wider variety of wildlife and greater opportunities for different kinds of recreation. The major area where the impacts of timber management are negative is in the appearance of newly cut old growth forests, particularly where clearcutting has been practiced. Efforts to increase utilization of slash and efforts to shorten the time between harvest and establishment of new stands should shorten the time period during which the logged-over area is unsightly.

Impacts of intensified forestry on the environment are in general positive. Most benefits are inherent in intensified management but a few will require close supervision if they are to be fully realized. No evidence exists to cause concern about the use of improved genetic stock or of soil cultivation and fertilizers. Intensified forest management generally causes little impact on the quality of water that flows from the land, on erosion, silting of streams, or an increase in water temperature provided the best current practices used on public lands and on the better managed industrial lands are followed. Intensive management can have a positive effect on the continued availability of roadless lands by requiring less forest land for production of the same timber volumes.

The Panel concludes that timber harvesting must be carefully planned and carried out and that, when this is properly done, such harvesting is not generally inimical to the maintenance of a sound biological environment.

*The Panel recommends:*

1. That the Federal land managing agencies continue to reserve from timber cutting all forested lands where sites cannot now be logged without causing unacceptable environmental damage; such reservation to continue until the means of timber management and harvest have improved so that such lands can be harvested under conditions that will provide full environmental safeguards.

2. That the Forest Service and the Bureau of Land Management protect the environment on Federal commercial forest lands by establishing roadbuilding standards and logging practices that minimize site disturbances, while at the same time retaining the discretion to use all proven and efficient methods of timber harvest, including clearcutting, under appropriate conditions. The Federal agencies should apply with the greatest possible skill the best silvicultural and conservation measures in forest management, particularly in timber harvest and forest regeneration. Application of extant research and technology to improve growth in managed forests is essential.

# Commercial Forests of the United States[1]

Recently released 1970 data credit the United States with 754 million acres of forests. Of these, 17 million acres are withdrawn by law or by executive action from timber harvest, and an additional 234 million are considered noncommercial because their stand of trees is too thin or their growth rate is too low to make them usable for commercial timber harvest. Nearly 3 million acres of national forest lands that meet productivity standards are under study for possible inclusion in the wilderness system and have been deferred from commercial forest land classification. This leaves nearly 500 million acres of "commercial" forest (table 3–1).

Commercial forest land as used in Forest Service statistics is defined as:

> Forest land which is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. Includes areas suitable for management to grow crops of industrial wood generally capable of producing in excess of 20 cubic feet per acre of annual growth. Includes both accessible and inaccessible areas.

The Panel would qualify this definition by adding that such land must be located so that it can be made accessible for forest management at costs consistent with the values involved. Although the Forest Service in its national statistics does not consider accessibility factors, the Service does exclude, in computing the allowable cut from national forests, areas of such extreme inaccessibility that there is no prospect of making the timber economically available.

The distinction between commercial and noncommercial forest lands is thus in part physical, in part biological, in part economic, and in part legal or varying combinations of the four. Much land grows trees of types not generally used for any commercial purposes. Gray birch in New England is an example. Woodlands are lands covered with scattered, open-grown trees of such low quality that they produce no wood for industrial use. Other forests have been withdrawn from harvest for parks, wilderness areas, and scientific natural areas. Additional lands are set-aside from timber

[1] For further information on the subject matter of this chapter see "Forest Statistics for the United States, by State and Region, 1970." Forest Service, U.S. Department of Agriculture, 1972.

**TABLE 3-1.—Area of Commercial Forest Land by Ownership Classes and Site Quality [1]**

[Areas in million acres by site classes] [2]

| Ownership class | I | II | III | IV | V | All site classes |
|---|---|---|---|---|---|---|
| National forest | 2.9 | 8.5 | 17.6 | 32.7 | 25.2 | 86.9 [3] |
| Other public | 2.0 | 3.5 | 6.0 | 16.7 | 16.0 | 44.2 |
| Forest industry | 4.1 | 8.0 | 18.8 | 24.9 | 11.5 | 67.3 |
| Other private | 4.4 | 18.0 | 73.8 | 121.2 | 78.8 | 296.2 |
| All ownerships | 13.4 | 38.0 | 116.2 | 195.5 | 131.5 | 494.6 [3] |

[1] Source: "Forest Statistics for the United States, by State and Region, 1970"; U.S. Department of Agriculture, Forest Service, 1972 pp. 16–19.
[2] Site classes I to V refer respectively to lands capable of producing growth of 165-plus, 120–165, 85-120, 50–85, and 20–50 cubic feet of timber per acre per year.
[3] Estimates of area subclasses do not include 5.0 million acres of national forest lands in the Rocky Mountain States that are not included in the base for allowable cut because of such factors as unstable soils, small size of isolated patches and stringers, or special use constraints. Volume and growth data are also excluded for these areas.

harvesting because of special scenic features or recreational use.

The total area of commercial forest land of 500 million acres constitutes slightly more than a quarter of the land area of the contiguous States. Commercial forests substantially exceed the area of land used for crop production, including cultivated pasture. By any standard, forests are a major form of land use in the United States. Of the commercial forest area, 54 percent is in hardwoods and 42 percent in softwoods. The remaining 4 percent is nonstocked. There are many important tree species and forest types in both major groups. The various species and types have their silvicultural variations and requirements, and also vary in the adaptability of their wood for various uses. These silvicultural differences are highly important and often are the factors governing the kind of forest practices that must be followed if desired results are to be attained.

## FOREST REGIONS OF THE UNITED STATES

For convenience in collecting statistics and in discussion the forest regions of the United States are divided into the North, the South, Rocky Mountain, and Pacific coast. The North includes New England, the North Central States, and Lake States; the South encompasses Virginia, Tennessee, Arkansas, Oklahoma, and the States lying south of these; the Rocky Mountain region includes both Rocky Mountain States and those of the Great Basin region; the Pacific Coast States include California, Oregon, Washington, and Alaska. Within these broad regions are innumerable variations in climate, soils, geology, topography, and hence in forest types. Similarly each broad region contains forest sites varying from the most productive sites to those that are marginal and submarginal as commercial forest land.

## SITE CLASSES

*Site class* is a measure of the capacity of forest land to grow timber. The rate of tree growth is affected by climate, soil, and the associated fauna and flora of the site. In the Forest Service publication "Forest Statistics for the United States, by State and Region, 1970", five site qualities are recognized. Table 3–1 shows the commercial forest area distribution by ownerships and by site classes.

Two facts stand out, when the data of table 3–1 are further analyzed (table 3–2):

1. There is a wide range in productive capacity within each ownership class; no ownership class of forests has all the most productive forests, none has all the least productive ones. Although there is some variation in percentages in each site class, among the various ownership classes—with significance which is discussed later—yet there are great similarities in the frequency distribution by site classes.

2. The distribution of *area* of land among the site classes differs greatly from the distribution of *productive capacity*. For all forests, one-fourth the area has one-eighth the capacity; and the relationship is similar in each ownership class. The sites of low productive capacity shown in table 3–2 are not the same as the sites with wilderness potential nor as the fragile sites discussed in other chapters; but the table does emphasize that area of forest land is not necessarily the same as productive capacity.

These data can be analyzed further (table 3–3). The various ownership classes differ in *average* productive capacity. The forest industry lands have the highest average productivity per acre; this is to be expected, since these companies have

**TABLE 3–2.—Area and Productive Capacity,[1] by Site Class, for Forests of Different Ownership Classes**

| Ownership class and item | Approximate percentage in site class [2] | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| National forests: | | | | | |
| Area | 3 | 10 | 20 | 38 | 29 |
| Productive capacity [1] | 8 | 18 | 27 | 33 | 14 |
| Other public: | | | | | |
| Area | 4 | 8 | 14 | 38 | 36 |
| Productive capacity [1] | 11 | 16 | 19 | 36 | 18 |
| Forest industry: | | | | | |
| Area | 6 | 12 | 28 | 37 | 17 |
| Productive capacity [1] | 12 | 19 | 33 | 29 | 7 |
| Other private: | | | | | |
| Area | 2 | 6 | 25 | 41 | 26 |
| Productive capacity [1] | 4 | 12 | 34 | 37 | 13 |
| All ownerships: | | | | | |
| Area | 3 | 8 | 23 | 39 | 27 |
| Productive capacity [1] | 7 | 14 | 32 | 35 | 12 |

[1] Calculated by multiplying midpoint of class interval by respective acreage.

[2] Site classes I to V refer, respectively, to lands capable of producing growth of 165 or more, 120–165, 85–120, 50–85, and 20–50 cubic feet of timber per acre per year.

Source of basic data: Table 3–1.

**TABLE 3-3.—Productivity and Growth of Wood in 1970, by Ownership Class of Forests**

| Ownership class | Estimated productive capacity[1] (cubic feet per acre) | | Growth achieved in 1970 on sites I-V | |
|---|---|---|---|---|
| | Land in site classes I-V | Land in site classes I-IV | Cubic feet per acre | As percent of productive capacity of sites I-V |
| National forests | 76 | 93 | 30 | 39 |
| Other public | 72 | 92 | 39 | 54 |
| Forest industry | 88 | 98 | 52 | 59 |
| Other private | 74 | 88 | 36 | 49 |
| All ownerships | 76 | 91 | 38 | 49 |

[1] Productive capacity estimated by multiplying acreage in the specified site classes (as reported in "Forest Statistics for the United States, by State and Region, 1970," Forest Service, U.S. Department of Agriculture, 1972), by the midpoint of each site class interval (taking 180 as the value for class I). Data include both hardwood and softwood forests.

generally selected the more productive forests, as presenting the best profit prospects. The other ownership classes differ but little, as far as their respective averages are concerned. Are the forest industry lands significantly more productive than the national forests? The estimated capacity to produce wood is about 15 percent greater; since many of the per acre costs of administration and management vary relatively little for productive and less productive forest lands, the profit prospects of the industry forests are probably much greater than this 15 percent difference—quite possibly two or four times greater. This table well demonstrates the desirability of concentrating intensive forest management on the better sites; site classes I to III, with one-third the total area, have well over one-half the total productive capacity.

For each ownership class, dropping out the site class V lands increases the average productivity of the remaining lands by about a fifth for all forests; less for industry forests, since they include relatively much less site class V land, relatively more for the national forests and other publicly owned forests.

No ownership class of forests was growing wood in 1970 up to its productive capacity, even at the level assumed in making this productivity rating of forests. It is based upon potential yields of fully stocked natural forests; intensive forest management would increase those yields considerably. All forests were growing wood at about half their productive capacity; forest industry forests were doing significantly better, national forests were growing wood much more slowly in relation to their capacity. Some of the wood grown in 1970 was on site class V land; but the growth of wood from all site classes was substantially less than the total capacity of lands in site classes I through IV.

These data and this analysis emphasize the wide range in productivity between the better sites and the poorer sites for all ownership classes. Land that grows less than 50 cubic feet per acre per year not only has a low-growth rate but it responds poorly to intensified forest management. By contrast, land that grows 120 or more cubic feet per acre per year not only produces a lot more timber each year but tends to respond several times as well to precommercial thinning, application of fertilizer, and use of superior genetic stock. It is for this reason that *the Panel strongly recommends* that both public and private measures to increase timber output be concentrated on the higher quality lands which are most responsive to intensified management.

## TIMBER TYPE GROUPS

Forest lands of the United States are separated into two major type groups: Hardwoods and softwoods corresponding roughly to broadleafed trees and needleleafed trees. Broadleafed forest types are the major ones occurring in the Northeastern United States, the Central States, and the mountainous parts of the Southern States. Needleleafed trees or conifers are the dominant types in the Southern Coastal Plains, the Rocky Mountains, and the Pacific States. Lumber made from broadleafed trees is known as hardwoods and is used for flooring, furniture, and to a limited extent for general construction. Coniferous lumber or softwood is preferred for general framing and construction. Both hardwoods and softwoods are used for paper pulp though softwoods, because they have longer fibers than hardwoods, are generally preferred. The demand for softwood timber is far greater than that for hardwood timber. Consequently, softwoods have characteristically been cut somewhat more rapidly than the timber grows whereas hardwoods since 1952 have grown more rapidly than they were harvested. Within each broad category, though, certain species are preferred over others. Among hardwoods, sugar maple, ash, walnut, white oak, and cherry are preferred species. Among conifers, white pine, ponderosa pine, Douglas-fir, spruce, and southern pines are preferred over true firs, cedar, and hemlock.

## OWNERSHIP OF COMMERCIAL FORESTS

It is useful to distinguish four major classes of ownership. They are: National forests, other public, forest industry, and other private. The *national forests* are owned by the Federal Government and are managed by one agency under one set of laws and regulations; their area, volume of timber, management policies, and potentials are given special attention by the Panel. *Other public* forests include federally owned lands under the jurisdiction of the Bureau of Land Management, the Bureau of Sport Fisheries and Wildlife, the Department of Defense, and other Federal agencies. They also include State-owned lands, and some country or local government lands. *Forest industry* forests are owned by companies producing mainly lumber, plywood, and paper, in varying proportions. Most are in relatively large ownerships, and though integrated operations are common, the processing part of the companies' businesses has usually been more important than the timber-growing part. *Other private* forests include some farm woodlots, some owned by companies, associations, or individuals for profit, but much owned in small holdings for a variety of personal reasons.

*National forests* lie mostly in the West, hence support mainly softwoods (table 3–4). They account for less than 20 percent of the commercial forest area, but they include about a third of the total standing timber volume and 51 percent of the softwood sawtimber volume.

They have a large volume of standing softwood sawtimber per acre—two-thirds more than the average of all forests and three times more than the lightly stocked *other private* lands. National forests have a low net growth per acre and a still lower growth in relation to standing volume—their many mature stands have little or no net growth. Annual harvest of softwood is low in relation to area and especially low in relation to volume of standing sawtimber; but softwood sawtimber harvest in 1970 exceeded current growth by 48 percent.

The *other public* forests are a highly varied lot, as to ownership, managing agency, and physical characteristics. They have a total acreage less than half that of the national forests. The per acre volume of sawtimber is substantially below that of the national forests. Their current harvest rate per acre is about the same as that for the national forests but is greater in relation to standing volume. Some of these forests have been relatively heavily cut in the past. Current growth of all softwood on these lands exceeds current harvest rate by 29 percent, but sawtimber harvest exceeds growth by 7 percent.

*Forest industry* forests include 13 percent of the total commercial forest land. Forest industry forests are particularly important in the South and along the Pacific Coast. Their softwood timber stands per acre are about average, but their growth rates per acre are the highest of any major ownership class and their growth rate in relation to timber volume is well above average (table 3–4). Similarly, their current rate of harvest per acre and in relation to volume of standing softwood timber are by far the highest for any major ownership class—more than double the average rate for all forests. The current rate of harvest exceeds the current growth of sawtimber by 64 percent. This major class of ownership is one of relatively modest acreage, but includes some of the most productive forest land, the most intensively operated and managed forests, and the highest output per acre and per unit of standing timber, and probably per dollar of investment, of the four ownership classes.

*Other private* forests vary greatly as to site characteristics, size of ownership unit, ownership objectives, and other parameters. They include 59 percent of the entire commercial forest area, and are especially extensive in the North and South, but less so in the West. They include much forest land of low-site quality, and include extensive areas of hardwood forests, many of which produce trees of low value and dubious marketability. The volume of all standing timber and of sawtimber per acre is by far the lowest of any major ownership class, but the large area of such lands makes volume of standing timber relatively large. Since 1952 their rate of growth has exceeded their rate

**TABLE 3-4.—Area of Commercial Forests, Volume of Standing Softwood Timber, Annual Growth of Softwood, and Annual Removals of Softwood, by Major Ownership Classes, 1970**

| Item and unit | Major ownership class | | | | |
|---|---|---|---|---|---|
| | National forest | Other public | Forest industry | Other private | Total |
| FOREST LAND AREA (MILLION ACRES) | | | | | |
| By type: | | | | | |
| Softwood | 66. 8 | 21. 7 | 36. 4 | 82. 3 | 207. 2 |
| Hardwood | 16. 8 | 19. 8 | 29. 4 | 200. 7 | 266. 7 |
| Unstocked | | | | | 20. 7 |
| Total | | | | | 494. 6 |
| By region: | | | | | |
| North | 10. 5 | 21. 4 | 17. 6 | 128. 4 | 177. 9 |
| South | 10. 8 | 6. 5 | 35. 3 | 139. 9 | 192. 5 |
| West | 65. 8 | 16. 2 | 14. 4 | 27. 9 | 124. 3 |
| Total | 91. 9 | 44. 1 | 67. 3 | 296. 2 | 494. 7 |
| VOLUME OF STANDING SOFTWOOD TIMBER | | | | | |
| Growing stock—total (billion cubic feet) | 199. 8 | 48. 4 | 73. 2 | 110. 5 | 431. 9 |
| Sawtimber—total (billion board feet) | 982 | 223 | 318 | 382 | 1, 905 |
| board feet per cubic foot | 4. 9 | 4. 6 | 4. 3 | 3. 5 | 4. 4 |
| ANNUAL GROWTH OF SOFTWOOD | | | | | |
| Growing stock—total (billion cubic feet) | 2. 05 | 0. 97 | 2. 55 | 5. 10 | 10. 67 |
| in relation to volume (percentage) | 1. 0 | 2. 0 | 3. 5 | 4. 6 | 2. 5 |
| Sawtimber—total (billion board feet) | 8. 60 | 3. 97 | 9. 97 | 17. 72 | 40. 26 |
| in relation to volume (percentage) | . 88 | 1. 78 | 3. 13 | 4. 63 | 2. 11 |
| ANNUAL HARVEST ON SOFTWOOD | | | | | |
| Growing stock—total (billion cubic feet) | 2. 07 | 0. 74 | 3. 08 | 3. 74 | 9. 62 |
| in relation to volume (percentage) | 1. 0 | 1. 5 | 5. 2 | 3. 4 | 2. 2 |
| in relation to growth (percentage) | 101 | 76 | 121 | 73 | 90 |
| Sawtimber—total (billion board feet) | 12. 74 | 4. 24 | 16. 31 | 14. 45 | 47. 74 |
| in relation to volume (percentage) | 1. 3 | 1. 9 | 5. 1 | 3. 8 | 2. 5 |
| in relation to growth (percentage) | 148 | 107 | 164 | 81 | 119 |

Calculated from data in "Forest Statistics for the United States, by State and Region, 1970," Forest Service, U.S. Department of Agriculture, 1972.

of harvest, hence inventories have been building up.

From this general description and from the data in tables I–2, 3–1, 3–2, 3–3, and 3–4, there emerge four economically important softwood forest management situations in the United States on which policy consideration might focus:

(*a*) National forests in the West, with their very large volume of standing softwood timber, their low growth rates, and their low harvest rates;

(*b*) Forest industry lands in the West, occupying on the whole the more productive sites, practicing more intensive forestry, with much greater growth and much higher harvest rates;

(*c*) Forest industry lands in the South, on generally productive lands, specializing in the production of pulpwood, with fairly intensive operations, high growth rates, and high harvest rates; and

(*d*) Other private lands, especially in the South, on variably productive sites, with generally low volumes per acre, low harvest rates per acre but high harvest rates in proportion to stand, and low levels of management.

Although there are additional forest situations, these are less important for the production of softwood timber of the kinds most needed and will receive less attention in this report.

If the growth rate per acre on all softwood forests were brought up to the level of that on the forest industry lands, timber growth would be 43 percent higher than it now is. If harvest rate on all forests could be at the rate per acre of forest industry forests, the harvest of all timber would be 98 percent higher. Because of the higher site quality and consequent productivity of forest industry lands, it is unlikely that other forests can ever reach the same level. Thus, these comparisons are to some extent unrealistic. On the other hand, forest industry forests can be made to grow faster and can be cut at higher rates per acre in the future, so that their present performance indicates a minimum goal for comparable lands. These comparisons, rough as they are, clearly demonstrate vast potentials for increased production of usable softwood from all classes of forest land.

## LUMBER PRICE TRENDS

The demand (in the economist's sense of a schedule of quantities and prices) for lumber, plywood, pulp for paper, and outdoor recreation as products or uses of the forest, has risen over the years. If information were available to quantify the demand for the other uses of the forest, probably an increase in demand would be apparent there also. However, the increase in demand has taken different forms of price and quantity adjustment for the various uses. In general, increased demand for lumber has taken the form of increased prices for essentially the same quantity; for the other uses, such as recreation, the major adjustment has been increased quantity at the same or nearly the same prices. As with any broad generalization, there are exceptions, but this is useful, nonetheless.

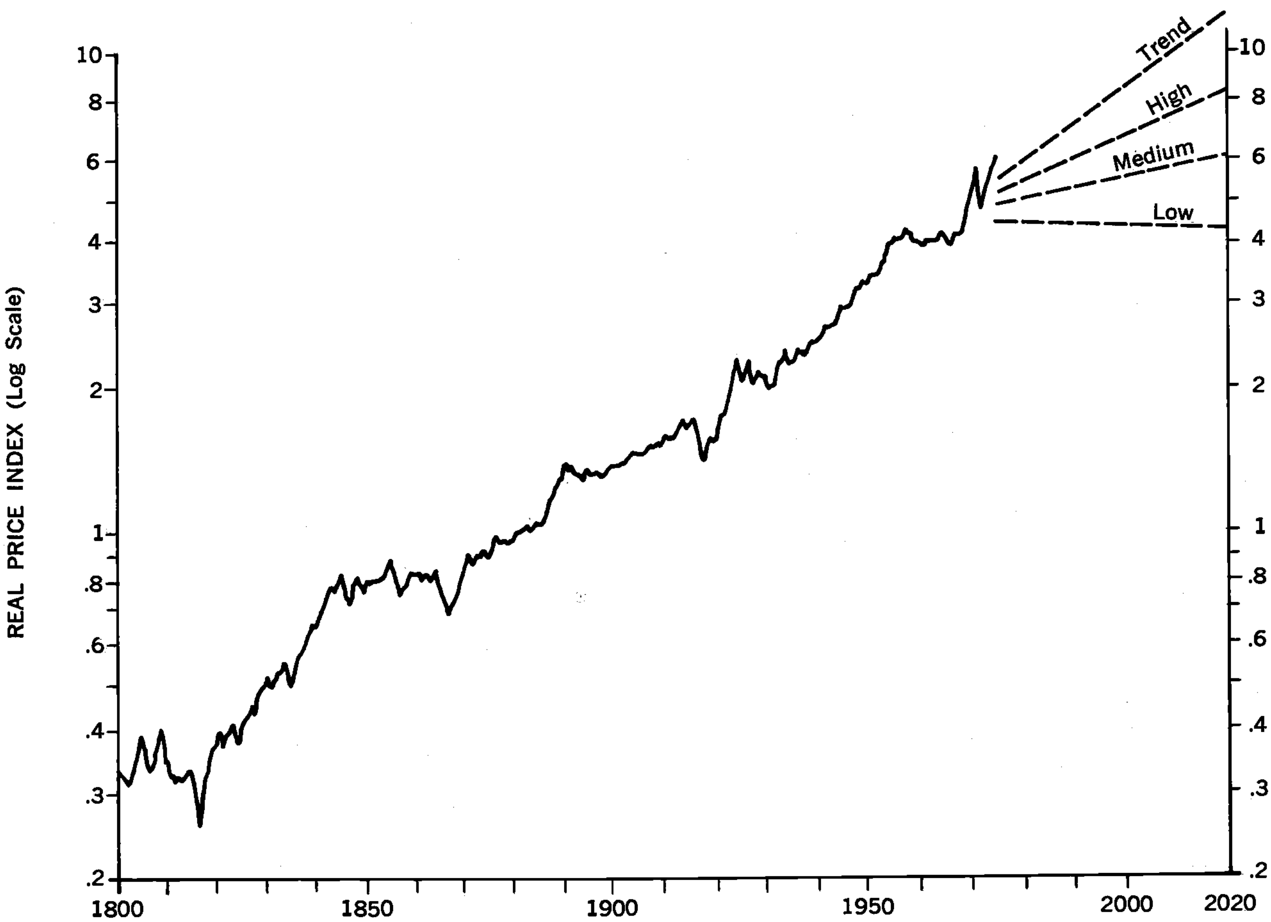
In any analysis of prices, it is essential to distinguish between prices in absolute or current dollar terms, and prices in relative or constant dollar terms. Thus, if lumber prices advanced by 10 percent between 1 year and the next, the price in terms of current dollars has risen by 10 percent; but if the average price of all commodities has also advanced by 10 percent, then lumber prices relative to the price of all commodities have stayed constant. For a great many purposes, relative prices are more useful than are absolute prices, so in the analyses to follow relative prices are used unless otherwise qualified. They show how lumber prices have changed, or might change, relative to the general price level; or they show the influence of either demand or supply upon relative prices, eliminating (as far as possible) the influence of a changing general price level. Relative prices sometimes seem unreal, unless their basis is understood; for instance, in late 1972 lumber prices were about 175 percent of their level in 1967 (the base year for the present index); but, since the general price level was about 120 in terms of 1967 prices, the relative index for lumber was about 145.

In the discussions in this report, emphasis is placed upon lumber prices; prices of other wood products, such as plywood and paper, are somewhat related to lumber and somewhat separate. Lumber uses about half of all timber harvested, hence its volume makes its price significant. Paper prices are generally less volatile than are lumber prices. More detailed calculations of the prices of all wood products could be made, but lumber prices may serve as a general indicator of the level and trend of prices for all wood products.

The price of lumber has risen more or less steadily since 1800 (fig. 3–1), at a rate averaging about 1.7 percent annually, compounded. A closer look at this price rise indicates periods of approximate stability followed by short periods of steep price rise; thus, something like stability was apparent between 1800 and 1820, between 1850 and 1870, in the 1920's, and again from about 1950 to about 1965. The persistent price rise since 1820 has increased prices today to about 20 times their level in 1800. All these prices are in terms of dollars of constant purchasing power, so these increases are "real." If the past trend is followed, by 2020 lumber prices will be about double their present prices (in terms of today's general price level, and much higher in actual prices if inflation continues). In later chapters, analysis will be presented of probable future supply and demand for three price levels for lumber and other wood products. It will be noted that all of these contemplate a lower rate of future price rise than has prevailed over the long period.

A chart such as figure 3–1 is useful in providing a broad historical perspective, but its necessarily small scale tends to obscure the sharpness and the extent of recent rises in lumber prices; these are better shown on figure 3–2. But even this, which uses annual average prices, also conceals shortrun price changes. In late 1968 and early 1969, absolute lumber prices rose from an index of little over 100 (1967=100) to an index of 160 in March of the latter year, after which they quickly receded to 116 by October. Again in 1971, lumber prices rose from an index of 114 in January to over 150 by the end of the year, a trend which has continued, with some pauses, into 1972 to bring lumber prices by the end of the year to over 175 in absolute terms or 146 in relation to all commodities. The increases in relative terms have been less, and by an increasing margin in later years, as the general price level

FIGURE 3–1.—Longterm Lumber Prices, in constant dollars, 1800 to Date, with Alternative Projections to 2020

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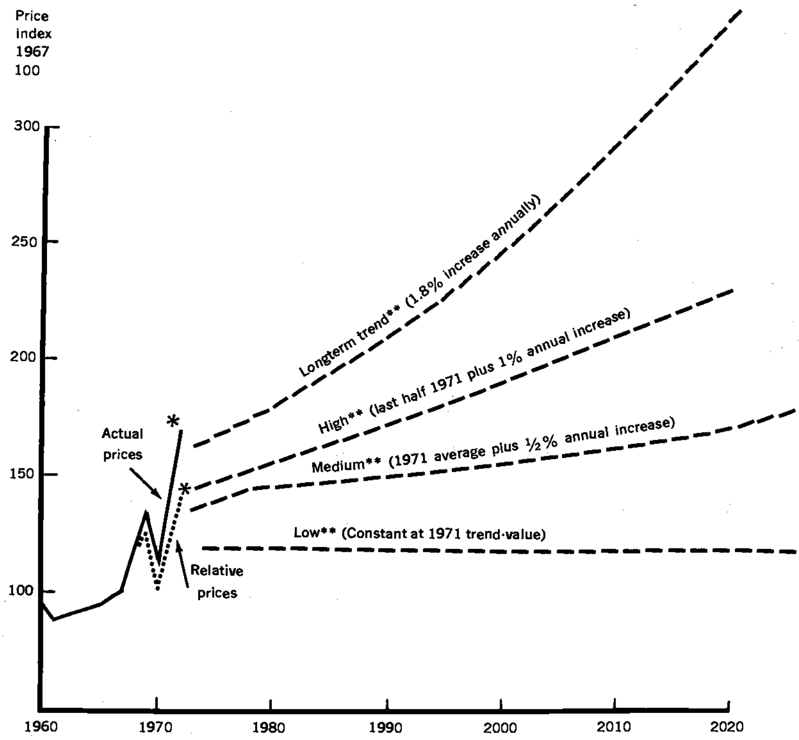
Updated by R. J. Marty

has advanced also. Figure 3–2 shows the same price projections for the future as were shown on the previous chart; figure 3–2 is on an arithmetic scale whereas figure 3–1 is on a logarithmic one. Again, it can be seen that the projected prices are low, relative to the actual lumber prices which prevailed in 1971 and 1972, but more reasonable in relation to the relative prices of those years.

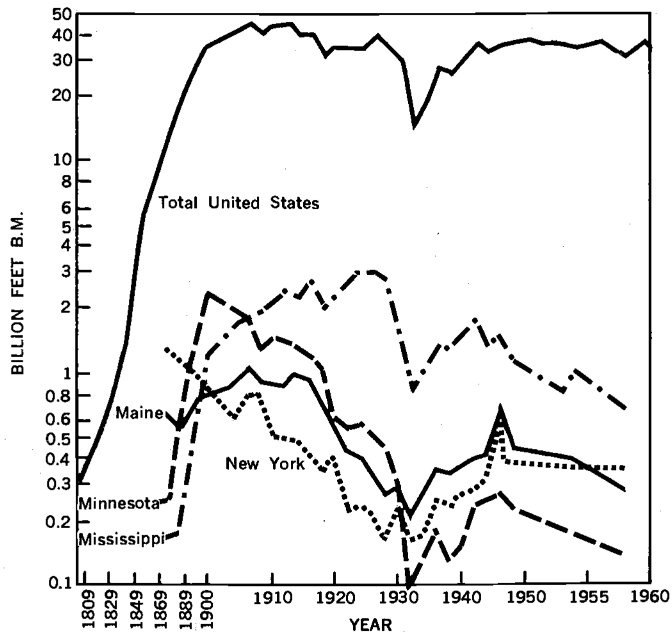
Total lumber consumption in the United States remained fairly constant from about 1908 until the mid-1960's with, of course, fluctuations depending upon economic prosperity or depression (fig. 3–3). Since the mid-1960's, annual lumber consumption has risen about 20 percent. The approximate constant consumption thus contrasts sharply with the generally persistent upward trend in prices. In contrast, plywood and paper consumption both in total and per capita, have risen rather steadily and sharply from the date of earliest records to the present. Paper prices have been relatively steady (in real terms), especially in recent years. In all cases, price trends reflect supply conditions, including costs of processing, as well as demand conditions. For outdoor recreation we lack firm estimates of costs of visitor use of forests, but it is doubtful if these have risen much, if any, in real terms, whereas volume of use has risen sharply at a rate of about 8 percent annually on national forests. Lumber production and prices will be dealt with further in chapters 4, 5, and 6.

FIGURE 3–2.—Lumber Prices 1960–1972, and Alternative Projections to 2020




* Preliminary estimate.
** In relative prices.

FIGURE 3–3.—Lumber Production in Four States and in the United States from 1799 to 1960.




(Data from "Lumber Production in the United States 1799–1946," by Henry B. Steer, U.S. Department of Agriculture Miscellaneous Publication 669, October, 1948; U.S. Department of Agriculture, Forest Service, "Historical Forestry Statistics of the United States," compiled by Dwight Hair, Statistical Bulletin 228, 36 pp., 1958; and National Lumber Manufacturers Association, "Lumber Industry Facts 1960–61.")





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# Capacity of Forest To Meet the Needs of the American People [1]

The rich and varied forests of the United States produce generous quantities of goods and many different services to meet the needs and desires of the American people. These needs and desires have expanded severalfold since 1900. The area of forest land, on the other hand, has remained more or less constant while the amount of timber standing in the forest has declined. Consequently the Nation has now reached the stage in which one use or service can no longer be expanded greatly without having some impact on other uses and services or on the environment as a whole. The task for the future, therefore, is to determine how the productivity of forests, in goods and services, can be increased and integrated so as to meet as completely as possible the desires of the American people.

The function of this chapter is to describe and quantify, to the limits of present knowledge, the capacity of the American forests to supply the various needs and desires of the people as these were described in chapter 1. The demand for those products and services will be considered in chapter 5 and the reconciliation of supply and demand, together with an analysis of price policy will be treated in chapter 6.

## MAINTENANCE AND ENHANCEMENT OF THE FOREST ENVIRONMENT

The Panel states unequivocally that in its opinion the protection of environmental quality over the long run should take precedence over all uses of forest resources. Of highest importance is preserving the productivity of the soil itself. This means far more than merely preventing soil erosion. It means protecting the soil-building propensities of trees, herbs, and shrubs; protecting the forest litter; and above all, protecting the macroorganisms and micro-organisims that dwell in the soil and decompose litter and other forest debris, thereby releasing the water, carbon dioxide, and plant nutrients for recycling through the living elements of the ecosystem. The permeability of the soil to air, dissolved substances and water is a key attribute of a healthy environment because storing and releasing water to underground supply and ultimately to streams is an essential factor in soil productivity. The forest cover has a significant influence on microclimate. It intercepts rain and snow thereby returning moisture to the atmosphere before it reaches the soil. The forest makes drafts on soil water and thus decreases the total amount of runoff from a forested area. It influences the drifting of snow and the accumulation of a snowpack during winter as well as the rate of snowmelt in the spring.

It is the interactions of climate, soil, and living organisms that make up the functioning of ecosystems; and it is the healthy functioning of the forest ecosystem that accounts for its overall productivity.

Some forest ecosystems are much more useful to man than others. It has already been implied that ecosystems of hardwood forest types are less valuable for producing construction timber than are those of conifers but this is not necessarily true for other forest values. Mixed forests of conifers and hardwoods usually support a richer and more

[1] For more detailed treatment of the subject of this chapter, see "Appendix C: Softwood Sawtimber Supply and Demand Projections," by Robert Marty; also see parts of apps. D, E, F, I, K, L, M, N, O, and P.

varied population of birds and mammals than do either pure forests of conifers or pure forests of hardwoods. Fortunately, nature has supplied Americans with many different types of forest, each of which has its charm, its rate of productivity and its contribution to the total environment. Each forest type also has its utility for man's purposes.

In recent years the forest area of the United States has increased somewhat due to afforestation of low-quality agricultural land as improved crop management has increased output of farmlands. This period of net forest increase may be ending for in 1972 some forests were being cleared for agricultural use. Forest land is also being taken over for highways, airports, suburban and urban expansion and many other purposes. Still it is expected that a large proportion of the total land area of the United States will remain in forests for the indefinite future.

The public accepts without question the need for harvesting the crop of corn or wheat when ripe for they know that the plants will die, fall down, and go to waste if not harvested. The public also knows that the old crop must be removed to make way for a new one the following year. The same applies to forests; the old crop must be removed to grow a new one. The public generally accepts clearcut harvesting on industrial pine forests of the South because it can see that the slash is promptly disposed of, the soil prepared for a new crop and trees planted within a year after timber harvest. Within 3 or 4 years the new forest is clearly visible and the unsightliness forgotten.

Clearcutting applied to the old growth on western national forests gives quite a different impression. The mountainous topography makes cutover lands highly visible, regenerating a new forest is slower, and much logging debris covers the ground. Nevertheless, the objective is the same as that of the farmer: to harvest the crop and establish a new one. The material left on the ground was deemed uneconomic to remove and utilize. It also serves to return valuable nutrients to the soil as it decomposes.

The Panel finds the popular conception that timber cutting causes severe damage to soil, watersheds, streams, water quality, wildlife habitat, and forest regeneration to be grossly unjustified. It is true that careless or misapplied logging practices on fragile soils can lead to erosion, silting of streams or clogging of channels with logging debris, and in rare cases can trigger landslides or avalanches. But vulnerable areas can be identified in advance and appropriate measures taken to avoid significant harm. (A full discussion of this question with pertinent citations is given by Smith in appendix L.) Some 95 percent of the erosion associated with timber harvest results from road construction and maintenance, not from logging as such. Erosion follows road construction irrespective of whether the roads are built to log timber or for general travel.

Clearcutting does expose the forest soil and litter to direct sunlight which raises the temperature and causes more rapid decomposition. The resulting release of valuable plant nutrients greatly hastens the development of a new forest. The herbs, shrubs, and tree seedlings that come in following cutting are more richly supplied with calcium, potassium, and nitrates and hence grow vigorously and provide much forage for ground-dwelling herbivores. Such release of plant nutrients does not lead to soil impoverishment, but rather to rapid growth of the new forest. (Careful documentation of this is provided by Stone, appendix M.) Within a decade or so, if proper forestry measures have been taken, new tree seedlings grow to form a new canopy 10–15 feet above the soil surface hence the land becomes less attractive to many ground-feeding birds and animals. The sapling- and pole-sized stands provide thickets for nesting birds but tend to shade out the raspberries and other bushes, shrubs, and herbacious plants that were sought by herbivores and fructivorous birds during the first few years after harvesting. In a managed forest some land will be cutover each year so that a variety of age-classes is introduced. (For additional information see Webb, appendix N.) In general, timber harvesting under proper forest management improves the habitat for a great majority of species. Many recreationists prefer well-managed forests because roads, paths, open glades, vistas, and distribution of timber age-classes all add variety and interest.

The Panel concludes that timber harvesting is compatible with a vigorous and diverse wildlife population and with the maintenance of a healthy forest ecosystem. This has been demonstrated time after time by studies of effects of timber cutting operations throughout the United States. Even such extreme practices as clearing the land of forests and cultivating farm crops for a number of years do not prevent a forest with associated wildlife from reclaiming the land once cultivation ceases.

It is evident that in the past inadequate consideration had been given to forest esthetics. Much more consideration should be, and is now being given to the esthetic aspects of timber harvest. The general public, and the "environmentalists" must realize though that here as elsewhere in natural resource use and management, one cannot have the best of all worlds. A forest blighted by disease or windstorm and left unsanitized may be esthetically repugnant, too.

*The Panel recommends* that public agencies and private forest owners give careful attention to the forest environment in general and to forest esthetics in particular, to reduce adverse forest management impacts.

*The Panel further recommends* that appropriate forest management and timber harvest practices be adapted to the circumstances of the particular forest area, and worked out on the ground by competent professionals.

## OUTDOOR RECREATION (Exclusive of Wilderness Use) IN FORESTS

Both publicly and privately owned forests of the United States are extensively used for outdoor recreation activities which make varying demands upon forests. Their capacity to provide recreation can be increased substantially. Particularly, opportunities for site intensive outdoor recreation activities (such as camping and picnicking) can be increased greatly by the designation of more forested lands for these purposes. Opportunities for more dispersed, less site-intensive outdoor recreation activities are also good. Even allowing for the effect of outdoor recreation upon other uses of the forests, the potential recreation capacity is large compared with present use. In a study of possible recreation development impact on timber productivity from three national forests in California, two resource economists estimated that the recreation capacity could be increased 10 times with only a 13-percent reduction in sustained yield capacity from productive timber lands.

In some situations, outdoor recreation activities such as picnicking and camping can be rotated with timber harvest, to the advantage of both. Thus, when the recreation area begins to show the effects of severe use, it may be closed and another area opened; the mature trees in the first site may then be harvested. Such rotations would extend over many years.

Outdoor recreation does not require highly productive forest sites; in fact, rather open stands of trees, not especially large or fast growing, often make better recreation sites than do denser and heavier forest stands. Outdoor recreation and timber harvest have long been compatible in Western Europe and in the Northeastern States. They can and are becoming compatible in western forests, as rotations of new growth are established following timber harvests.

To meet the recreation needs of the residents of the inner cities commercial forests must be supplemented by local parks and woodlands.

*The Panel recommends* that some areas of publicly owned forest lands should be reserved from timber harvest, either permanently or as part of a planned rotation, in order to provide adequate areas for outdoor recreation. This recommendation is conditional upon the one made in chapter 6 about financing outdoor recreation on public lands. The Panel does not attempt to estimate the acreage of public lands that should be so reserved, nor to estimate the volumes of commercial timber and growth capacity involved. Among such lands would be some that for ecological reasons would require restraints on timber harvesting. It seems probable that relatively generous allowance can be made for outdoor recreation without serious impact upon timber harvest.

## WILDERNESS AREAS AND WILDERNESS EXPERIENCE

Much popular attention has been focused on wilderness areas in the past decade or so. The term "wilderness" has been loosely used, both as to the nature of the area and as to the form of withdrawal which authorized it. The Wilderness Act of 1964 defined wilderness thus:

> A wilderness, in contrast with those areas where man and his works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has out-

standing opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic or historical values.

This definition both defines the kind of area and suggests the kind of experience possible within wilderness areas; both parts of the definition are highly important. In practice, many people apply the term wilderness to any largely undeveloped area, including many areas penetrated by roads, and apply the term to other types of withdrawals, irrespective of their statutory wilderness status. Thus, Forest Service primitive areas (which are a temporary class of wild lands being reviewed for possible designation as statutory wilderness under the 1964 Act and which will not exist after 1974), BLM primitive areas (which are not statutorily covered by the 1964 Act), research natural areas (which are closed to most public use in order to protect the ecosystems for which the withdrawal was made), national game refuges, national wildlife refuges, wild and scenic rivers and others may all seem to some people to be examples of wilderness. While the term "wilderness" should be used in its exact meaning, as defined in the Act, other types of withdrawals of timber from harvest should also be considered as somewhat similar.

In 1972, there were 14.5 million acres of national forests (containing 6.7 million acres of commercial forest) withdrawn as wilderness or primitive areas. An additional 3.1 million acres were withdrawn from timber harvest for other purposes of which an unknown acreage was in commercial forest.

These acreages were in addition to the substantial acreages in national parks or other categories of Federal lands designated or soon to be designated as wilderness areas, but which were previously withdrawn from timber harvest by their creating legislation. There are also 56 million acres of essentially unroaded national forest land, in over 1,400 units of 5,000 acres or more, which have undergone Forest Service review for purposes of selecting additional areas for detailed study as possible wilderness system additions. In January 1973 the Secretary of Agriculture announced that the Forest Service was proposing 235 of these areas, involving about 11 million acres, for such study and potential wilderness designation. The remaining 1,200 areas and 45 million acres will see no activity which threatens their current wilderness potential, however, until environmental impact statements on them have been prepared and processed according to National Environmental Policy Act (NEPA) procedures.

The Forest Service has been unable to provide the Panel with estimates of the volumes of commercial timber involved on present or contemplated wilderness withdrawals, or upon the annual sustained-yield capacity of either class of lands. The Panel has been troubled by the inadequacy of the information about these present and possible wilderness areas on national forests.

In the absence of such information, the Panel can only express its judgment about wilderness areas in rather general terms. Much wilderness area does not contain commercial stands of timber, even accepting the generous definition of "commercial" used by the Forest Service. Less than half of the presently designated wilderness areas within national forests have commercial stands of timber; most of the rest are near or above timber lines. Some, perhaps most, of the included commercial timber areas have relatively low volumes of timber per acre. Some of this could be cut only with difficulty because the slopes are steep, the soils easily erodable, or both (see the section on watersheds and conservation, below), or because the remote location would make the timber of limited value even if these areas were open for timber harvest. This may be true from the national perspective, but it is conceded that local economic interests may disagree. Moreover, the growth rate on much of this land is low, so that sustained annual yield of timber would be low, even in relation to the relatively low volumes of standing timber.

The 14.5 million acres of national forest land presently designated as wilderness or primitive areas have been estimated by the Forest Service to contain about 58 billion bf of sawtimber. The equivalent volume of sawtimber could be produced in 60 years by Douglas-fir (800 bf per acre per year) on but 1.2 million acres of good quality land in western Oregon, for example. It could be produced in 50 years by southern pines (500 bf per acre per year) on 2.3 million acres of good quality land. The Panel concludes, therefore—and it should be emphasized again, in the regretable absence of dependable data—that the present wilderness reservations in national forests have a real but limited effect, nationally, on the volumes of timber that could be annually harvested under a sustained yield program. In the case of projected wilderness withdrawals in the national forests, it cautiously judges that the same general conclusion applies.

The Panel is also sympathetic to the view of wilderness advocates that the area of wilderness land has declined in the past, that it will decline further if timber harvest is pushed into every area where merchantable trees now stand, and that wilderness areas, once destroyed, can be reestablished only over very long periods, if ever. But the Panel also feels that wilderness as a use of the forests must be compared with, and judged against, alternative uses. If better data were available on commercial timber inventory and growth potential of present and potentially withdrawn forest lands, real opportunity costs of withdrawn uses could be included in decisionmaking.

Wilderness use of a forested area is incompatible with many other uses; wilderness must be the single or dominant use of the area, if the definitions of the Act are to be followed. Wilderness use is compatible with watershed, wildlife, and conservation values generally, but is incompatible with intensive recreation, timber harvest, mining, and even grazing to some extent, given the definitions of the Act. Moreover, the capacity of a wilderness area to provide a strict wilderness experience is limited. If solitude is to be preserved, then use cannot exceed some level or carrying capacity. The carrying capacity of national forest wilderness areas has not yet been measured exactly, and perhaps never can be precisely determined, but it is surely limited to some amount beyond which the basic character of the wilderness experience is destroyed. The carrying capacity can perhaps be increased by more careful routing of users, by spacing their visits, and possibly in other ways consistent with the nature of the area and of the wilderness experience, but it can never be high.

Because the "Environmental Impact Statement" provisions (sec. 102(c)) of NEPA have been notably applied to challenge actions and planning related to the status of national forest lands of wilderness character, the Panel offers an observation at this point. The provisions of NEPA which require preparation of environmental impact statements prior to actions potentially affecting the environment do constitute a means for creating delay, extra costs and governmental inefficiency as well as provide a means to better decisionmaking relative to environmental quality. So long as such impact statements are required and so long as their adequacy and findings are subject to public and judicial review, the additional costs in dollars and personnel of their preparation and defense should be budgeted and provided and not merely taken from timber management funds. The Panel believes speedy and proper resolution of conflicts related to the NEPA 102(c) provisions is very much in the public interest. Such conflicts have not been fairly and quickly resolved in the past and delays have been costly.

*Therefore, the Panel recommends:*

1. That relatively generous withdrawals of roadless areas should be made, whenever found to be qualified, for additional wilderness areas; these withdrawals should be completed by 1980. Reservation of commercial forest lands for wilderness or other purposes, involves costs of foregone timber harvests. These costs are lower for less productive forests than for the more productive ones, but such costs should be recognized.

2. That in the East and South where true wilderness areas are scarce, Federal agencies in cooperation with State agencies and private firms should seek to establish and protect an additional system of quasi-wilderness areas; timber harvest would be eliminated or conducted only at very long intervals, and natural conditions would be restored as far as possible; recreation use should be limited to the wilderness type.

3. That some system must be established in all wilderness areas to limit use to the reasonable carrying capacity of the area, having in mind primarily the nature of the wilderness experience. Unless such limitations can be devised and enforced, the Panel sees little national gain from the withdrawal of additional national forest land for wilderness use, since in a relatively few years overuse could destroy its wilderness character.

## WILDLIFE IN FORESTS

The forests of the United States have a great capacity to provide homes for many species of wildlife. The value of the wildlife lies largely in relation to the forest environment as a whole and to outdoor recreation, although some people who seldom visit forests support efforts to enhance forest wildlife because of the pleasure they receive in knowing about it ("psychic income"). As noted above and in chapter 3, some wildlife species thrive best in undisturbed forests, some in recently cut-over areas and most where mixtures of harvested and unharvested forest areas are found. Rare and endangered species deserve special habitat consideration if they are not to become extinct. On some national forests specific areas have been set aside to meet such habitat needs.

*The Panel recommends:*

1. That rare and endangered species of wildlife be given high consideration in planning and execution of land use programs;
2. That on federally owned forest lands each agency be held responsible for development and execution of a wildlife program which includes both game and nongame species;
3. That impact of forest management operations on wildlife be carefully considered along with the impact on environmental quality, generally.

## WATERSHED VALUES OF FORESTS

Water is, and increasingly will be, a scarce and valuable resource in the United States; accordingly, the watershed function of forest lands of all types and ownerships will become increasingly important. Concern about water involves both its quality and its quantity.

Various forest practices, but particularly timber harvest, may but need not adversely affect water quality. Adverse effects may be due to soil disturbance on the site, to building and maintenance of roads (discussed in more detail in the following section), to the warming of the land and water surfaces that takes place when forest canopies are opened up, and to other aspects of timber harvest or forest management. In general, the more a watershed resembles an unharvested forest area, the better the quality and lower the quantity of the water yield. One goal of watershed management is to provide for timber harvest without unacceptable damage to water quality.

The quantity of water flowing from a watershed may be increased by timber harvest since more of the precipitation reaches the ground, less is used by the plants in their transpiration and more reaches the ground water to augment streamflow. Shrubs and small trees that take over after cutting the high forest often consume much less water than do the deep-rooted old trees.

Good watershed management in the future will certainly stress maintenance of high water quality. It may also include measures to increase water yields. As streamside vegetation is a larger user of water, efforts to encourage low growing vegetation as opposed to large trees on streambanks often pay high dividends in low season flow in arid and semiarid regions. The capacity of forest watersheds, as a whole, to provide water of acceptable quality and approximately present quantity is large.

*The Panel recommends:*

That, in timber harvest, special precautions be taken along permanent streams to avoid disrupting or clogging channels, and, in arid and semiarid regions, to favor a low cover to shade the stream, stabilize streambanks, and minimize draft on low season flow.

## SOIL CONSERVATION VALUES OF FORESTS

The soils and the landforms of forest areas of the United States differ greatly as to their erodability. Some soils are deep, well-drained, modest in slope, and not easily eroded; others are steep, often shallow, sometimes granitic in origin or otherwise easily washed away, and hence erosion is a serious hazard. A combination of various soils and slope characteristics results in some areas being fragile or easily and often seriously damaged. In many instances, a fragile area naturally supports a thin and slowly growing stand of trees; the same limitations of soil and slope which make it fragile may also limit tree growth. Some fragile areas support old-growth stands of timber, suitable for harvest. However, in such instances, both the annual growth rates and sustained yield capacity are generally low. In other instances, deeper soils or gentler slopes, on which tree growth may be relatively good, may still have high erodability, and should either be classed as fragile or otherwise designated for special treatment.

In forest management, the construction and maintenance of roads is believed to cause 90–95 percent of soil erosion associated with timber harvesting. Forest management plans which minimize the length of necessary roads and minimize the severity of the cuts and fills along the roads will do much to reduce the subsequent erosion. The Panel notes with approval that the Forest Service has recently begun to modify its road construction practices to build roads which lie more lightly on the land instead of cutting more severely into it. Other public agencies and many forest industry firms have also modified roadbuilding practices to reduce soil erosion. At one time it was generally believed that road grades and curvatures had to be severely limited in order to permit efficient operation of logging trucks. Though gentle grades and curves are still preferred, modern logging equipment permits use of steeper grades and sharper curves than once were believed possible. In any case, some logging efficiency may have to be foregone to avoid serious erosion.

Where timber harvest is undertaken, there often must be some tradeoff between road spacing and log skidding distance. The Panel believes that more research should be directed toward methods of log movement in the woods that minimize damage to the remaining trees and soil; this will be essential as commercial thinning becomes more common. Some soil disturbance is usually desirable to expose mineral soil for seedling establishment following harvest cuts. Soils on gentle slopes are unharmed by such soil disturbance. If timber is to be used some soil disturbance from road construction and log skidding are unavoidable. Minimum overall soil disturbance may be achieved with fewer roads but relatively larger disturbance within the woods. Relative costs of different harvest methods must also be considered. It should be emphasized that roads and the soil disturbance they create are needed for uses of the forest other than timber harvest—for recreation, in particular.

In order to conserve the soil and to preserve and best utilize the productive capacity of the forest resource, *the Panel recommends:*

1. That usable systems of land classification be developed and applied by public agencies and private organizations, to classify forest soils and sites accurately according to erosion susceptibility; and that such classification systems be applied as rapidly as possible to all forest land, in order to identify and locate the fragile forest soil areas.

2. That on the more seriously fragile soil areas so defined, timber harvest not be undertaken until the need for the timber is acute or methods of harvest make possible removing such timber without significant harm to the land. On less seriously fragile areas appropriate precautions should be prescribed and enforced in timber management to reduce erosion and other adverse effects to an acceptable level.

3. That forest research agencies and logging equipment manufacturers collaborate in developing economically feasible machinery and methods for timber removal by both clearcutting and partial cutting that minimize damage to the site and residual trees.

4. That forest management planning on public and private lands seek to keep surface disturbance due to road construction and use to a practical minimum.

## GROWTH, HARVEST, AND UTILIZATION OF WOOD

Timber is a versatile raw material with many advantages, including that of having less environmental impact than does any substitute raw material. Hence, the future output of forests is highly important to the American people.

In considering wood supply, it is necessary to distinguish among the related but separate concepts of tree growth, timber harvest, forest stand, and wood utilization. The use of cubic volume instead of board foot volume would contribute substantially to the accuracy of forest inventory data. In the long run, harvest is limited by growth, and conversely growth is limited by harvest and other mortality. Either may exceed the other as timber volumes are built up or drawn down.

In managing the Nation's timber resource, synchronizing output over time is essential. For the remainder of the 1970's, lumber must come almost exclusively from trees now of sawtimber size. The concept of a normal forest managed on a 60-year rotation would have approximately equal areas supporting stands of age-classes 1–10, 11–20, 21–30, 31–40, 41–50, and 51–60 years. Such a distribution would enable the owner to harvest the same volume of timber each decade. During the decade in which the trees 51–60 years of age are harvested, the others each move up one decade in age and in volume. In such a forest, harvest is synchronized with growth to provide a sustained yield of evenflow by decades for the indefinite future. The significant point is that trees to be harvested for lumber during the period 1973–80 must already be of sawtimber size now and will add little to their volume during the 7-year period. Those to be harvested during the decade 1981–2000 also are now mostly of sawtimber size or approaching it. However, trees tend to grow very rapidly in volume as they advance from 8 to 12 inches in diameter, hence trees of such size in 1973 can become an important component of total harvest during the midperiod, 1981–2000. Harvest for the 2001–20 can come in part from residual old timber carried forward from 1973, in part from trees in the 8- to-12-inch diameter class in 1973, but increasingly such harvest will come from trees that today are less than 8 inches in diameter. Some sawtimber by 2020 will be coming from trees that were seedlings in the 1970's.

The above implies two things:

1. That investments in forestry must be made at least one full tree rotation ahead of harvest, usually 40–80 years in the West, 20–30 years in the South; and
2. that timber growing stock must be so manipulated as to avoid an absence of trees of harvestable size during any decade of the total rotation.

Some persons looking at these time-supply relationships (table 4–1) might erroneously draw the conclusion that timber stand improvement, tree-planting programs, improvement of genetic stock, and other measures to increase growth of timber for future harvest have no significance for harvest in the 1970's. Such a conclusion is unwarranted: it is the prospect of future tree growth that determines the willingness of forest owners/managers to cut today. In deciding how much to cut from present stands of timber, the responsible owner/manager always has in mind how this will affect the kind of forest and volume of timber that will be available for future harvests. At one extreme is the small private forest owner, one whose land tenure averages some 8 years and an owner who is interested usually in early income from his forest. His tendency has been to make a sale as soon as he has an attractive offer. This results in a "loggers choice" cut of every tree that will yield a net return as it runs through the saw. Neither owner nor logger gives much thought to future timber growth from that area. At the other extreme, a large industrial forest owner with a substantial investment in processing plants and a real concern for a continued supply of wood will govern his present harvest very much by his concern for the future. Likewise, most publicly owned forests will be harvested with a real concern for the long-run supply of wood. In fact, present harvests are conditioned on meeting legally mandated provisions for assuring perpetual future harvests.

**TABLE 4–1.—Sources of Harvest for Softwood Sawtimber and Plywood, 1970–2020**

| Harvest source for softwood sawtimber and plywood | 1970's | 1980's | 1990's | 2000–20 |
|---|---|---|---|---|
| Trees of merchantable size, standing in 1972: | | | | |
| Wood in existence in 1972 | XXX | XX | X | X |
| Additional wood grown on these trees | O | X | X | X |
| Trees of unmerchantable size, standing in 1972: | | | | |
| Trees mature at harvest | | O | X | X |
| Thinnings of young but merchantable trees | | O | O | X |
| Trees planted or established after 1972: | | | | |
| Trees mature at harvest | | | | O |
| Thinnings of young but merchantable trees | | | | O |

Code: XXX=nearly sole source. XX=major source. X=important but not major source. O=minor source.

This table is in general, not specific, terms; it intentionally uses such terms as "sole," "major," and "minor" rather than specific percentages of volumes. It may not apply equally well to all tracts of softwood timber, but the dominance of present wood for the supply for the near future and the shifting sources of supply for later decades are applicable to most if not all timber areas.

## Response of Forest Owners to Price

Private forest owners tend to sell and harvest more timber when prices are high and less timber when prices are low but this response is by no means directly proportional to price changes. Evidence of supply response to price increases in 1970 and 1971 suggests an elasticity of about 0.5. The responsiveness among ownerships to a price increase, however, as measured by elasticity coefficients varies widely. It may be almost zero in some cases and approach 0.8 or 0.9 in others. In general, an increase in lumber price is soon reflected in higher prices for logs and stumpage and for standing timber in the forest. The price of stumpage tends to be more responsive to lumber prices than is the price of land on which to grow timber, especially if such land has little timber currently of commercial size. The several classes of forest owners tends to respond differently to a stumpage price increase.

An individual owner is likely to be highly responsive to price when offered what he considers to be a high price for timber he has already standing in his forest. He will be less likely to engage in precommercial thinning to increase growth on the remaining trees because the results probably would not be realized by him personally but might be realized by his immediate heirs. He would be still less likely to plant trees that could be harvested only during the lives of his grandchildren. The long-term response to price increases depends more upon the confident expectation for rising prices or maintenance of high prices relative to the cost of growing timber.

The case of a forest industry dependent largely on the output of its own lands is quite different. It too will tend to respond to price increases but when it harvests a specific forest area it will proceed immediately to plant it for a second crop so as to maintain a continuous timber output. The corporation has an indefinitely long life, idle land is an idle asset whereas young growing timber is an asset of high value.

Public forestry agencies without exception have a long-term planning horizon and a long-term dedication to continued forest production. Their ownership purposes involve much more than timber production; consequently, they may not respond at all by increasing sales when prices increase. In fact, small public forests such as those held by counties and many States are managed primarily for recreation and watershed protection: forest uses other than timber production. The same tends to be true of water company and Corps of Engineers forest lands. Accordingly, responsiveness to price increases may often be insignificant.

In the case of the national forests, however, arguments can be made that the timber sales should be increased when prices of stumpage are high, partly as a means of serving national economic policy: placing more timber on the market tends to restrain steep price rises. The sheer volume of timber now standing in the national forests (over 50 percent of the total softwood forest inventory of the Nation) means that sales from national forests can have a highly significant influence on log and lumber prices as well as on future supplies of timber.

The record housing construction activity that started in 1971 was stimulated by the national housing program. While demand for lumber and plywood rose, the timber offerings from the national forests were reduced each year thus adding to upward price pressures.

The domestic supply of wood in its various forms is also affected by wood exports and imports. In general, the volume of each is closely responsive to prices, both in the short run and over the longer run. As chapter 9 will show, the chief source of softwood imports into the United States is Canada; that country can increase its exports to the United States greatly if wood prices rise or remain high in the future. The United States exports logs largely to Japan and paper largely to Western Europe. Each is likely to take larger volumes in the future, but the amounts will be responsive to United States prices relative to prices from alternative sources of supply.

### Biologic Potential

Every acre of forest or farm land has a certain biologic productive potential. This is determined by the climate, by the character of the soil and its capacity to supply water and plant nutrients, and by the stocking of the land with productive vegetation. The biologic potential can be increased by irrigating arid soils, fertilizing soils lacking in plant nutrents, and cultivating soils to increase infiltration of water and air. In the case of agricultural crops, biologic potential is greatly increased by using superior genetic stock. This may also add to the biologic potential of forests for the purpose of growing more, high quality merchantable wood. The true parameters of biologic potential, however, are the basic site productivity factors of solar radiation, carbon dioxide supply, water supply, mineral nutrient supply, soil and air temperature, and the vegetation present to respond to the site. Primarily because of inadequate stocking or of stocking with vegetation of low or negative commercial value, the forest lands of the Nation as a whole are producing probably no more than 25 percent of their biologic potential. A few especially favored forest soils of the South and of the West Coast produce wood at the rate of 200 cubic feet per acre per year. Under very intensive management even higher growth rate might be achieved. When these values are compared with the current nationwide average growth rate of 38 cubic feet per acre per year, one can appreciate how far short of full biologic potential most of the forests of the United States are.

One point should be made clear to the reader. Thinning, weeding, and other forms of timber stand improvement do not result in increased photosynthesis nor biomass production. What such practices do accomplish is to concentrate the photosynthetic process on those trees deemed to be most valuable to man. Commercial thinning salvages trees that otherwise would die and permits utilization of their space and growth capacity by those trees selected for future growth. Thinnings, and other cultural practices achieve an increase in the value of the trees that are grown.

Another important reason for using superior genetic stock and intensifying forest management, in general, is to shorten the period between the harvest of one crop and the time in which merchantable timber can be cut from the crop to follow. In the South this can be reduced to 15 years; in the North perhaps 25 years would be required to produce trees of merchantable size that could be removed in thinnings. As sawtimber can be produced only on trees already of sawtimber size, one of the objectives of intensified management is to shorten the period during which the growth is placed on trees below commercial size, and to extend the period over which the growth is placed on trees that are increasing most rapidly in volume and in value. A limit exists, however, as to how long timber will continue to increase in growth rate and value per acre above that of the average for the rotation. At the upper limit of this period, it becomes more profitable to harvest the remaining trees and establish a new forest stand for the future.

### Control of Fire, Insects, and Disease Outbreaks

Until recently foresters attempted to eliminate fire from the forest and insofar as possible to stamp out destructive insects and tree diseases, especially those introduced from other lands. Such approaches have proven far from successful. Forests that in the past had been subjected to frequent fires and were then protected from fire for many years tended to build up a heavy accumulation of fuel. If ignition did occur under these conditions, disastrous wild-fires resulted which were extremely difficult to control. Moreover, research investigations have convinced foresters that light fires often do relatively little damage and tend to promote desirable tree reproduction. They may also greatly reduce the competition of unwanted hardwoods with valuable conifers. Prescribed burning has been a cheap and effective method of controlling the composition of future forest stands.

The reproductive capacity of insects and of many fungal diseases has proved to be such that efforts to wipe them out completely are doomed to failure. Sufficient seed stock always seems to remain for populations to buildup to outbreak proportions when conditions are favorable. The present approach to both insect and disease control is to seek to monitor populations and so manipulate them to keep damage within acceptable limits. This approach recognizes that for millenia forests have supported populations of insects, fungi, and various forms of wildlife in healthy ecosystems in which the balance between growth, death, and decomposition of plant and animal forms remained in balance for cycle after cycle. Effort, therefore, is now being concentrated less on distribution of insecticides and fungicides and more on bringing about an effective balance of forest growth with the other forms of life in such forests.

### Concentrating Efforts on the Most Productive Sites

In the discussion of biologic potential it was brought out that forest lands differ widely in their productivity. It is known that the more productive the land is for timber without management, the greater is the responsiveness of the land to intensified forest management. This subject is dealt with extensively in appendix D by Marty. In general, the forests of the South and of the Pacific Coast give the greatest response in terms of timber volume per dollar expended for intensified management. The spread between the best and the poorest in terms of yield on investment can be enormous, as much as from onefold to eightyfold in specific cases. It is interesting to note that the past practice most often recommended to private timber owners and for which the most Federal and other public moneys have been spent; namely, tree planting, is one that yields relatively low returns on the investment. However, without tree planting many sites may remain understocked or unstocked for decades. High returns follow precommercial and commercial thinning and such other timber stand improvement measures as releasing conifers from hardwood competition. To augment timber supplies for the period 1980 to 2000, precommercial thinnings and other timber stand improvement measures will pay far larger dividends in timber growth than can be expected from other options open to the landowner, including tree planting.

*The Panel recommends:*

That Federal efforts to increase output of timber on public and private forests be concentrated first on those sites, types and age-classes that yield the highest timber return per dollar expended.

## CONVERSION OF OLD GROWTH TIMBER TO MANAGED FORESTS

Most of the timber on the western national forests is old growth in which over millenia mortality has necessarily equaled growth. The ecologist recognizes that a forest reaches a maximum biomass in terms of standing timber per acre after which it can only decline in volume until rejuvenated or until the dominant species are replaced by others capable of growing in denser stands. Even then a decline in biomass usually occurs. Nature converts old growth to young forest by fire, windthrow or insect or disease outbreak. A forest manager converts by harvesting the timber and establishing a new stand by seeding or planting. Such a conversion is not easy to bring about, nor does the general public view the process with a sympathetic eye. However done, by nature or man, the area becomes unsightly until the new forest grows up to cover the soil and debris left on the ground. Great skill and considerable investment of money and labor is required to get a new stand established and freed of competing vegetation so that the desired trees will henceforth dominate the site.

Harvesting old growth and establishing a new stand is but the beginning of the long-term task of converting an unmanaged forest to a managed forest composed of a proper distribution of species, pure and mixed stands, age and size classes, and densities; and with annual workloads and product yields to make it a productive, well-organized, and smoothly operating enterprise.

The harvesting process introduces greater ecological diversity with concomitant enriching of variety in plant cover and wildlife populations. It also requires establishment of a road system which provides easy access to more of the forest for purposes of hunting, fishing, camping, and motoring for pleasure. Finally, such conversion leads to reduced danger of undesirable wildfires, and reduced incidence of the insect and disease outbreaks that often ravage decadent, old growth stands. However long and painful the process of such conversion may be, the end result—the well-managed forest—can be both a delight to the eye and a boon to mankind through its contribution to the national economy and general welfare.

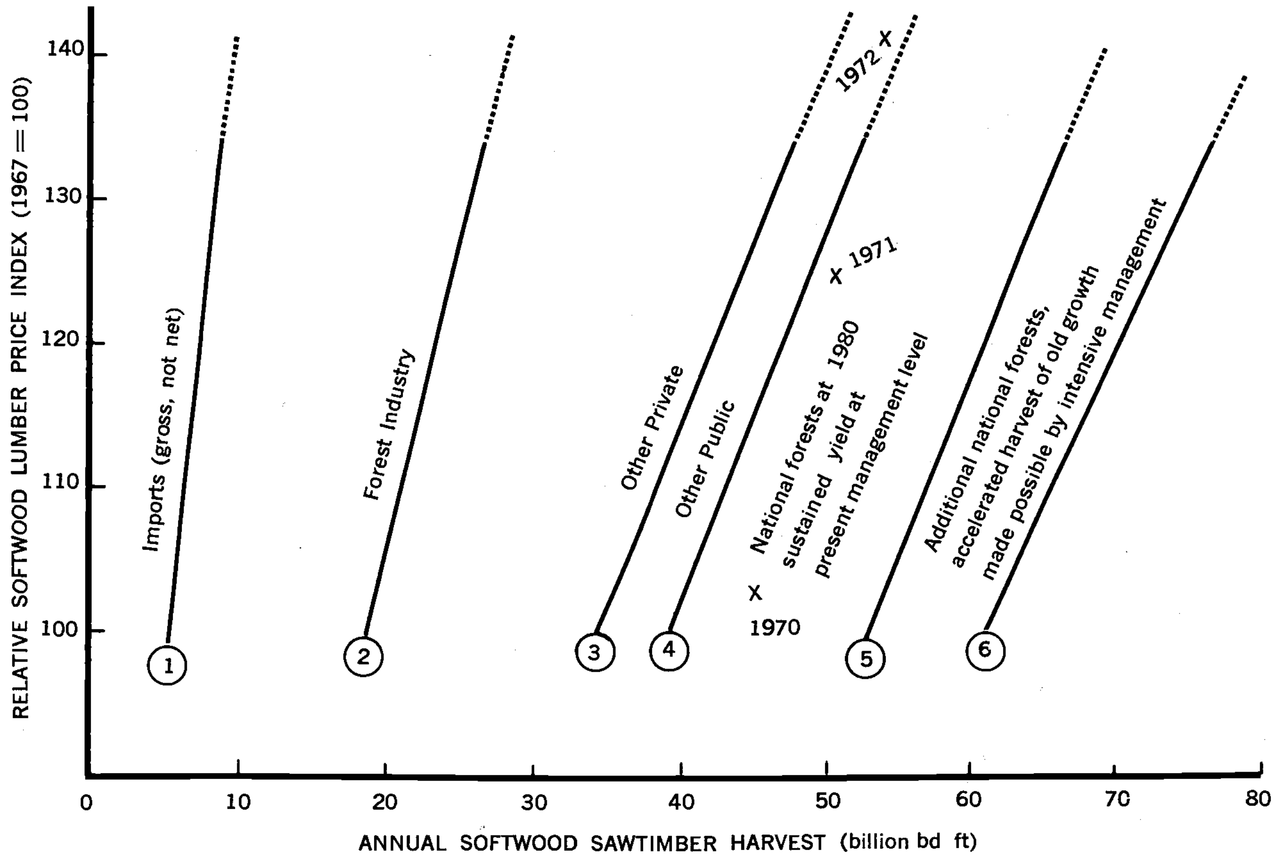
### Harvest Possibilities

As table 4–1 portrays, *softwood sawtimber harvest* for the remainder of the 1970's must come from merchantable trees already standing in 1972, and nearly all of it must come from wood already grown by 1972. The supply of sawtimber for the various wood demands to be discussed in chapter 5, therefore, depends upon the readiness of forest owners/managers to harvest some of this standing volume during the remainder of the 1970's; and in this decision, their concepts of future timber growth and inventory on their properties are decisive. One picture of annual softwood sawtimber harvest possibilities is given in figure 4–1; other pictures could be drawn, as the ensuing discussion will suggest. This figure is for a year of average business activity near the end of the 1970's. It must be emphasized that the data in this figure are possibilities only; how far they can be translated into actual supply will depend upon many factors.

Figure 4–1 is largely based upon data in "Appendix C: Softwood Sawtimber Supply and Demand Projections," by Robert Marty, which in turn is largely (but not wholly) based on Forest Service data. Volume of timber forthcoming at three relative price levels (103, 126, and 134 [1967=100]) was estimated for each of the major sources, as described below. The three points were connected by straight lines. Indeed, the points for the lowest and the highest prices could have been so connected and the point for the intermediate price would have fallen on the line in each case. The resultant supply curve does not rise more steeply as output reaches higher levels. The lines have been tentatively extended (by dots) above a relative price index of 134, up to the mid-140's; in late 1972 absolute lumber prices were 175 to 180 (1967=100) and lumber prices relative to the index of all commodity prices were in the 140's. The lines in each instance are harvest (or import) responses to price; they do not reflect the response of growth to price except as the latter influences forest owners/managers to harvest their standing timber. The figure portrays the separate response of timber harvest from each major source, as this is affected by price; the individual responses are cumulative at any given price.

There is good reason to believe that softwood sawtimber imports from Canada will be responsive to price during the rest of the 1970's; specifically,

FIGURE 4–1.—Annual Softwood Sawtimber Harvest Possibilities for the Balance of the 1970's




gross imports are estimated at 9 billion bf at a relative price index of 134. For the forest industry and other private forest lands, it is assumed that each 10 percent increase in price brings a 6-percent increase in lumber output (a supply elasticity of about 0.6). This increase is not immediate, at least in terms of increased harvest though it may be immediate in terms of increased sales from lumber inventories when these exist, but increased harvest is forthcoming in a few years. If the higher levels of harvest shown on figure 4–1 were achieved, this would be in excess of current sawtimber growth for the forest industry lands (see table 3–2). Hence these businesses might be unwilling to make this large a harvest, since it would mean some reduction in volume of standing timber which may already be at an economically efficient level. For the other private forests, even the larger volume of harvest shown on figure 4–1 is below the growth shown on table 3–2 so that inventories of sawtimber could still be increasing. However, many private small forest owners have been reluctant to cut their timber, valuing it for esthetic, recreation, or personal reasons, so that this response to higher prices may be unrealistically high.

For the federally owned forests it is assumed that volume of timber *sales* are *not* adjusted in the short run (over a period of 5 years or less) to meet relative lumber prices. A consideration of the budget-appropriation-expenditure process and a review of past Federal timber agency experience supports this position. Over a much longer run—from 1948 to 1968, for instance—timber sales from Federal lands have expanded as have demand and higher prices. The actual *harvest* of timber from Federal lands is determined, within narrow limits, by the forest industries which have Federal timber under purchase contract. In a time of active demand and high prices for lumber, such purchasers may cut relatively heavily from the standing timber they have bought. This happened in late 1971 and in 1972. But such increased harvest for 1 or 2 years must inevitably come to an end as volume of timber under contracts is drawn down. It is likely to be succeeded by harvest at or below sales volume for a short period. In figure 4–1, it was assumed cut equaled sales in the year considered; it might, in any year, have been more or less but would average out at this level.

For the national forests, the first volume of harvest shown on figure 4–1 is at the sustained yield level as this is now estimated to exist in 1980—at 13.9 billion bf. This may be compared with an estimated sustained yield of 12.7 billion bf in 1970. It must be emphasized that present (1972) timber cut from national forests is *not* up to the present sustained yield level, and that it is substantially *lower* that it was only a few years ago. In view of demands for reservation of national forest lands for nontimber uses, current Forest Service manpower levels, and presently established Forest Service timber sale and forest management practices, it may well be doubted that the actual supply of softwood sawtimber forthcoming from national forests will achieve the possibility shown in figure 4–1. It would, however, be possible to increase national forest timber harvest during the remainder of the 1970's by a program of accelerated harvest of old growth timber. On figure 4–1, this has been estimated at 8 billion bf of softwood sawtimber if lumber prices were low (an unrealistic outlook) and at 10 billion bf if lumber prices were higher (but below present levels). Such an accelerated rate of harvesting old growth timber would obviously impact on presently standing timber—but this is true for all sawtimber harvest of the 1970's from all ownerships. It would be acceptable and even desirable only if a program of intensified management were instituted on national forests.

In chapter 6, the supply and demand relationships at various price levels are considered, and policy recommendations made. At this point, however, it should be pointed out that increasing national forest timber sales by accelerating the harvest of old growth timber does *not* necessarily increase total timber harvest by amount of the accelerated cut. Increased Federal timber harvest would affect lumber price, if demand were constant, and this in turn would tend to depress harvest from other ownerships and also to depress imports. This relationship is explored in more detail in chapter 6.

Figure 4–1 also shows the volume of lumber produced and imported in 1970, 1971, and 1972, and the respective relative prices. The volumes are significantly *less* than the possibilities for the later 1970's. Timber harvest from national forests was below full sustained yield capacity; and timber harvest from other private forests was below their growth rate. The apparent price-volume supply relationship was somewhat *less* adjustable than the data in figure 4–1 assume, but a definite rise in supply as prices rose is evident.

The situation shown on figure 4–1 raises questions about the meaning of sustained yield. At its very simplest, it means growing and harvesting an equal acreage or equal volume of timber each year. This is possible only when the forest has an exactly equal distribution of trees in each age class and an exactly equal rate of growth in the land used for each age class. The forests of the United States have never had an age distribution even faintly approximating this ideal. Harvesting old growth and growing new stands of trees which will someday be harvested at much younger ages than the present stand are necessary to *grow* wood. It may mean, however, a fall off someday in volume of harvest timber unless annual harvest is so low that the period of old growth liquidation is spread over an extremely long time. Does the managing agency then insist upon an even flow of timber during the liquidation period and afterward? This seems to have been the Forest Service policy. In calculating sustained yield, how much consideration is given to measures to grow additional volumes of timber, when these measures have been begun but not yet proven, or when they are proposed but not yet begun? The Forest Service seems to have practiced an extremely cautious calculation of sustained yield in considering the influence of intensified management of the national forests. We do note that this subject is currently under review by the Service.

In chapter 6, the Panel makes recommendations about the level of national forest harvest for the next decade.

For an intermediate future period, 1980 to 2000, the supply of softwood lumber will also depend on many factors. If timber cut should be heavy in the 1970's, growing stock would be depleted and the cut in these two decades would gradually have to be curtailed if further depletions were to be avoided. In chapter 6, it will be shown that a relatively great acceleration of harvest of old growth timber on national forests for the rest of the 1970's would lower timber inventory on national forests by 4 percent or less. Intensified management during the 1970's, and continued into the 1980's and

1990's would make possible heavy timber cuts without seriously impairing growing stocks. The cutting of national forests, even if accelerated during the 1970's, could continue to be accelerated during the 1980's and 1990's, though at reduced rates.

A picture of the supply possibilities for softwood sawtimber for the entire period 1970 to 2020 is shown in figure 4–2. It should be emphasized that this is but one of numerous possible supply projections; it may not be the most likely one, nor the most desirable one. It assumes that softwood timber growth will increase slightly, even at current management levels, and that the increased growth can be harvested; a substantial early net addition to supply is possible by inventory reduction, primarily of old growth timber on national forests. By the 1990's, improved utilization of the timber grown will be making a significant addition to lumber supply; and shortly thereafter intensified forest management practices on lands of all ownerships, many of which would have begun in the 1970's, will be making a still greater addition to supply and will largely take the place of the harvest from inventory of the earlier years. It is assumed that net imports, mostly from Canada, will also increase.

Most of the Panel's recommendations about timber supply are postponed until demand for wood products and prices have been considered. Some recommendations which are largely independent of the supply-demand balance follow.

*The Panel recommends:*

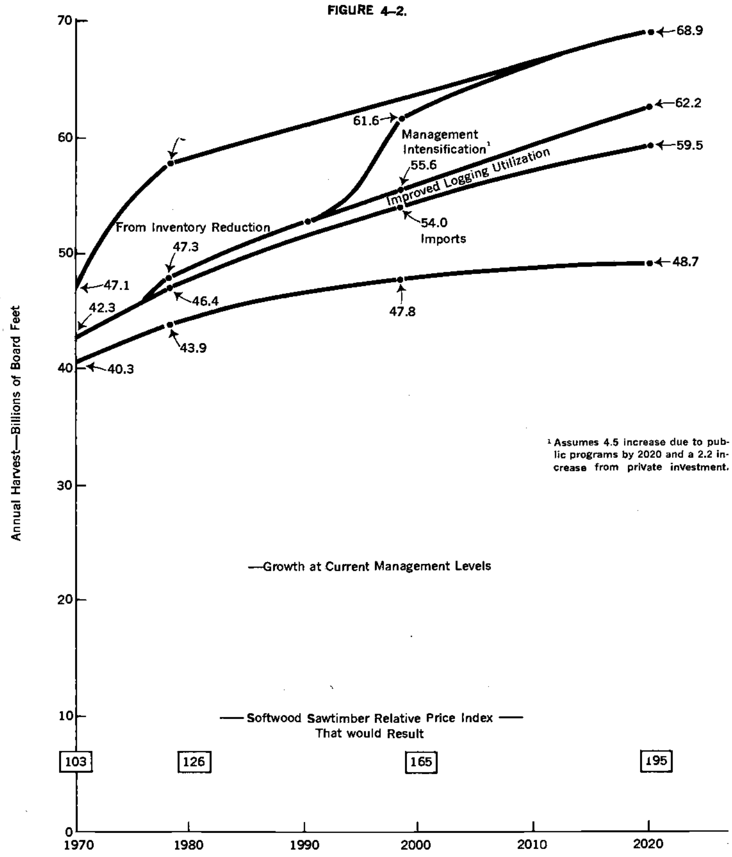
1. That the Forest Service redefine its classification of forests into commercial and noncommercial categories, in order to arrive at more realistic figures on area, standing timber volume, and annual growth.

2. That a classification of commercial forests according to site quality or productive capacity be completed as rapidly as possible.

3. That the Forest Service reconsider its timber management priorities, in order to concentrate more of its efforts, manpower, and funds on intensive management of its more productive sites.

4. That research be supported to measure more accurately than has been done to date, the responsiveness of timber harvest and timber growth to price. Such research should consider forests of different types, site classes, and ownerships, and should measure the speed, certainty, and volume of the response. The forest policy board proposed in chapter 11 might well stimulate such research and evaluate its results.

FIGURE 4–2.



chapter 5

# Potential Demand for the Output of Forests[1]

"Demand" is a word of several meanings when applied to forest products and services; two of the most important are: (1) The economists' meaning of a quantity and price schedule—how much is sold (or purchased) during a given time period at various prices; and (2) a popular concept, under which "demand" is essentially equal to volume or use with no consideration of price. We use both senses of the term but distinguish between them by use of quotation marks around demand used in sense two.

The demand for all forest products and services is best measured at the point of use or consumption. For intensive outdoor recreation, wilderness experience, and similar services of the forest, demand exists at the forest for it is only there that the service can be utilized. For the various wood products, the point of consumption is outside the forest such as the printing plant for paper, the construction site for lumber and plywood, and so on. From the overall demand at the point of consumption, component demands may be derived at earlier points in the production process—lumber at the mill, stumpage in the woods, and so on. Transportation costs and processing costs markedly affect the timber value in the forest.

For all forest products and services, demand is more local or regional than national. Some personal use of the forest, as for outdoor recreation or wilderness experience, may indeed draw people from long distances, but in fact most of the use is relatively local, with numbers of visitors falling off rapidly as distances increase. It costs time and money to travel to a forest site, and the greater these costs, the lower the participation of people who live distant from the site. Wood is both bulky and heavy, hence only that of good quality is suitable for transport to a distant market.

## NONTIMBER OUTPUTS OF FORESTS

For outdoor recreation, wilderness experience, wildlife, watershed use and related purposes, "demand" is essentially synonymous with volume use. Thus, when someone says the "demand" for outdoor recreation in some forest is heavy, he means that the total number of visitors is large. They may, or may not, pay a fee for the recreation opportunity but if they do, it is likely to be nominal.

In chapters 2 and 4 attention was called to the growing public interest in a healthy, attractive forest environment. Large numbers of vocal people, some well informed and some less so, have rather strong convictions about the kind of forests they think should be maintained in this country. They may push for legislation affecting both public and private forests in such matters as methods of timber harvest (clearcutting, for example) and seek through administrative and judicial channels to influence the management of publicly owned forests. For some of the privately owned forests, used primarily by the owner and his friends for nontimber purposes, the conviction as to the desirable form of the forest may find some degree of expression in a market sense. It is hard to describe this kind of interest in forests, and virtually impossible to measure it; yet it would be foolish to ignore its strength and the probability that it will find increasing expression in the years ahead. In the economist's language, individuals are said to derive "psychic income" when they attach real value, no matter how difficult to measure, to knowledge of the

[1] For more detail on the subject matter in this chapter, see "Appendix C: Softwood Sawtimber Supply and Demand Projections," by Robert Marty; "Appendix O: Forest Recreation: An Analysis With Special Consideration of the East," by the Panel staff.

mere state of being of some entity such as an endangered species of a forest.

Engaging in outdoor recreation in a forest setting involves costs for travel to the site, specialized recreation equipment, supplies, and other items. Thus, even if no charge is made for use of the forest area, the whole experience is not free. Where recreation use of the forest is unrestricted, each person uses it to the extent that the costs of so doing equal the value to him; relatively nearby residents, whose costs are lower, make more use of the forests than do more distantly located people of similar incomes and personal characteristics. If users of the forest had to pay an entrance fee, then some would reduce visits or not come at all.

Recreation use of forests ("demand") has been rising steadily and rapidly for many years. Several factors are involved: (1) The number of people has increased, and more of them live in urban and suburban locations which they are anxious to leave during part of their leisure; (2) average incomes have risen, permitting more discretionary spending, some of which goes to outdoor recreation; (3) leisure has increased, including more young people not yet in the labor force, more retired people, and longer paid vacations for workers; (4) methods of transportation have improved with better roads (including the Interstates), better cars, more plane service, etc.; and (5) a preference for outdoor recreation appears to have risen.

The effect of each of these five factors has been to increase "demand" for outdoor recreation steadily and rapidly and will continue to do so into the foreseeable future.

All the studies of future "demand" for outdoor recreation have reached the same general conclusion that is stated here; they differ only in their precise estimates of numbers. The Bureau of Outdoor Recreation is now making a national plan for outdoor recreation which should produce more accurate estimates of future demand, in both senses of the term, than have been available. The Panel has not attempted to make a numerical estimate of future numbers of recreation visitors for the national forests or for all forests of the Nation but validly concludes that the future demand (in both senses) will be substantially higher than at present because past trends clearly show that this likely will be the case. At the present growth rate, total recreation attendance doubles each 8 years; this rate of increase cannot go on much longer, but even a slower rate of increase might easily see two, four, six, or more times as many recreation visits to all forests in a few decades as are reported today.

The wilderness experience is a particular form of outdoor recreation; all of the foregoing factors apply to the wilderness experience but with increased intensity. Use of wilderness areas has increased at a more rapid rate than has outdoor recreation as a whole, although it is still only a small fraction of total outdoor recreation. Use of wilderness areas has been stimulated by organizations which promote travel into such areas. Were it not that human crowding debases the wilderness experience, then wilderness activity would almost surely continue to increase at a relatively rapid rate for a long time into the future. The potential demand for wilderness experience is great and the capacity to provide it is limited, regardless of how much land may be reserved for wilderness use.

The "demand" for wildlife in forests is closely related to the foregoing. The opportunity to see wildlife, photograph it, and to hunt and to fish are important outdoor and wilderness experiences and a much cherished right extending back to colonial days. There is also a scientific and a general conservation interest in wildlife, not specifically related to outdoor recreation as such. These types of "demand" for wilderness will increase in the future too.

Water is becoming an increasingly valuable resource in the American society and economy; perhaps greater concern has been expressed over its quality than over its quantity. The Federal Government has provided several billions of dollars to help cities and other units of local government treat their waste waters, as well as proposing regulations and instituting other actions to improve water quality. With these solid expressions of national concern over water quality and quantity, the relation of forests to water becomes increasingly important.

These varied concerns and actions for nontimber outputs of the forests reflect deep convictions on the part of growing numbers of people. The concern is often more an emotional than an economic one; many of the people who feel strongly have little or no personal economic stake in the matter, nor even necessarily a personal use stake. They have strong convictions about how forests of all ownerships especially public forests, should be managed and this concern is proper and laudable. Foresters have tended to underestimate the strength and intensity of such attitudes; "good



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forestry" is not a sufficient defense for forest management practices which many people believe—perhaps mistakenly—will adversely affect outdoor recreation, wilderness areas, wildlife, conservation, watersheds, or forest esthetics. The Panel hopes that such attitudes will affect forest management positively, and this entire report supports that end.

At the same time, it must also be emphasized that much of the apparent "demand" for outdoor recreation, wilderness experience, and other facets of nontimber uses has been stimulated by public and private pricing of such outputs. The recreationists have incurred travel and other personal costs, but they have rarely paid for the forest recreation opportunity at a level to cover the costs which their activities imposed upon the forest manager, whether public or private. Neither have they paid sums equal to the value of the recreation experience to them, much less paying amounts which would have produced a profit from the forests. In short, recreationists have had access to forests, both private and public, either without charge or at very nominal cost. Their demand for all of these nontimber outputs has been greatly stimulated by this method of pricing. Had the users of these nontimber outputs paid all the costs their use entailed, their demand would have been lower, perhaps substantially lower. The building of a new campground, which people may use for charges which do not begin to cover costs, stimulates demand and this has been the rationale for building another campground.

The demand for these various nontimber outputs of forests has thus been stimulated by both public and private policies. At an earlier time—three or four decades ago—such pricing might have been defensible because their uses of forests were so low; today, its consequences are far more serious. Private forest owners have been reluctant to impose charges commensurate with the value of the service when public areas were available free or nearly so. They feared adverse public reaction. Public agencies are only beginning to impose charges for outdoor recreation which approximate the administrative costs of providing the areas and services. The primary responsibility for policy in this area rests with the Government.

The low charges, or none at all, have been a form of subsidy to recreationists and others who benefited from these nontimber outputs. This subsidy has not been on the basis of need or ability to pay; on the contrary it has benefited those who could afford the necessary outlays.

The Panel's recommendations on nontimber uses of forests are postponed to chapter 6, where the balancing of supply and demand is considered.

## FOREST TIMBER OUTPUTS

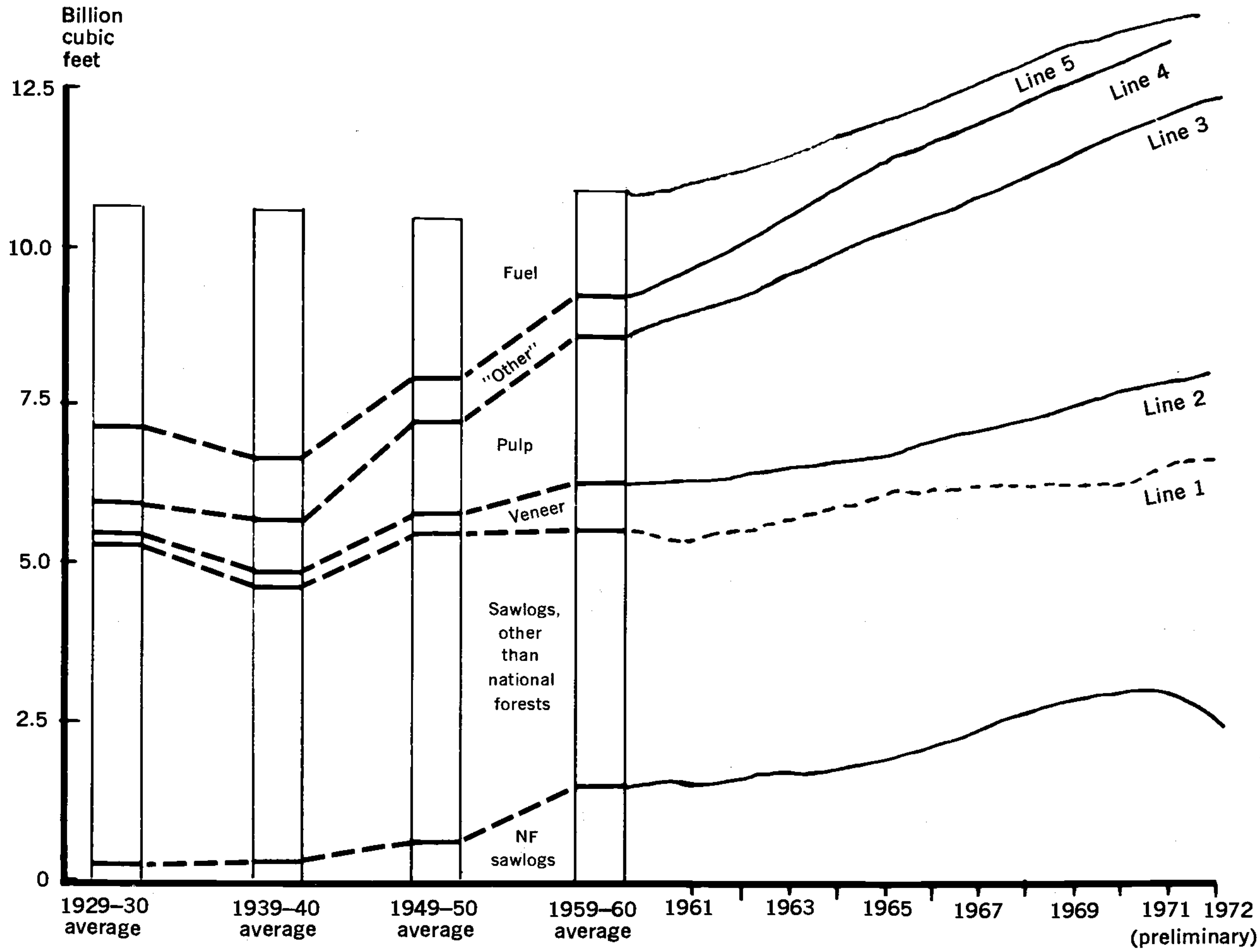
Wood is a versatile raw material and is used for many purposes. As figure 5–1 shows, the dominant uses of wood are for lumber, plywood, and pulp (for paper), with approximately 50, 10, and 30 percent, respectively, of the total roundwood harvest in 1970. About a third of lumber consumption in 1970 was for the construction of new homes; this is the part of lumber consumption which varies most from year to year. Additional lumber is used for residential upkeep for improvements, nonresidential construction, shipping, and a host of miscellaneous uses. Plywood is used for the same general purposes as lumber, in somewhat similar proportions. Paper is used for many purposes, including printing, packaging, as components for building board and other construction materials, and in numerous miscellaneous ways. Supplies of all these consumption products are augmented in some degree, by imports, particularly softwood imports from Canada and hardwood imports from various Pacific countries.

The production of lumber varies from year to year, depending largely upon the general business activity and on construction in particular; but total volume of lumber production up to the mid-1960's had not exceeded a level reached as early as 1908; in the past half dozen years it has increased somewhat (fig. 5–1). In contrast, the volume of both plywood and of pulpwood harvested annually has risen rather steadily and to a substantial degree over many years.

The supply, demand, and price policies for softwood, and more particularly for sawlogs and veneer logs, are more serious than for hardwood. This is not to deny that there is concern about the adequate supply at reasonable prices of hardwoods of good quality in the right locations, but national attention focuses most on softwood supply problems, hence the following discussion is directed toward demand for softwoods.

A number of socioeconomic factors affect the demand for softwood lumber, plywood, and paper; these factors affect the volume of each product

FIGURE 5–1.—Removals (harvest) of wood fiber, all forests in United States, by type of wood, stated years 1929 to 1972




that will be taken at any given price, or affect the price that will balance supply and demand at any given volume.

One major factor is total population in the United States which has risen steadily in the past, to about 207 million in 1971. Birthrates have dropped dramatically in the past decade and if continued indefinitely at the present level would lead to a stationary population in time. However, the present age distribution of the population is such that increases in total population will continue for two generations even at a fertility rate which will ultimately bring a zero population growth. Moreover, it is dangerous to assume that the recent downward trend in birth rates will continue or that it will not be reversed. The best present population outlook is for a total population ranging from 266 to 301 million in 2000. Whatever may be the longer run projection, population is increasing in the 1970's and will almost surely reach the 225- to 230-million range by 1980.

For wood demand associated with housing construction, including demand for wood for furniture and other articles in the home, the rate of formation of new households is more significant than the rate of total population growth. New household formation is a function of the number of young people in their twenties, since this is the general age of marriage and establishment of new homes. It is also a function of the tendency of young unmarried and of older persons, often single, to establish separate homes. There has been a marked trend toward single- and two-person households in recent years. This in turn has been partly a function of average income levels; when incomes are relatively high, many younger and older persons establish their own households when under other circumstances they would have lived with parents or children or with others of their own age class. Household formation for the 1970's and 1980's is affected relatively little by birth rates in those decades; if birth rates are high, perhaps more couples will establish their own homes, or will seek larger homes, than if birth rates are low, but the differences will not be great. The number of children and young people under 20 years of age in 1972 provide a relatively accurate index to the formation of new households in the following two decades. By any reasonable estimate, numbers of new households in the 1970's and 1980's will considerably exceed, perhaps by 20 to 30 percent, the rate of the late 1960's. By 2000, the rate of new household formation may well drop to or below levels of the 1960's. After 2000 further drops in the rate of new household formation are at least probable though by no means certain. The housing shortage will be particularly evident in the next two decades.

A second major component of the housing demand is the replacement of units that become no longer usable. During the 1960's, replacement accounted for about 40 percent of all housing construction. Much of the total housing stock is old, and relatively undesirable because of age; some other housing is also undesirable because substandard in one or more of several characteristics. Housing replacement is very much a matter of income levels; in times of depression, people are willing to live in shelters which they will reject in times of prosperity. It is notable that many large cities have thousands of abandoned and derelict housing units today; yet many people still live in unsatisfactory dwellings. Replacement housing will be larger in the 1970's and 1980's than it has been in the 1960's and might easily be 50 percent or more. Since housing replacement primarily affects low-income people, either directly or on a "trickledown" basis, public policy on housing is particularly important in affecting the volume of replacement housing.

A national housing goal of 26 million new housing units during the decade following 1968 was adopted in the Housing Act of 1968. The rate of housing construction has risen significantly since 1968. Though the goals may not be met, the rate of construction during the 1970's will almost certainly run well ahead of that in the 1960's. This housing goal, if achieved, will go a considerable distance toward replacing the substandard housing present in the 1970's. However, replacement housing will still continue high, in part because not all substandard houses will have been replaced by 1978, in part because aging will make other units substandard, in part because mobile homes have a relatively short useful life, and in part because standards of housing will almost surely continue to rise. Demand for housing will remain high at least through the 1980's because of the fairly certain high rate of household formation implicit in the large number of young people today.

The consumption of housing and many other products (such as furniture) which use wood is much affected by the average per capita income. This has risen rather steadily in the past, and is likely to continue to do so. Per capita income (in 1967 dollars) was just above $3,000 in 1971; by 1980 it may range from $3,700 to $4,000; by 1990, from $4,800 to $5,400; and by 2000, from $6,300 to $7,500, all in constant dollars. The precise figures at these dates are, of course, impossible to foresee; but the general trend is agreed upon by almost all economists.

Paper consumption per capita has risen steadily and by about four times since 1920. In part, this may have been due to the relatively stable prices of paper compared with the general price level, but it also measures some rather fundamental social and economic trends in the American society and economy. We are a paper society; paper is essential to communication for personal, business, and public purposes; paper is a packaging material of great usefulness. The trend in paper consumption is clearly upward, and total consumption might well double by 2000.

In addition to the foregoing socioeconomic factors which will affect consumption of wood and wood products during the future years, there are several factors more directly concerned with wood which will also affect its consumption during the same period. As with virtually all other commodities, the volume consumed is a function of the price at which it is available. The demand for lumber and plywood, and so to some extent that for paper, is derived from the demand for the end product. The response in consumption to changes in price is partly a function of time. If lumber and/or plywood prices rise, a builder usually cannot make much adjustment in wood use for the buildings already under construction; greater adjustments are possible for later construction. There is little solid evidence as to the extent and the timing of the adjustment to changing prices (elasticity of demand). The Forest Service estimates that a 10-percent rise in lumber and plywood prices will result in a 1 percent reduction in consumption in the first year, a 3 percent reduction in the fifth year, and a 5 percent reduction in the 10th and subsequent years. These seem reasonable, but it must be emphasized that they are largely judgment figures, not yet fully supported by solid economic analysis. The consumption of paper and its products is estimated to be less responsive to price—one-half of 1 percent, 1 percent, and 2 percent reductions in response to a 10-percent increase in price, after 1, 5, and 10 years, respectively.

Over the past several years there has been a trend toward less lumber and more plywood per dwelling unit constructed. Houses and other dwelling units have tended to become larger, in response to higher incomes of average families. Further increases in average size of dwelling units newly constructed are expected for the future, as are further shifts to plywood instead of lumber use. There has also been some trend toward the use of substitute materials instead of lumber. In particular, steel has been increasingly used for studding in houses, as has aluminum for siding. Some of this is in response to price of wood, and thus contributes to the elasticity of demand for wood, but some might have occurred under any circumstances. The net effect of these various substitutions of other products for wood and of one kind of wood product for another, together with a probable increased average house size, is likely to be a slight decline in total wood use per dwelling unit built in the future.

For paper products, recycling or previously used paper is a source of material to augment wood. Although there has been some increase in the tonnage of paper reported as recycled in recent years, this increase has been relatively less than the increase in total paper production. As a result, wastepaper has declined from nearly 35 percent of all wood fibers in 1920 to 19 percent in 1971. Increased interest in the waste disposal problem has led to much interest in recent years in paper recycling, but many obstacles to increased paper recycling remain. Some problems are technical—"paper" is really paper plus ink and many other "contaminants," and paper loses fiber strength with each recycling. In our society the major problem is an economic one. The costs of collecting used paper for recycling may be too high to be justified by the end product price or by savings in wood used, given the present market structure.

The Panel has not attempted detailed economic and technical analyses of the demand for wood; the Forest Service has made far more elaborate studies than the Panel could possibly make, and its results are now available. The Panel's consultant, Robert Marty, in appendix C, has utilized Forest Service data and analyses and added some interpretations of his own. The Panel has devoted more attention to the years in the remainder of the 1970's than has the Forest Service whose focus is more upon the longer run future. In general, the Panel considers the Forest Service estimates of quantities consumed under different price and economic conditions as reasonable, more probably on the low side than too high. In our judgment, the Agency's range of probable prices does not extend sufficiently toward high prices; the Panel uses its own estimates in chapter 6. Forest Service studies clearly indicate that the quantity of wood, consumed in the future will be much higher than in the past, provided available supplies permit and if prices are favorable. The Panel agrees with those indications. While it is important to make the best economic analyses and projections that present understanding and information permit, such projections remain imprecise. The general direction of demand is upward; the general magnitude of the projected increase in domestic consumption of softwood roundwood is 10 percent for 1980, 25 percent for 1990, and 45 percent for 2000, at relative prices above 1970 of 30 percent for lumber and plywood and 10 percent for paper. At higher prices, the increase would be less. The public policy issues, discussed in chapter 6, relate to the desired price and consumption levels, and how they might be attained.

In addition to the domestic demand for wood, discussed in the preceding pages, there is an export demand also. In recent years, there has been a movement of logs from the Pacific Coast to Japan, which has increased from minimal amounts in the 1950's to 2.8 billion board feet in 1970. The Japanese use these logs to manufacture wood products, including lumber and plywood, and for housing. This demand was sharply upward in late 1972, and is likely to remain high and perhaps to increase further in the future. Japan is embarking on a major program of dwelling construction to remedy her serious housing situation. Japan has sought and will seek wood from other sources, but the Pacific Coast is an important source for Japan's supply. Her imports of logs are somewhat price responsive, although greatly influenced by Government programs and by economic-social conditions unrelated to log price.

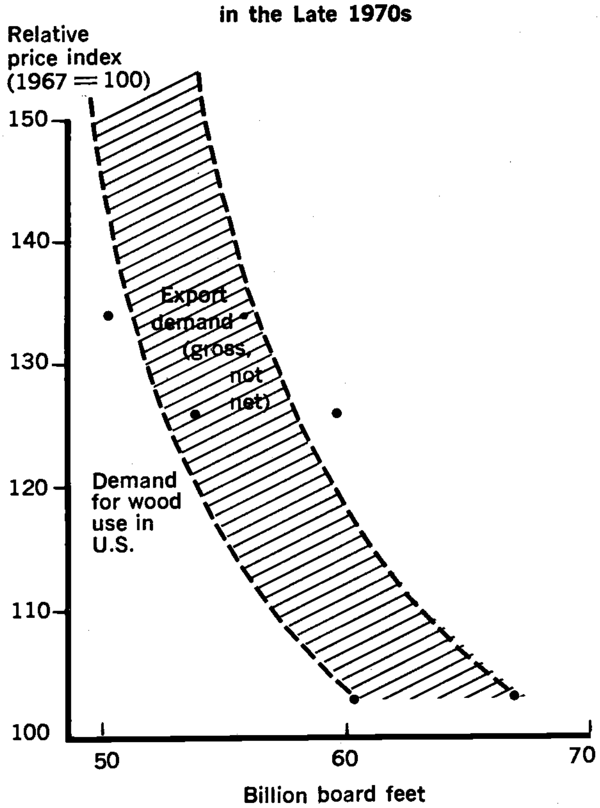
Japan has also bought a considerable volume of woodchips from the Pacific Coast. These chips have generally represented, in the past, species, volumes, and forms not in high demand on the Pacific Coast so these exports have largely represented material which otherwise would have had no market. This export market permits a better job of a wood's management, by providing for economically profitable cleanup of slash and other residues. It also makes possible logging and utilization of materials that otherwise would not be economic. It seems probable that Japan will continue to take such chips in any volumes which are likely to be available.

There has also been an increasing export of U.S. paper to Western Europe. Countries in that region are expanding their use of paper, in trends parallel to the United States but at lower per capita levels. The United States is only one source of paper, the other being the Scandinavian countries, Russia, and in the future possibly some tropical nations. U.S. exports of paper to these countries is likely to be price-responsive.

One picture of the demand for softwood sawtimber, for a "normal" year toward the end of the 1970's, is summarized in figure 5–2. The data for this chart come from appendix C and thus, at least in large part, from the Forest Service. On the basis of estimates of likely population, household formation, economic activity, and other projections, the volume of wood that would be used in the United States (wherever it originated), and the volume of U.S.-produced wood that other countries would demand was estimated for three relative prices of lumber (103, 126, and 134). These three estimates of volumes at the respective prices are shown in figure 5–2 by heavy dots. These estimates purport to show demand in a particular year in the relatively near future; in this sense they are shortrun demand curves. They show the effect of price upon consumption (including exports), but do not show the effect upon supply; this will be considered in chapter 6.

If a demand curve were constructed by connecting these dots with straight lines, a most peculiarly shaped demand curve would result. Its position and slope at lower prices may not be unreasonable, for both domestic use and for exports, but its slope

FIGURE 5–2.—Annual Demand for Softwood Sawtimber in the Late 1970s




at higher price levels is contrary to all expectations in economic theory. For longer run demand curves, discussed later, it might be argued that demand will become elastic at high prices because of the substitution effect—the substitution of other raw materials for wood. But, for the remainder of the 1970's, substitution on a truly large scale seems less likely. The Panel concludes that a smoother curve, somewhat reflecting the location of the three dots for the 3 years but somewhat independent of them, is more reasonable, and this has been drawn on the figure. In addition, it has been extended to higher relative prices than were used in the source. In this connection, it should be recalled that relative lumber prices in late 1972 were about 146; absolute lumber prices were 175 to 180 (in each case, 1967 = 100) but the prices of other commodities had moved up to about 120.

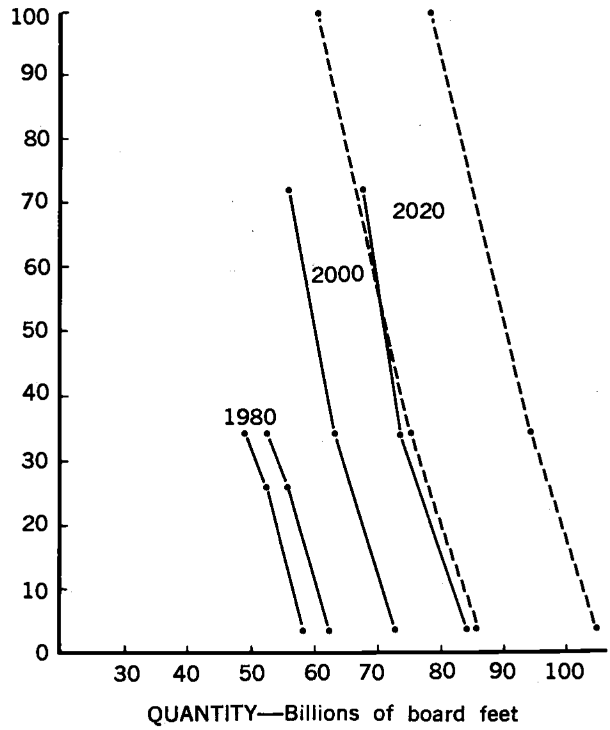
Regrettably, great reliance cannot be placed upon either the position or the elasticity of the demand curves shown in figure 5–2 yet they are basic to any recommendations as to timber supply policy. *The Panel* feels that additional research on timber demand is urgently needed, and *recommends* that the forest policy board, proposed in chapter 11, undertake or commission such research. Lacking more accurate and dependable demand analyses, any recommendations about timber supply, demand, or price are necessarily somewhat arbitrary and may be unreliable. However, despite the deficiencies, it is quite clear that rising prices reflect a very strong demand.

For the longer run future, the total demand for sawtimber within the United States will depend partly upon the date and partly on assumptions about such variables as total population, new household formation, average per capita income, and other variables. The quantity consumed at each date and for each assumed set of conditions will also depend upon prices of lumber and other products (fig. 5–3). These are now longer run demand curves, reflecting conditions which will exist over a considerable period of time. For them, it may be argued that demand at higher prices will be somewhat more elastic, because the opportunities to substitute other raw materials will be greater. However, all the curves shown on figure 5–3 raise questions—those for 1980, because of the peculiar shape at higher prices, those for later years, because they so closely parallel earlier years which means a significant shift in elasticity for which there is little real evidence.

There are some aspects of figure 5–3 which do seem reasonable and important. At each date, quantity consumed will depend in part upon price. At any price level, the quantity taken will increase over time, under the influence of changing economic and social conditions. A likely course is that at each future date the volume will be higher as will also the price. The shift will be to a somewhat different demand curve and to somewhat higher prices along the same curves.

It is clear from the foregoing that there exists no such thing as the "need" for wood products, not

**FIGURE 5–3.—Projected Demand for Softwood Sawtimber**




even a single demand for them. Much depends upon other variables, such as population and income dynamics, national housing policy as reflected in funded public programs, concern for the environment, and the like. Moreover, it is clear that at every date and level of housing demand, the price at which wood products will be available will affect the quantity consumed. The availability of wood supplies at various prices was considered in chapter 4; now we need to match demands and supplies, to see at what level they are equal, and what the price will be at that level, and then to consider the national policy implications of such prices. This will be the subject of chapter 6.

# Demand—Supply Balance, Price Relations, and Policy Implications

Demand and supply are brought into balance by price, the equilibrating mechanism. Demand may be stimulated by advertising, promotional selling, subsidies, or other devices; or it may be restrained by taxes, public limitations on transactions, monopolistic restraints, or in other ways. Likewise, supply may be either stimulated or restrained. If prices are allowed to move freely, then demand and supply come in balance at some level of prices. If prices are restrained or confined, there will be shortages unless means are found to reduce demand or expand supply. If prices are artificially high, there will be overproduction unless means are found to increase demand or contract supply. The role of price as an equilibrating mechanism works for competitive, monopolistic, or semimonopolistic markets, and works whether supply or demand is quickly and closely responsive to price or is sluggish and uncertain.

Policy issues may arise if the price seems unreasonably high or unreasonably low; prices may be modified by various kinds of actions, but manipulation of demand or supply or both is necessary to avoid serious dislocations. There may be reasons why the electorate wishes to establish prices higher or lower than would arise in the market, but efforts are more likely to bear fruit and to avoid greater dislocations, if they are based upon an understanding of the supply-demand situation.

These statements apply to lumber, plywood, and other wood products from the forest. Demand will exceed supply only if price is somehow controlled; if prices are allowed to move freely, then demand and supply will be brought into balance. From the market viewpoint, timber "famine" or timber "shortage" results only at some price other than a freely determined one. In this study, the Panel explicitly rejects the idea that some level of supply must be achieved, regardless of cost. Demand, supply, and price must be examined together, and policy determined in light of their interrelationships; that is the function of this chapter.

In rejecting arbitrary levels of demand and of supply, the Panel does not reject the idea that prices of wood products are a significant issue for national policy. The creation of this Panel grew out of a dissatisfaction with occasional sharp rises in wood product demand and prices, and with tight supplies which had forced those price rises. A national government may be dissatisfied with the supply-demand-price situation for any product and may undertake programs to bring about a new balance. But such programs must recognize these interrelationships, or else they are likely to be misconceived, may well fail, and may create more trouble than they cure.

## DEMAND-SUPPLY BALANCES FOR NONTIMBER OUTPUTS OF FORESTS

In chapter 4 we considered the supply potential and chapter 5 the demand for the nontimber outputs of forests such as outdoor recreation, wilderness experience, wildlife, and water. Since these outputs are not commonly sold in a commercial market, their prices are not competitively determined. Many carry little or no price, or in the

[1] For more detail on this subject, see "Appendix C: Softwood Sawtimber Supply and Demand Projections," by Robert Marty and "Appendix G: Timber Sales Policies and Procedures on National Forests in Relation to Short Run Timber Supply," by Carl Newport.

case of public lands are determined administratively or legislatively, not by economic competition.

The Panel was established to study and recommend policies with respect to timber production and the environment; a strict construction of its task might suggest that it should not be concerned with price and related policies for the nontimber outputs of the forest. But these nontimber outputs compete for forest land and to some extent for forest stands or inventories; many advocates of wilderness and other nontimber outputs of the forest have sought to restrict the harvesting of timber from forest lands, especially from public lands. The Panel cannot ignore these nontimber uses of the forest; on the contrary, it has sought to give them full recognition and protection. But one aspect of such nontimber uses of the forest is the pricing policy with which such uses are made available. A reasonable interpretation of our task, therefore, must include consideration of pricing policy for nontimber resources.

The supply of nontimber outputs would probably be responsive to prices provided charges were made for these on both public and private lands that reflected the costs of providing them. Supply increases, when they occur at present, are more likely to be in response to a political than to an economic process. The "output" of these products is partly due to the inputs of labor, capital, and management, and partly to innate forest resources. The amounts of these other inputs, and the resultant increases in supply, are probably least for the wilderness experience; by definition this output per unit of land area must be small, and is largely but not wholly beyond response or increase. To some extent, the same general statement applies to the watershed function; the objective of forest management is more likely to be to preserve the quantity, quality, seasonal flow, and the like of a natural watershed, than it is to improve any of these characteristics. The esthetic values of a forest often may need preservation; they can also be enhanced when management includes artistic and landscape input such as occurs in many Eurasian forests. Limited possibilities exist for more or better output of each of these services or products of the forest. On the other hand, the provision of opportunity for the more popular forms of outdoor recreation can be increased greatly, as additional forest areas are set aside for this activity, and as more labor, capital, and management are invested for their development.

The demand for these noncommercial outputs of the forests has surely been stimulated, in some degree, by the lack of a price for their utilization or by free access to them. As we noted earlier, the recreation experience as a whole is not free, since costs— sometimes substantial ones—must be incurred in travel and for other necessary actions to enjoy the forest area. Likewise, water at the farm or in the city home is not free, because costs must be incurred to transport it from watershed to point of use. But little or nothing has been paid for the resource as such; in the economist's terminology, no rent has been charged.

The Panel concludes that complete reliance on pricing, as a means of allocating outdoor recreation and other noncommercial outputs of forests, would be undesirable. When the entrance fees or other charges (prices) for outdoor recreation are very low or zero, the extent of use is stimulated, overuse to the physical detriment of the area is likely to occur, and psychological value of the recreation experience may have been degraded by the resultant crowding. Further, the subsidy has gone to sectors of the populace generally affluent enough to pay the cost of providing the facility they use. While it would be theoretically possible to establish fees or charges for outdoor recreation which would reduce attendance to any estimated carrying capacity, such fees likely would be unacceptable to the public. They would stop the physical damage from overuse, and they would remove the subsidies, but they would almost surely be so high, at least for many areas, as to be offensive to a large segment of the total public. Recreation use of forest areas will have to be influenced by other means, including the provision of additional areas to siphon off some of the heavy demand.

Although complete reliance on prices for outdoor recreation is undesirable, the Panel judges that substantially greater use of pricing mechanisms can and should be made in the future. We judge the stimulation of recreation activity, as a result of low or zero charges for use of forest resources, to be unsound from a national policy viewpoint. As long as charges are low on public lands, they cannot rise much above this level on private lands; no incentive then exists for the private forest owner to develop the recreation opportunities that his land might provide. Thus, not only is the demand stimulated on the public lands, but the potential supply is unrealized on private land. Subsidies to relatively affluent recreationists would seem to be unnecessary on public lands.

A further reason for pricing recreational use on public land is to acquaint the users with the actual costs involved in providing and servicing facilities and with the extent of income foregone from associated lands to elevate visitor pleasure. Direct costs involved in building, maintaining and servicing picnic areas and campgrounds can readily be appreciated by the users. They are less likely to think of the additional costs of road construction and maintenance required, or of views and vistas maintained; and many seem to be blissfully unaware that any public costs are involved in the restrictions on timber use of the associated forest lands and public travel ways.

The Panel believes investment by public and private forest owners alike to augment scenic and other attractions of their forests is both desirable and proper. Yet it would also recognize, in addition to direct costs, the indirect costs in timber income foregone to increase visitor satisfaction. If landscape architects are employed to naturalize roadsides and timber sale boundaries and intensive sale cleanup is required, the public users should be aware of the costs incurred and judge the value of amenities protected and achieved.

1. *The Panel endorses*, as a general policy, the statement in the report of the Public Land Law Review Commission [p. 128] that "* * * every user of the public lands should pay for his right or privilege. As a general standard we recommend fair-market value * * * ." The Panel feels that this standard subject to the previously stated reservations about reliance on complete pricing, can and should be applied to many of the nontimber outputs of forests.

2. *The Panel recommends* that needs for providing recreational facilities and forest amenities on national forests be evaluated on the same bases that apply to evaluating such services on other Federal lands.

3. *The Panel further recommends* that other public and private forest owners charge fees for recreational use of their lands to the extent that this is feasible; the expectation is that availability of private forests for recreational use can thereby be increased and become more widely dispersed.

4. To meet the needs of those people who cannot afford outdoor recreation in remote forest areas, *the Panel urges* the creation of more park and recreation opportunities in or near cities, where they can be enjoyed conveniently by urban populations.

5. *The Panel calls attention* to its recommendation in chapter 4 to the effect that some system must be developed to limit use of wilderness areas to their carrying capacities; *it recommends also* that charges be levied for this type of forest land use, in accordance with the principles stated in this chapter about charges for outdoor recreation.

6. *The Panel recommends*, whenever special programs are undertaken on publicly owned forests to increase the quantity or to improve the quality of water flowing from the forests above that which otherwise would have existed, that the beneficiaries of such increased water supply or improved water quality be required to pay an amount fully equal to the public costs incurred.

## DEMAND-SUPPLY BALANCES FOR WOOD PRODUCTS

Lumber, plywood, pulpwood, and other wood products from the forests are normally sold in a reasonably competitive market, and demand is equated with supply by prices established at various points. There is one demand and supply (and price) for the finished products at the construction site or the printing establishment, another supply and demand situation at the point where these products leave the mill, and still another situation in the woods from which the logs came.

The demand-supply situation for these various products must be analyzed in terms of some time dimension. For instance, demand depends upon total population, per capita income, and other socio-economic variables likely to change considerably with time. The harvested volume in any time period can be varied greatly if withdrawals from or accumulation to standing stock of timber occur. However, it should be clearly recognized that this will affect future supplies just as the harvest possibilities during the present time period depend largely on the harvests in earlier periods as these have affected present volumes of standing timber and past timber growth rates. The demand-supply situation may vary greatly from time to time, as may the policy alternatives open to the forest planner, and thus the demand-supply analyses must be repeated for relevant time periods.

For the longer run forest outlook, an almost infinite number of time periods is possible. To keep the analysis and discussion to reasonable limits, four time periods are chosen: (1) Business or building cycle variability; (2) the relatively near future, or the rest of the decade of the 1970's; (3) the middle term future, or 1980–2000; and (4) the longer term future, or 2001–20.

### Business or Building Cycle Variability

This type of variability in demand and supply often arises quickly, may be acute for some months, and then subsides or is adjusted to in some manner; in this sense, it is a very short-term phenomenon. During such periods, price movements may be extreme, with great disturbance to the industries affected. For instance, in the late months of 1968 and the early months of 1969, prices of lumber and plywood increased more than 50 percent within a 6-month period due to a variety of factors; but within a year prices had returned to the predisturbance level. This type of short-term disturbance to the supply-demand balance is likely to recur at intervals, perhaps indefinitely; in this sense, it is a continuing problem for the future.

Some, or all, of the following elements may create or exacerbate a short-term disequilibrium of demand and supply, of one or more wood products:

1. There may be a short change, upward or downward, in the demand for some product, particularly for lumber and plywood. This is likely to be because of changes in the volume of building construction, particularly of dwelling construction; and this in turn may have been affected by changes in interest rates, availability of credit, and other demand-influencing factors. When the demand increases suddenly for lumber or plywood, many users are unable to cut back on their use, in spite of the price rises; they have structures partially built, which they must complete if they are to salvage their earlier investments, even if doing so entails some losses.

2. There may be temporary interferences with a full supply of the lumber or plywood, at least in the volume demanded. Transport, especially railroad cars, may be inadequate; strikes in the woods or in the mills may cut off part of the flow of products; or severe weather may interfere with normal woods or mill operations.

3. The lumber and plywood industries may be unable to respond as quickly as demand rises; they have limitations of mill capacity, or of logging equipment, or of labor force, which limit their rapidity of adjustment. Over a few years, all of these input factors can be changed, but the type of demand-supply disturbance and price fluctuation considered here is ordinarily over with before mill capacity can be increased significantly.

When any one or more of these building cycle disturbances arise, prices are likely to fluctuate quickly and sharply. Neither supply nor demand can respond easily and quickly, hence prices change greatly.

Timber growth cannot affect the demand-supply balance of this type; that is, the shortrun increase in demand must be met by harvesting existing standing timber, or by an increase in price. Likewise, limitations of sustained yield management may not be serious for this type of maladjustment; other factors may be limiting, so that sustained yield limits are not likely to be the bottleneck. Measures to increase growth of wood are extremely important for the longer run, as will be discussed later, but they are relatively unimportant here. Differences in degree of timber use have little effect on this type of demand-supply imbalance.

Measures to avoid this type of imbalance in demand-supply relations lie in trying to avoid, or to lessen the impact of, the kinds of situations which produce such imbalances.

1. *The Panel recommends* that interested public agencies and private industry representatives make periodic (perhaps monthly) reviews or analyses of the prospective demand and supply situation for the various wood products, in order to discover possible imbalances and warn against them. Such reviews would be similar to those now made in the Department of Agriculture for agricultural commodities, but should involve both suppliers and users of wood products to a major degree for the knowledge such groups can contribute and also as a means of making the projections more widely known and more effective in use. The forest policy board that the Panel is recommending (ch. 11) could be the key agency to coordinate this activity.

2. *The Panel notes* with concern how public and private monetary action to stimulate new housing construction seems to cause sharp to violent fluctuations in lumber and plywood prices. *It therefore recommends* that such actions be planned well in advance so that the lumber and plywood industries can be prepared to meet the situation

without the new demands triggering violent price reactions. The latter serve neither the home buyers nor the forest industries.

3. *The Panel recommends* that the Forest Service aim to have a total volume of outstanding contracts equal to from 3 to 5 years of normal cut, instead of the present objective equal to from 2 to 3 years' cut. *It recommends* that this increased volume of outstanding contracts be achieved by more sales of present average size and with use of longer contract periods in accordance with recently issued Forest Service guidelines (three operating seasons for sales of 2 million bf, four seasons for 5 million bf, and five seasons for 10 million bf). It believes that the assurance of a longer term timber supply would give the buyers of national forest timber more flexibility to meet this type of essentially short-range variation in demand-supply-price relationships.

4. *The Panel also recommends* that the Forest Service make adjustments in volume of timber offered for sale in response to the short term or business cycle type of changes in market demand. Such responses should be downward as well as upward, but since the prospects in the 1970's are for stumpage to be in short supply, it is only realistic to anticipate few if any near term market developments which will present an opportunity to make downward adjustments. As a preliminary control over the use of such adjustments the following guideline is suggested:

> Additional timber sales should be not more than a 25-percent upward adjustment in any year and not more than a net upward adjustment of 1 year's annual allowable cut in any 5-year regulatory period.

These limitations will serve to restrict the use of additional sales to dampen market swings within limits which can readily be met by minor adjustments in allowable cutting rate at 5-year regulatory periods until experience and study permit establishment of a more refined and less arbitrary set of guidelines.

## Near Future, or Balance of 1970's

From the viewpoint of forest planning and management, the remainder of the decade of the 1970's is near-term future. There will be differences among years of this decade: (1) There will be a gradual growth in several factors, including population and probably income; and (2) there may be year-to-year variation of the building cycle type. For the purposes of this section we assume a more or less normal year, somewhat past the midpoint of the decade—1976 or 1977, perhaps.

As noted in table 4–1, for the decade of the 1970's all wood *harvest* must come from presently standing trees; the growth on presently standing stems will be an increment to volume available for harvest, but for the most part the wood to be harvested in the 1970's is now in existence. New trees, planted or naturally seeding in the 1970's, cannot supply timber for harvest in the 1970's; they may, however, as discussed below, play a significant role in indicating how fast to cut presently standing trees. Presently standing trees of merchantable sizes and species might be cut at any rate that they could be transported and processed, if there were no concern for future timber supply. Both private and public forest owners/managers must consider how to balance present harvest, future growth, and future harvest for the time period for which they are willing to plan.

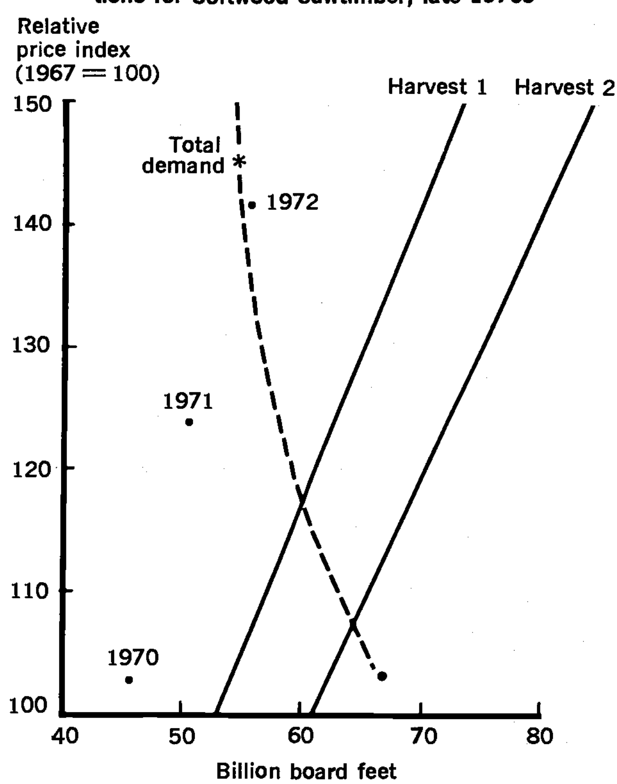
Even with a full concern for future timber supply, the present old-growth forests might be cut on any one of several time paths. Two contrasting time paths of harvest are: (1) Find a rate of cutting which can be projected at the same rate for an entire rotation. The excess old-growth inventory is thus scheduled for liquidation over an entire rotation. In the second rotation the cut must necessarily drop to the rate which can be supported only by the growth at the degree of stocking which it will have been possible to attain; and (2) adopt as the minimum annual cut objective the amount which can be supported by growth after old-growth timber stands have been converted to new crops. Old-growth inventory surplus to such needs is available for cutting over whatever period and schedule as promise optimum benefits when local or regional economies and domestic supply needs, both current and future, have been considered. The first course is obviously the more conservative policy. It provides for the highest possible even-flow supply for an entire rotation period and postpones the inevitable adjustment of the cutting rates to growth until all areas have had an initial cut. The latter alternative makes provision for a minimum cut at the rate which can be supported by growth and allocates old-growth volume which is surplus to such needs for liquidation according to the criterion of optimization of benefits considering local or regional economies as well as domestic supply. One of the variants of the second method is to adopt a specific liquidation period such as 20 years and to plan to cut one-twentieth of the surplus inventory per year in addition to the minimum base cut. The difference between these two methods of old-growth liquidation, as shown later, is very great in terms of prices and national impact.

During the decade of the 1970's, the impact of prices upon timber *growth* will be modest. Higher prices, if they seem likely to be sustained, may stimulate somewhat more tree planting and stand improvement than would take place with low prices. Higher prices for timber provides incentives for taking out of the woods more lower grade logs, and for higher utilization standards in mills. Management of public forest has not been very sensitive to prices of wood products in the past; the smaller nonindustrial private forests are only partly sensitive to price changes; the larger industrial forest owners do respond more.

For the decade of the 1970's, the volume of wood consumed (in some form) will be responsive to many factors, including its price. The decade of the 1970's has high housing goals, as previously noted; these are particularly important in their effect upon housing available to lower income people, either by subsidy or by trickledown. Prices of wood products will affect the demand for substitute building materials. To the extent that environmental concerns limit production of raw materials, the volume of wood used is likely to increase, since the environmental impact of wood production is less than the impact of producing substitute materials. Although conversion capacity for wood products is limited at any point in time, over a period of months or years it would be increased if demand and profit prospects justified it.

One picture of the demand-supply-price situation for softwood sawtimber for a typical year toward the latter part of the 1970's is shown in figure 6–1. The demand curve comes from figure 5–2; it relates quantity consumed in the United States (regardless of the source of the wood) and quantity of U.S. produced wood exported, to the relative lumber price index. It is a relatively shortrun relationship; the curve is highly inelastic at higher prices; although some substitutes can be used for wood, in the short run the extent of this substitution is limited. Nevertheless a considerable adjustment of quantity demanded to price is evident. The two supply lines come from figure 4–1. Each measures willingness of various classes of owners to harvest timber under the particular price; the influence of timber growth on this volume is negligible except as growth prospects affect owner/managers willingness to harvest at a price. The two lines have identical assumptions about elasticity of imports and elasticity of harvest from industrial and other private forests; they differ in that one assumes national forest harvest at the 1970 level, the other assumes accelerated harvest of old-growth timber from national forests. Each may be somewhat unrealistic, if the 1970, 1971, and 1972 experience is any guide. While response of harvest to price in those years is evident, in none of them did the volume harvested come up to the supply line; there were shortfalls in harvest from several classes of ownerships, including national forests in 1971 and 1972. For all of the supply response lines, a considerable elasticity of supply to price is shown; this results from the elasticity of imports and of harvest on private forests.

**FIGURE 6–1.—Projected Annual Supply-Demand Relations for Softwood Sawtimber, late 1970s**




* All wood consumed in U.S. plus gross export demand.
Harvest 1: National forest harvest at 1970 level.
Harvest 2: Accelerated harvest of old growth timber on national forests.

On the basis of supply line No. 1, demand and supply would be equal at a relative price index of about 117.5; with the price index for all commodities at about 120 in late 1972, this relative price index would mean an absolute price for lumber of somewhat over 140, instead of the 175 to 180 that actually existed. If inflation continues, by the late 1970's the absolute price would be still higher for this same relative price; at this price, demand and supply would be equal at 60 billion board-feet. If the harvest of old growth national forest timber were accelerated, demand and supply would be equal at a relative price of 107 and at 64.5 billion board feet.

Before interpreting the relationships on figure 6–1, it is necessary to emphasize two further facts: (1) Both supply curves on the figure assume that harvest on the national forests are at the stated allowable cut; this is not true today, as we pointed out in chapters 3 and 4, due to environmental considerations and manpower limitations; and (2) lumber prices in late 1972 were above the demand-supply equilibrium levels shown in figure 6–1.

An accelerated cut on the national forests could in part be achieved by greater use of dying timber and of timber killed by insects and disease, if there were more roads into areas presently inaccessible and not withdrawn from harvest for wilderness or other purposes. For the most part, however, it would have to be achieved by reducing some of the present inventory of old growth or mature timber; estimates of effects of this option are presented later. If there should be an accelerated cut of old growth timber on national forests, fragile and other sensitive areas are not to be harvested; the accelerated harvest should *not* be at the expense of conservation of the forest nor at the expense of the long-term capacity of the forests to produce timber.

Figure 6–1 measures the willingness of owners of various classes to harvest timber under different prices, as accurately as the available data and available research will permit. It cannot, however, tell the whole story, without bringing additional information into the picture. For instance, if the harvest of old-growth timber on national forests is accelerated, this lowers the price of lumber from what it would otherwise be; as other owners may be expected to react to these lowered prices, by reducing their harvest. This both helps to sustain lumber prices and shifts the burden of the cut somewhat from private to public land. The estimated harvest from each class of forest land ownership is shown in table 6–1. When the harvest from national forest is higher, prices are lower, and this leads to smaller imports, less harvest from industrial forests, and less harvest from private nonindustrial forests. By reducing the latter two, the timber inventories on these forests will be built up somewhat higher than they otherwise would be; cut will still exceed present growth from forest industry lands, but by a smaller amount; it will be less than growth on other private forests, and by a larger amount than if national forest harvest were not accelerated. Accelerating harvest from national forest does not increase total harvest to the extent of the accelerated cut; the price effects on other forests must be taken into account. And the harvest on each type of land is not independent of harvests on other types of land, when the price effect is considered.

Since softwood sawtimber growth on national forests in 1970 was 8.6 billion bf, harvesting such timber throughout the rest of the 1970's at sustained yield level, as presently calculated at 13.6 billion bf, would reduce inventory by 5.0 billion bf annually or 35 billion bf. This is 3.5 percent of the volume of standing softwood sawtimber in 1970. If harvest on national forests were accelerated for the remainder of the 1970's, beginning with perhaps 2 billion bf in 1973 over present allowable cut by the end of the decade, this might include as much as 35 billion bf accelerated cut for the remainder of the 1970's. Ignoring any harvesting of dead and dying trees which might also be significant, this would at the outside mean a further reduction in inventory of standing softwood sawtimber on national forests of 35 billion bf or about 3.5 percent of volume standing in 1970. The total reduction in volume by 1980 therefore from cutting at sustained yield level and from accelerated harvest would be 70 billion bf or 7 percent of the 1970 inventory volume. The effect of accelerated harvest upon standing volume would be greater, were the acceleration to continue into the 1980's, of course; but, to take an extreme case, an accelerated cut of 10 billion bf annually throughout the 1980's (and making no allowance for salvage of dead or dying trees and for increased growth) would reduce inventories of standing timber on national forests by 150 billion bf or from 982 billion in 1970 to 753 billion in 1990. Timber growth should, of course, eventually increase significantly as a result of the accelerated

**TABLE 6-1.—Softwood Sawtimber Harvest, by Major Source, Late 1970's, Under 2 Alternative Harvest Programs for National Forests**

| Source of sawtimber supply | National forest harvest (billion board feet) At 1970 level | At accelerated rate (illustrative only) | Difference |
|---|---|---|---|
| Imports | 7.5 | 6.3 | −1.2 |
| Forest industry | 15.5 | 14.4 | −1.1 |
| Other private | 18.3 | 16.8 | −1.5 |
| Other public | 4.8 | 4.9 | +0.1 |
| National forests | 13.9 | 22.1 | +8.2 |
| Total | 60.0 | 64.5 | +4.5 |

Data taken from fig. 4-1; for a harvest of 60.0 billion fbm, the figures by class of ownership are read from the chart for a total harvest of this size assuming national forest harvest at present management level; for a harvest of 64.5 billion board feet, the figures are also read from the chart for harvests by classes of ownership, assuming this size total harvest with accelerated harvest from national forests. The results are slightly approximate because readings from the chart cannot be precise; more importantly, they incorporate all the assumptions on which fig. 4-1 is based.

harvest, but this assumption needs to be quantified by the Forest Service.

Table 6-1 shows clearly the effect that the volume of timber harvest from national forests has upon the volume of timber harvest from forests of other ownerships. Where national forests have such a large proportion—approximately half—of total sawtimber volume, their harvest program cannot be considered by itself alone, but rather must be considered in light of its effect upon all forests of the Nation. The Panel recognizes that national forest management, including harvest, in the past has been concerned entirely with the effects of management on future timber supply from the national forests alone. It feels that the time has now arrived for management of the national forests to also consider the effects of that management upon the total timber harvested and upon growth and management of forests in all other ownerships.

An accelerated harvest of old-growth timber from national forests, in addition to making possible greater growth of wood from such forest lands, would mean early cutting of big trees and replacing them with smaller trees of sawlog size for later harvest, even if volumes of wood remained the same. A second effect would be differential cut-growth response by type of forest land ownership. The early accelerated cut would come on federally owned lands, the increased growth of sawlogs for later harvest would occur in large part on privately owned lands. A third effect would be a regional one; the increased cut would be in the West, primarily along the Pacific Coast, while the increased growth would be in the East and South, especially in the latter.

An accelerated harvest of old-growth timber on national forests would have some conservation effects; the extent and nature of those effects would depend more upon how the harvest was managed, than upon when or whether it was made. Accelerating the harvest of old-growth timber will adversely affect some species of wildlife while favorably affecting others. In particular, grazing and browzing species such as deer will be greatly benefited by opening up the forest in carefully planned cuttings. The harvest of old-growth timber, whenever made, is likely to result in large volumes of wood residues of unusable or dubiously usable value. Such old-growth forests often have far more defective trees and rotten parts of trees than will the new managed forests that will replace them. These wood residues must be disposed of—if commercially usable, by harvest; if not, by burning. But this is a problem not made worse by acceleration of such harvests—it exists anyway, and in fact may be less if old-growth stands are cut relatively soon rather than later when stand decadence has proceeded further. The alternative to cutting old-growth forests is not their indefinite preservation; as they get older, wind, disease, and insects will bring them down in any case. The Panel judges that the harvest of old-growth national forest timber could be accelerated to any desired degree without creating any more serious environmental problems than will result from a slower rate of cutting, if suitable precautions are taken.

The question may reasonably be asked: what difference does it make to the American people if the relative price index of softwood sawtimber is 117.5 or if it is 107 during the latter part of the 1970's? First of all, price is always an index to economic relationships. A higher price index is evidence of a shorter supply of wood; this in turn makes structures or articles made of wood more expensive, reduces their supply, and encourages the use of substitute raw materials with their greater adverse environmental effects. Price in itself is important, but price as an indicator of basic supply-demand relationships is more important.

The higher relative prices for lumber and related products (and still higher absolute prices, if general inflation continues) would have at least three major direct effects:

1. Houses would cost more to build, and hence fewer would be built or larger subsidies to make

the higher cost houses available to some buyers would be necessary. In 1969, the wood products including furniture in the average house cost $4,580; the higher index for lumber would increase this amount by $460 per house. If the volume of construction should be 2 million houses a year (in addition to mobile homes, which use comparatively less wood products), the total added cost to the Nation would be about $1 billion annually. To the extent that the houses built in the late 1970's were larger than those built in 1969, this sum would be larger; to the extent that substitute building materials would be cheaper than wood at the higher costs of the latter, the sum would be less; perhaps these two effects will approximately offset one another. The precise higher cost may be different from this figure (i.e., $460 per house), but it seems a reasonable estimate.

2. To the extent that substitute building materials—steel, aluminum, cement, and plastics—were substituted for wood, the environmental impact would be increased, particularly when the environmental impact of more energy input for these substitute materials is included.

3. A higher price for wood products would contribute to the general inflationary forces in the economy. Lumber and other wood products contribute 2.65 percent to the weighting in the general wholesale price index. Therefore, a lumber index change of plus 10 percent (as from 107 to 117.5) results in a general price index 0.3 percent higher than before. A late 1970's total volume of perhaps $700 billion worth of good and services entering the economy would thus suffer an inflationary addition of about $2 billion annually as a result of that 0.3 percent increase in the general price index. One must note, too, that this inflation is attributable to direct or first order effects alone. The total inflation border may be much higher when higher order economic effects are included, such as increases in wages to match the cost of living advances.

The Panel judges that it would be impossible, and perhaps undesirable, for national policy to attempt a stabilization of lumber at their 1967 relative price of 100. As noted, relative prices of lumber in late 1972 were 146 (and absolute prices were in the 175 to 180 range).

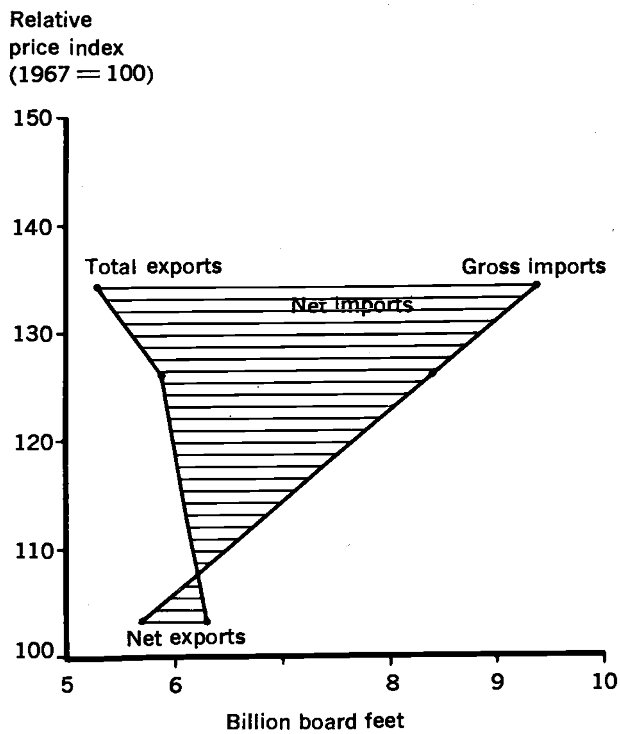
The Panel's concern is not so much to roll back the price rise of 1971 and 1972, or even to prevent further price rises, as it is to smooth out price increases by insuring higher levels of available supply. A high and rising price for lumber should provide a substantial incentive for private investment in forest management and growth, as well as adding a further incentive to public investment in forestry, both of which will increase the supply of lumber and plywood to the market.

The Panel believes a price incentive must exist for timber growing if adequate investment is to be made and maintained each year to assure the Nation of adequate timber supplies in future years. The Panel further contends that increased public and private investment in timber growing is very much in the national interest for all foreseeable time horizons.

Such investments, and the price incentives necessary to induce them, are alone justified by the importance to the Nation of wood as a commodity. However, elsewhere in this report we have stressed the additional, significant, and valuable societal benefits, in addition to those of wood production, which timber growing brings.

Implicit in the foregoing analyses has been a quantity-price relationship for sawtimber exports and sawtimber-lumber imports which is made explicit in figure 6–2. Exports (chiefly sawlogs to

**FIGURE 6–2.—Total Exports and Total Imports of Softwood Sawtimber and Lumber, in Relation to Relative Price**



Japan) and imports (chiefly lumber from Canada) are somewhat but not highly responsive to price in the short run. At the more probable higher prices (a relative index of 140 or more), total imports will rise allowing enough time for installation of additional processing capacity, and the United States will be a substantial net importer. Because both gross imports and total exports respond to prices, but in opposite ways, net imports are particularly sensitive to prices.

*The Panel recommends:*

That in scheduling timber sales the Forest Service take into consideration not only the effect of such timber harvesting on the timber growth and inventory of the national forests, but also its effect on growth and inventories on other forest lands of the Nation, and upon the supply and price of lumber and other forest products. The Forest Service should be more responsive to the raw material needs for lumber and other forest products.

*The Panel recommends:*

Subject to its qualifications in chapter 7, that the Forest Service examine the possibility of increasing the harvest of old-growth timber on national forests substantially under sustained yield principles. The precise volume to be harvested annually should be determined by careful calculations by areas or regions, and must be determined in light of the capacity of processing facilities. Although the effect of an accelerated cut for the remainder of the decade of the 1970's would be an additional reduction in volume of standing timber of approximately 5 percent, the effects might be more severe in some areas and hence would require modification. Based upon nationwide inventory data a timber harvest from national forests in the range of 17 to 20 billion bfm annually might be possible by the late 1970's.

This recommendation is contingent upon adequate financing to intensify forest management to a level sufficient so that areas harvested will be promptly regenerated, and precommercial thinnings and other improved practices are carried out so as to assure a future growth rate commensurate with such levels of timber harvest. Such financing should include funds to extend the permanent road system so that as much as possible of the increased timber harvest may come from stands having a high percentage of salvagable dead and dying trees.

To the extent that Federal financing falls short of funds necessary to achieve the above intensity of management, timber harvests should be reduced.

In suggesting the possibility and the economic desirability for acceleration of the rate of cutting of old-growth timber and including an estimate of the total harvest which might result by the late 1970's, the Panel is not suggesting that a quantitative requirement or cutting goal be established for the National Forest System. As noted in this recommendation, volume to be harvested should be determined by careful calculation of allowable cut by areas or regions under sustained yield principles. Need for consideration in these area calculations of timber stand conditions, accessibility, and effect on future timber supply is discussed in chapter 7. How much the total harvest from the National Forest System will be in any year should continue to be determined by the decisions made based on such local area considerations rather than through an apportionment of a predetermined total to individual areas.

For the rest of the 1970's and on through the 1980's additional supplies of saw logs are clearly needed to meet domestic requirements. The old-growth sawtimber on the western national forests is the major possibility for increased domestic supply of saw logs. The Panel believes that the rate of cutting of old-growth stands on the western national forests can be increased with due regard to environmental impacts and within statutory sustained yield limitations. This accelerated cutting rate can be made possible by intensifying cultural practices to increase timber growth, by more effective road development and other measures needed to expand salvage and thinning sales, and by modernizing cutting schedule policies to take into account national supply considerations.

The Panel has noted that meeting needs of competing forest uses will reduce the commercial timberland base available for timber production. The fact that some significant reductions in forest land base for timber production appears certain makes it all the more advisable to adopt measures which will make possible increases in the rate of cutting on the national forest lands which are retained for timber production. The ongoing contests for land-use priority between timber and other forest uses will also be determined on an area by area basis. What the net effects in terms of possible sawtimber supply from the national forests of a decreased land base but an increased

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per unit area production cannot yet be clearly foreseen. The Panel's estimate of a possibility that the total cut from the National Forest System by the late 1970's may be from 17 to 20 billion fbm is an expression of a desirable cutting level from the demand side, and of a possible level of attainment from the supply side, if the various conditions for financing of intensified management and other management improvements are forthcoming, and also if due recognition to timber supply needs is given to restrain tendencies to make excessive withdrawals from the forest land base available for timber production.

*The Panel recommends:*

That timber harvests from the national forests be concentrated as much as possible on stands approaching or achieving decadence during the coming two decades.

## Middle Future, 1980–2000

For this period, the possibilities of modifying softwood sawtimber *growth* and *harvest* are greater than in the immediate future, and the possible variations in demand are also greater. Hence, the range of alternative programs or policies is greater.

To these other factors must be added the variations that might be introduced because of timber management practices during the 1970's.

As shown in table 4–1 the softwood sawtimber that may be harvested from forests in a typical year in the 1990's will come in more or less equal proportions from additional wood grown on trees already of sawtimber size in 1972, and from the trees of less than sawtimber size in 1972 growing to reach that size by the 1990's. Upon western lands a few trees planted in the early 1970's might be cut by the late 1990's, in thinnings or in pulpwood harvest, but the volume will be relatively small. The volume of wood growing during the 1970's, 1980's, and 1990's on stems (sawtimber and less than sawtimber size) standing in 1972 will be an important part of the total supply, especially during the latter part of this period. This growth might be accelerated by thinnings or other stand improvements, fertilization, and other intensive forestry measures. In addition, harvest of lower quality materials and salvage of dead or dying trees might add to the total volume of wood removed from the forest. Increased utilization of the harvested materials could add to the effective supply. Some liquidation of old-growth timber will occur during the 1980's and 1990's, irrespective of the rate of liquidation in the 1970's; but the rate during the 1970's will affect the volume left to be harvested in the 1980's and 1990's. The extent to which intensive forestry practices, especially including stand regeneration, are applied during the 1970's, will greatly affect the confidence with which mature stands can be harvested during the 1980's and 1990's in the expectation that young growth stands will be able to provide the desired supply of timber during the period after 2000.

For the decades of the 1980's and the 1990's, especially the latter, new forms of use of wood are likely to become increasingly important. Sawn lumber will certainly still be used in absolutely large volume, though perhaps taking relatively less of the total wood harvest. Plywood is likely to take a high, possibly a greater, proportion of the total wood harvest, and will surely take an absolutely larger volume, than it now does. Paper will surely continue to be a large user of wood fiber, more in absolute volume than now, and perhaps more as a percentage of total supply. But it is the new products, such as fiberboard and particle board, where relatively, as well as absolutely, larger volumes of wood will be used. Increasingly, attention in production and utilization will shift to wood fiber as such, with the form of utilization dependent not only upon characteristics of the trees harvested but also upon relative demands.

Demand, in the quantity-price sense, may also vary considerably during the 1980's and 1990's. The population outlook is unclear, but birth rates to the end of the century will not much affect the number of new households formed during that period, though they will affect the family size and hence to some extent affect demand for housing. The quality of the total housing stock might be upgraded considerably in response to higher average incomes and/or public programs to improve the housing for the lower income classes. Technological developments may both increase and decrease demand for timber; on balance, their net effect is likely to increase the demand for wood. Environmental concerns, if intelligently directed, will surely increase the demand for wood because of the lower environmental impact of wood production relative to the environmental impact of the production of substitute materials. This will more than overbalance the reductions in timber harvest being made to meet esthetic, recreation, wilderness, and other demands.

Whatever may be the precise supply and demand situation possibilities for the 1980's and 1990's, the price-quantity relations of both supply and demand will continue. The specific demand relations were outlined in figure 5–2; some doubts about the accuracy of those relationships were expressed at that point and need not be repeated. The harvest of timber around the year 2000 depends upon: (1) Prices for lumber and related products, as these affect owner/manager-decisions about harvest, and (2) public programs on publicly owned forests and as they affect private forests. The Forest Service has made some projections of supply, based upon assumptions on these matters; its projections are analyzed in our consultant's report, appendix C. The Panel feels that the validity of these projections of supply are limited for several reasons. These projections assume that the full sustained yield from the designated commercial lands of the national forests will actually be harvested; in the light of experience in recent years, this may be optimistic. The Panel's concern about accelerated harvest in national forests apply primarily to the period before 2000. The issue is: Will the full sustained yield be actually harvested in that year? A more seriously optimistic assumption in appendix C is that the full annual growth on private nonindustry lands will be harvested each year. Harvest has been below that level in the past; the Panel's recommendations, if executed, will significantly increase the volume of standing timber on such lands. The physical base would then exist for a considerably increased harvest, but it is doubtful if the owners of such land will make such harvests up to full sustainable capacity.

The Panel feels that the factual and analytical bases for estimating specific demand-supply relations for a normal year around 2000 are lacking, and hence it makes no such specific projections. It urges that research and analysis be pushed to develop better supply-response and demand response models which can be computerized and can provide quick and reliable projections for a wide range of reasonable policy alternatives. In the absence of such analyses, the Forest Service, the Panel, and all other agencies or groups concerned with forest policy are severely handicapped. The forest policy board, proposed in chapter 11, might well take the lead in pushing for the development of such models.

*The Panel recommends:*

That all economically feasible methods of increasing wood supply in the 1980's and 1990's be undertaken; especially that those measures taken in the 1970's which will increase later wood growth and increased harvest of old growth in the 1980's and 1990's be pushed with vigor. The Panel is much concerned that the country increase both *growth* and *harvest* of wood over these decades, and believes that this is possible, not only without serious environmental impact within the forests, but in fact with reduced environmental impact generally.

## Longer Future, 2001–20

The farther one looks ahead, the greater the range of policy alternatives in forestry. Demand for wood (in the quantity-price sense of the term) is likely to be higher after 2000 than now; more people (even if the fertility rate remains at or below an ultimate no-growth level), higher average incomes, more concern for the environment, technological change, and other developments are all likely to push the demand for wood upward, although the precise degree of that upward push is highly uncertain now.

The supply possibilities for wood *growth*, and for *harvest* geared to growth, are numerous; the potential exists for substantially greater annual growth after 2000 than at present or during the next two decades. The Panel judges that annual total wood production might readily be doubled by this more distant future. In addition to all the forestry intensification possible for the 1980's and 1990's, genetic improvement undertaken in the fairly near future might begin to pay off in a substantial way after the turn of the century. The annual volume of wood growth after 2000 will be largely determined by measures undertaken in the rest of the 1970's and in the 1980's; regeneration, stand improvement, fertilization, genetic improvement, and other measures in the nearer future will produce substantial added volumes of wood in the longer future.

In view of the wide range of alternatives for 2020 or any year near that date, and in view of the relatively unsatisfactory analyses available to date, the Panel does not present any specific supply-demand analysis for this later date. Such analyses as it has been able to make are, in its judgment, sufficient for at least two general conclusions: (1) The demand, in the quantity-price sense, for wood will rise by 2020; relatively large volumes can be sold at prices higher than exist today, and forest management, both public and private, should be based upon such expectation; and (2) the measures previously recommended for the period before 2020 will enhance the growth prospects for the period around 2020 and later. The increases in wood harvest in the intervening years are not at the expense of later harvests, if suitable management practices are followed.

*The Panel recommends:*

That a national policy be accepted which has as its goal timber production and harvest approximating the relationships shown earlier in figure 4–2. Accelerated harvest of old-growth timber on national forests during the next two decades or longer would increase growth on such lands; measures begun immediately would greatly increase growth on national forests and on private nonindustry forests, thus making possible increased harvests from the added growth by 2000 and later; and the management of the national forests would be governed in part by a consideration of the effect of such management on forests of other ownerships.

# Management Considerations for National Forests[1]

In any current study of forest policy for the United States, the national forests necessarily occupy a foremost place for two basic reasons: (1) Their area and volume of timber are so large as to make them the key element in the total timber supply picture, as will be outlined below; and (2) their administration is by a Federal agency, so that policy for their administration is a direct Federal responsibility. Whatever specific measures or actions are taken for the national forests, they have direct and inescapable policy consequences, as well as economic impact on other ownerships.

In addition, the Forest Service has responsibilities other than management of the national forests which further make it a major agency in influencing Federal forest policy. It has an important role in Federal policy development and for managing programs providing forestry assistance to State and private forest land owners; it maintains a continuing survey of timber inventory, growth, and removals for forest lands of all ownerships; makes projections of total future demand and supply for forest products; and makes recommendations on forest policies generally. While its current capacity for nationwide forest policy formation is inadequate, as will be discussed in chapter 11, it does play a larger role in this regard than any other single Federal agency. The Service's concepts of "good forestry" are applied not only to the national forests but, to some degree, to all forests.

For these reasons, this chapter deals explicitly with national forests and the Forest Service; the Panel feels a special responsibility to furnish its own review of policy alternatives for the national forest system.

## NATIONAL FORESTS TODAY

As was pointed out in chapter 3, the resources of the national forests are rich and varied. These lands have important watershed values, are the home for much wildlife, provide forage seasonally for domestic livestock, and have great and varied scenic and recreational values. About half of their total area has been classified as commercial forest—i.e., capable of producing 20 or more cubic feet of wood per acre annually. Compared with other forest ownership classes, however, the national forests show the largest gap of all between their current timber growth and the growth potential of the land they occupy (table 7–1).

As has been pointed out in previous sections of the report, this is due to the preponderance of old-growth timber still standing on the western national forests. The growth rates of national forest land in the South and East compare favorably with that of industry-managed forest lands.

The dominant fact about the national forests, as was shown in chapter 3, is that today they contain half of the softwood sawtimber in the whole Nation. This is a unique national asset, a great treasure; at current stumpage prices, even allowing for the time and costs of harvest, their trillion board feet of softwood sawtimber would be worth $20 billion or more if liquidated for maximum immediate profit. The Panel most assuredly does

[1] For much more detail and supporting evidence for this chapter, see "appendix F: The Availability of Timber Resources From the National Forest and Other Federal Lands, by Carl A. Newport; "appendix L: Maintaining Timber Supply in a Sound Environment," by David M. Smith; "appendix C: Softwood Sawtimber Supply and Demand Projections," by Robert J. Marty; and "appendix D: The Economic Effectiveness of Silvicultural Investments for Softwood Timber Production," by Robert J. Marty.

**TABLE 7-1.—Potential Growth Versus 1970 Actual Growth, by Ownership Class**[1]

| Ownership | (1) Potential growth (billion cubic feet) | (2) 1970 actual growth (billion cubic feet) | (3) Actual growth as a percent of potential growth |
|---|---|---|---|
| National forests | 6.6 | 2.6 | 39 |
| Other public | 3.2 | 1.8 | 57 |
| Forest industry | 5.9 | 3.5 | 59 |
| Other private | 21.9 | 10.7 | 49 |
| All ownerships | 37.5 | 18.6 | 49 |

[1] Source: Areas in the 5-site classes shown in table 3-1 were multiplied by the midpoints of the respective site classes (taking 180 cf per acre per year as the midpoint for class I lands) to arrive at the potential growth by site and ownership classes; these values were then totaled by ownership to produce Col. (1). Col. (2) values are taken from table 1, app. C, by Robert Marty. Co. (3) is the percentage of the calculated potential growth which the 1970 actual growth represents.

not propose such liquidation, as its numerous recommendations make clear, but this calculation clearly indicates the value of these immense timber reserves.

This immense volume of timber is, for the most part, an inherited mature old-growth forest; that is, it either had grown before the white man occupied the present area of the United States, or it is the natural growth that has accumulated on such inherited forests. No policy or administrative decision was needed to establish such forests, although of course policy decisions to protect these forests from fire and to harvest them over a period of many decades were necessary. Of the total volume of softwood sawtimber on national forests, 71 percent is in the Pacific Coast States from Alaska down through California and an additional 24 percent is in the Rocky Mountain States. Softwood sawtimber on national forests is thus primarily a western resource, and the policies with respect to its management have particular importance to the West, although the effect of such management upon national lumber supply is important to all regions. Half of all commercial forest land in national forests now has more than 5,000 bf of sawtimber per acre while but a one-sixth of all commercial forest lands in all other ownerships have comparable stands. The national forests have about 40 percent of all land with this volume per acre. These figures, while not precise as to old growth versus second growth, nevertheless give a reasonable idea as to the importance—even the dominance—of mature old-growth forests both within the National Forest System and as between it and other forests.

Largely because the commercial forest acreage on national forests is predominantly old-growth mature stands on which net growth is usually low and may be zero or even negative, the average growth rate of all national forest commercial forest acreage is low. In 1970, national forests averaged 28 cf per acre net growth of all wood annually, compared with 52 cf for forest industry forests. Comparisons for sawtimber growth are similar. On the basis of published Forest Service data, the Panel estimates that the potential growth from fully stocked natural stands of commercial timber on national forests is about 75 cf per acre annually. If lands with a productive capacity of under 50 cf per acre are omitted, the potential for the remaining nearly three-fourths of the commercial forest area on national forests is above 90 cf annually. The potential under intensive forest management would be still higher. Thus, it is clear that national forests today are growing relatively little wood, whether the standard of comparison is the forest industry forests as currently managed or the national forest potential productivity.

By any standard, the mature old-growth forests of the national forests are extremely important reservoirs of standing softwood sawtimber and important sources of future growth of sawtimber. Moreover, as noted in chapter 4, harvest of softwood sawtimber for the rest of the 1970's can come only from trees now standing and of harvestable size, and it is here that the national forest supplies are crucial.

## SUSTAINED YIELD AND ALLOWABLE CUT

A key to the Nation's timber supply problem of this and the next few decades is the rate of timber harvest on the national forests and other Federal lands. Existing sawtimber inventory is, of course, the only source of timber supply currently and in the shortrun future. Over 51 percent of the Nation's inventory of softwood timber is on the national forest lands. The rate at which this inventory is harvested is controlled by laws, regulations, policies, procedures, and administrative decisions of the Forest Service and other Federal agencies. Because the national forests are by far the most important Federal lands in regard to short-term softwood timber supply, the interpretation of sustained yield, policies for determining allowable cut, and administrative decisions relating to these policies are of critical importance in determining the potential timber supply from these Federal lands.

The basic law for national forest lands is the Organic Administration Act of 1897. This Act established the national forest system and provided the authority for the Secretary of Agriculture to sell timber from these lands. In part, the Act says that:

> No national forest shall be established, except to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flow, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States * * *.

In addition, the Multiple Use-Sustained Yield Act of 1960 directed that the national forests shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. It directed that these lands be developed and administered for multiple use and sustained yield for several products and purposes.

Multiple use was defined to mean:

> * * * the management of all the variable renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over the areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources; and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output.

Sustained yield of the several products and services was defined as:

> * * * the achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land.

Certainly, the national forests of the United States should be operated on the sustained yield principles as defined by the Multiple Use-Sustained Yield Act of 1960. Considerable latitude, however, exists in how the principle of sustained yield is applied. The allowable cut under sustained yield management will differ with decisions as to: (1) The working circle for which the cut is computed, (2) the definition of commercial forest land, (3) policy decisions regarding the intensity of silvicultural practice, rotation age, the level of even flow desired, and the rate of liquidation of old-growth timber, and (4) the methodology employed.

Of prime importance is the geographical area for which sustained yield is established and for which an allowable cut is determined. This unit is known in forest management as the working circle. In keeping with former Forest Service practice, each national forest may be divided up into several working circles and the sum total of the allowable cuts of these working circles constitutes the allowable cut of the national forest. In other words, in most cases there have been in the past several sustained yield units within each national forest. The net effect of this geographical limitation in the definition of working circle has been to reduce the allowable cut in that the surplus of timber in one part of the national forest cannot be used to balance the shortage of timber in another part. The same is true in balancing regions and parts of the country. As an extreme example, it would be possible to treat the entire U.S. timber economy as a single working circle and to compute optimal cutting levels of timber to provide for sustained yield in terms of a supply of timber to meet the needs of the national economy. This is essentially what has been done in the supply and demand analyses of the Panel's report, the presentation of which has preceded this chapter. Such overall computations, however, obviously have to be modified as regional or even smaller geographic restrictions are placed as constraints upon the model.

Even within a given geographic region, there is room for debate as to whether the computations of sustained yield allowable cut should be based solely upon national forest lands or based upon the sum total of commercial forest lands available to a given market. While considerations of timber supply on private lands must be taken into account, the Panel supports the traditional method of computing sustained yield on national forest lands only. It does, however, believe that the working circle in most cases should be at least as large as the national forest and in many cases can include more than one national forest serving the same general market area in a given forest region. The Forest Service in recent years has indeed increased the size of the working circle to the national forest, or larger unit in some cases. Such a decision has the effect of building greater flexibility in the determination of a level of sustained yield management so that it will more closely approximate the overall productive potential of our American forests as detailed in the prior chapter.

Once the working circle is established, a critical consideration is the area of commercial forest land assigned to that working circle or unit. Obviously, lands to be withdrawn from commercial use into the wilderness system must be excluded in the computation of allowable cut. Since substantial areas of land are in limbo as to assigned use at the present time, all computations of allowable cut for national forests which include such lands can only be approximate at the moment. Much the same uncertainties result from questions as to whether or not forests on excessively steep slopes or excessively fragile soils should be taken into consideration in long-term forest management planning. If the *potential* yield assumes logging on such "marginal" areas, but if such areas are not logged, then it is obvious that the *programed* allowable harvest must be lowered. Similarly, where the choice of silvicultural management techniques is restricted as in "special" areas along the streams and in areas of high scenic importance, such limitations may well result in modifications on the amount of timber that can be harvested from these areas. Finally, the Forest Service defines as commercial forest land those forests which have a growing capacity of 20 cf per acre per year, a definition which takes into consideration neither the accessibility of the area, nor other economic considerations. Forest tracts that are submarginal from an economic point of view may be included therefore in the allowable cut computations even though the probability of their being logged under any predictable economic situations is virtually nil. The sum total of all of these factors is to lower the allowable cut of western national forests to the extent that wilderness areas are established in the future, marginal areas are withdrawn or deferred from logging, restrictions in silvicultural practices restrict forest yield, and forest stands submarginal from an economic point of view remain unlogged. Quite conceivably the effect of decisions along these lines might be to reduce very substantially the allowable cut on the national forests.

On the other side of the coin, the Forest Service consistently has been conservative in building assumptions into its allowable cut computations on such matters as the assumed improvement in forest yield that can be brought about by intensive silviculture, the establishment of the rotation age of timber, and the rate of liquidation of the old-growth timber. For areas which are predominantly stocked with old-growth timber, the annual cut in the first rotation may be higher than the annual growing capacity. For such circumstances, the Forest Service plans to maintain a level rate of cut for the first rotation, and then adjust to a cut level equal to annual growth. This concept of cutting rate determination is commonly referred to as "even flow." In practice, national forest plans have been drawn up which contemplate variations in average cut from one decade to another of less than 1 percent, though year to year variations might be greater.

Such even flow restrictions clearly result in a substantially lowered allowable cut than would be the case if full recognition were given to the fact that a typical western national forest is frequently overstocked with old-growth timber and the fact that this overstocking can be harvested over a period of time without any reduction in the amount of second-growth timber that can be grown in subsequent rotations. As Newport demonstrates from an analysis of four western national forests (app. F), full recognition of such factors by the Forest Service would have the effect of increasing the current allowable cut at least 30 percent above present rates in these cases while at the same time maintaining sound sustained-yield management. Clearly such important decisions as those relating to the determination of rotation age and the rate of liquidation of the reservoir of old-growth timber are major policy concerns and should be made after appropriate consultation in the Office of the Chief of the Forest Service rather than at the local level.

Finally, a word should be said about the method of allowable cut computation because vastly different figures can be obtained through the choice of method and technology. The Forest Service manual currently specifies that allowable cut "should employ a form of tabular scheduling through time by stand condition, size or age" and that "the use of allowable cut formulas should be avoided except as rough checks on tabular methods." The selection of the specific method for computing the national forest allowable cut has been left to the local forest or region. Increasingly, use is made of the timber RAM program which is a computer program based upon a mathematical model that utilizes the desired objectives within specified constraints. While those familiar with the program believe it to be sophisticated and capable of dealing with wide ranges of assumptions, the matter of defining objectives, constraints, assumptions and management intensity is left to the user. The results obtained will depend both upon the understanding of the program by the user and the assumptions built into the specific application.

As we have said earlier, the issue of how much softwood sawtimber can be harvested from the old-growth stands of the western national forests is of paramount importance in meeting our country's timber needs for the next several decades. Without the Panel's having made a specific analysis forest-by-forest, it is clear: First, that the total area of forest lands available for commercial timber production will inevitably be decreased by wilderness withdrawals and limitations placed upon the logging of marginal and special forest areas; and second, that considerably more latitude exists in patterns of harvesting old-growth timber, in the establishment of the rotation age, in determining the length of period over which the old-growth timber is liquidated, and in building in assumptions more nearly correct as to the effect of intensive silvicultural practices on timber yields from national forests. The net effect of a more sophisticated computation of allowable cut relaxing current restraints in these matters might well be to increase effectively the allowable cut on those forest areas remaining in commercial production on the western national forests.

On a purely nationwide basis, our analysis of timber supply statistics in terms of volume would indicate the possibility of increasing the harvest in western national forests by up to 50 percent for the next two decades. The recommendations of the Panel's consultant in the matter would indicate that, on the basis of the analysis of sample western national forests, the allowable cut on these and similar forests could be increased by at least 30 percent over the same period. On the other hand, the foresters allied with the conservation movement believe strongly that the net effect of silvicultural limitations and withdrawals of forest lands from commercial timber production assumptions should result in a substantial decrease in the allowable cut on some several of the same national forests.

Although the Panel is not in the position to make a definitive judgment in this respect, it is clear that in any event timber production on the western national forests should be determined by computing the allowable cut under sustained yield management principles under general policies and restraints established at a national level.

National forest timber in the past had been, and is today, managed for broad conservation purposes and under the principles of sustained yield. The objective of management has never been solely to maximize economic returns from these forests; nor does the Panel propose that this be the primary consideration, although it does strongly urge that comparative economic returns *within alternatives of sustained yield* be given very much higher consideration in the future than they have been given in the past.

The volume and timing of national forest timber harvests have been established on silvicultural and other criteria within the forest; the effect of timber sale volume upon prices of lumber and other products, and the level of demand for the latter, have not been factors in decisions about timber sales. In effect, the market has been taken for granted, as something outside the control of the Forest Service. In an earlier day, when timber sold from national forests was a very small part of total national timber supply, such an assumption was valid. Today, when the volume of standing softwood timber on national forests is half of the national total, and when sales from national forests are a fourth of the total, or more, the effect of sales policy for national forest timber upon the total timber supply and demand situation can no longer be ignored. This does not in the least imply that past objectives of sustained yield, conservation, and multiple-use management should be ignored or dropped, but it does assert that considerations of the total timber supply of the Nation must henceforth enter into national forest planning and administration.

## REQUIREMENTS FOR FUTURE MANAGEMENT OF THE NATIONAL FORESTS

The Panel concludes that the role of the national forests must be different in the future from what it has been in the past, because they now include a major portion of the Nation's softwood sawtimber inventory. What is done on the national forests has major repercussions on the forests of all other ownerships. They should be managed to make an optimum contribution to the present and future national supply of sawtimber, taking into account surveys and projections of commercial timber stocking, growth and removals on other domestic timberlands, and the net effects of foreign trade in forest products. With due regard to other uses and other values of the national forests, those lands classified as best suited for commercial timber production should be dedicated to optimum wood production in a manner fully compatible with the conservation ethic.

The interrelation between various ownerships of forest land, in making up the total timber harvest has been explored in previous chapters. It is clear that the level of harvest from national forests has a marked effect upon timber harvest and timber growth on forests of other ownerships. The Panel urges that this relationship be taken into account in the management of the national forests. In chapter 6, proceeding from a nationwide analysis, the Panel concluded that, given adequate and assured financing, the level of harvest on national forests could be increased to the 17 to 20 billion bf range by the end of the 1970's, and the effect of such a harvest level on forests of other ownerships was briefly explored. Given the time and resources at the Panel's disposal, this conclusion was, of necessity, general in nature.

The Panel's overall or national approach and the inductive approach of its consultant (app. F) are complementary, and arrive at generally similar conclusions. More refinement in both analyses is needed, but the general direction of the results seems clear enough. The Panel's consultant was concerned primarily to obtain the largest achievable timber harvest, within the principles of sustained yield and with adequate environmental protection. He clearly interpreted the rising prices for lumber and stumpage as a signal that the country demanded more wood, and he sought to suggest how this could be obtained. The Panel started from the national timber supply-and-demand situation, and sought to estimate how far timber harvest from national forests could be accelerated to meet the evident need. The effect of the increased national forest harvest upon forests of other ownerships was spelled out in earlier chapters but largely taken for granted in the consultant's report.

As the harvest of mature old-growth timber on national forests is accelerated, the possibilities for increased growth of new timber are opened up. Old-growth stands, making little or no net growth, would be replaced by new stands in which growth rates should be high. This will require prompt regeneration of harvest sites, good forest management of the new stands throughout their lives, and other appropriate measures. All of this will require capital investment and some continued management outlays. The precise measures will depend upon conditions at each site, but are, in general, well-known. The most important requirement, and the one least likely to be met on the national forests if past experience is a reliable guide, is assured and sustained financing for intensified management. This subject is considered in more detail later in this chapter.

As noted earlier, the Panel explicitly does not propose management programs for national forests based wholly on economic criteria. But, within the various alternatives possible under sustained yield principles, the Panel does now believe that greater attention must be directed to economic considerations in the future. Such considerations apply within national forests: What level of investment and of management, which specific practices, on which sites, are likely to be most productive? Since the sums required are likely to be considerable, even in modern terms, efficiency in their use is obviously desirable. But the economic analysis should not stop at the national forest boundary any more than does an analysis of agricultural policy stop at the farm boundary. In chapter 6, the Panel pointed out some of the national interest in lumber prices and in lumber supply. These, plus the effects of national forest management on other forest ownerships, should by all means be taken into consideration.

Irrespective of the level of timber harvest from national forests in the future, the methods by which such harvest is made must be modified to take greater account of environmental impacts. Much of the popular criticism of timber harvest from national forests has centered on the environmental impacts. The public has been understandably shocked at large volumes of timber residues, so common when old-growth forests are cut and special measures to clean up slash are not taken, at erosion scars (which may have resulted from the road rather than from the timber harvest, but in its mind were associated with the latter), and at extensive areas regenerating slowly or not at all. Earlier sections of this report and consultants' reports have shown clearly that such adverse environmental impacts can be avoided in nearly all cases if reasonable precautions are taken. The harvesting of old-growth timber often results in a large volume of waste material. Some was on the ground already, and merely becomes visible when the trees are cut; but the old trees often contain a lot of cull or rot, which is normally not worth taking out of the woods. By various measures, private harvesters may be induced to take more of this material in the future. That which is too costly to be removed must be disposed of on the site, often by windthrowing and burning. The techniques are fairly well-known; they must be applied, and sometimes this will cost substantial sums of money which must be available from some source. The managed forests of the future, which will take the place of the old-growth forests as the latter are cut (or blown down), will have much less of this kind of problem. More, perhaps all, of the wood produced will be worth taking out of the forest.

In reaction to the public criticisms about the adverse environmental effects of timber harvest, the Forest Service has tightened up on the restrictions it places on methods of timber harvest and of site cleanup. Planning of timber sales and applications of restrictions on timber harvest have taken substantial time from Forest Service personnel. This has reduced the volume of timber sale offerings at the very time when it should have been increased to meet the demand for lumber and other wood products. The added timber harvest restrictions have also imposed costs on timber buyers and harvesters. These reactions to increased environmental concern were natural and in the shortrun perhaps inevitable. But they have imposed a social cost, which may or may not have been less than the social gain from reduced environmental effect. Even when the necessity of such measures is unchallenged, this does not prove that they were the most efficient means of achieving the same ends. The Panel hopes that the need for greater environmental protection in the future can be met with more efficiency than has been apparent in the past few years. Regardless of who bears the costs—and it is generally the public in the end—some costs are involved, and there is a national gain in keeping costs down while at the same time achieving the desired environmental objectives.

In order to achieve better environmental protection in future timber harvest, and in order to avoid harvests where no method is likely to be fully satisfactory, new approaches to timber harvest are called for. Appendix G (Newport) suggests one approach; a Panel staff report, appendix H, suggests another. The Panel favors the latter. Under it harvesting of timber by the purchaser would be covered by a separate division of the contract, spelling out in detail the conservation measures to be performed by the purchaser and establishing a schedule of credits for their measured accomplishment and for removal of timber in accordance with the contract specifications. Credits would be allowed only for conservation measures, and timber removal in conformance with contract specifications. It is believed that this would provide a closer and more accurate control over timber harvest operations than is now the case. As it stands today, it is not possible to establish adequate contractual incentives for full performance of conservation measures; the alternative to the Forest Service, when proper harvest procedures are not followed, is to shut down the whole sale—a remedy so drastic that it is rarely imposed.

The Panel believes that increased cooperation of the timber processing industry in reducing environmental impacts in timber harvest, can be achieved and will lead to lower overall environmental damage. Most timber industry operators are concerned over the long run productivity of the national forests. In the past, they—as indeed most people—may have been less sensitive to environmental issues than now seems desirable; but the Panel believes timber industry people are as willing to cooperate in protecting the forest environment as are other users of the national forests. There may well be need for education, and for consultation, between timber purchasers, other users of national forests, and the Forest Service. The Panel is not so naive as to assume that stringent controls will be unnecessary. There are always some users, for every purpose, whose actions must be subject to control and discipline if the conservation objectives of the national forests are to be achieved. But the increasing complexity of timber harvest regulations, believed to be necessary to protect those objectives, can perhaps be modified and reduced in their burden on the environmentally conscious timber purchaser, by greater cooperation between the industry and the Forest Service.

The Panel makes the following recommendations relative to the future management of the national forest with the specific reservation that these be considered in the context of the Panel report as a whole and the other recommendations contained therein.

*1. The Panel recommends:*

That the Forest Service, in preparing future plans, operations and administrative actions for the national forests, give due consideration to the impact that national forests output will have on the outputs of other forest holdings in the United States and that it consider the desirability of optimizing the output of products and services of all forests of the Nation. The discussion in this chapter suggests the general form a broadened perspective and enlarged role for the national forests should take.

*2. The Panel recommends:*

That in order to make timber output from the national forests more responsive to national timber supply needs, the Forest Service promptly review and revise policies for allowable cut determinations, including rotation period determinations, stocking objectives, and old-growth management policies. The precise level of accelerated harvest should be calculated for appropriate geographical areas and must consider, for each area, conditions of existing timber stands, accessibility of stands and road conditions, market demands and future timber supplies, all within the limits of sustained yield and existing law.

*3. The Panel recommends:*

That this new approach to national forest planning and management be brought to the attention of the Forest Service, the Department of Agriculture at the Secretarial level, the Office of Management and Budget, the Council for Environmental Quality, and other concerned Federal agencies. Each will have a new role to play, if the general recommendations of the Panel are followed.

*4. The Panel recommends:*

That the Forest Service seek to increase the output of timber from the national forests and also the efficiency with which this is achieved. This will involve some acceleration in harvest of mature old-growth stands, sustained increased capital funding to promptly establish new timber stands and to give them appropriate care until they reach merchantable size, intensified management on the most productive forest sites and types, and lowered investments in timber management for the unresponsive sites and types.

*5. The Panel recommends:*

That future attention, greater than was common in the past, be given to the environmental impacts of timber harvest. The Panel notes with approval the substantial progress made to date in this regard and urges continuation of efforts in this direction, including measures to insure that some of the unfortunate experiences of the past not be repeated.

*6. But the Panel also recommends:*

That intensive efforts be directed at ways of achieving environmental protection in timber harvest at lower real cost to all parties concerned. It particularly urges the Forest Service to seek the cooperation of the timber industry and of the various conservation organizations in devising regulations and procedures which will greatly simplify the conservation measures included in timber sale contracts while at the same time insuring adequate performance.

7. Specifically to the immediately foregoing end, *the Panel recommends* trial of the proposal in the Panel staff report, of separate contract provisions for timber purchase and for timber harvest.

## FINANCING NATIONAL FOREST MANAGEMENT

The costs of national forest management are mostly met out of annual appropriations. Appropriations for natural resource management are not adequately distinguished from appropriations for the more customary types of Government programs. That is, the fact that national forest administration is a form of *production*, not one of consumption, is not adequately recognized. National forest operations produce large amounts of revenue annually—over $300 million in recent years. If the Forest Service were listed among Fortune's 500 largest industrial corporations, it would fall about midway in the list. National forests are big business in the current American sense of the word; but their financial management is little different today than it was when their receipts (in constant dollars) were one-tenth or less of the present level. The Panel urges far more concern for the economic output of the national forests, but always within the principles of multiple use-sustain yield management and of conservation of the natural assets of the forests. However, though appropriations for natural resource management are generally productive, this does not prove that every specific expenditure is wise or efficient.

The typical governmental appropriation process has several deficiencies when applied to natural resource management: budgets are made up too far in advance (nearly 2 years) of the beginning of the period to which they apply and can be modified only with difficulty; budgets tend to lag too far behind changes in economic, social, and technical conditions; they rely too much on "last year." As a consequence there is too little flexibility to meet either special problems or special opportunities; there is too little assurance that long-term programs begun one year can be continued until they pay off. Expenditures for investment are treated in the budget in the same way as are annual operating expenses; there is too little attention to the value of results in relation to costs; and there are too few incentives for efficiency.

In recent years attention has focused upon the idea of "balanced financing" for the national forests, by which is meant a level of appropriations for each major activity of the Forest Service in the same proportion of the estimated fully adequate budget of the Agency. That is, if recreation or conservation measures are financed at only 75 percent of the need as estimated by the Forest Service, then timber sale appropriations or expenditures should not exceed the same proportion of the Agency's estimate. This viewpoint assumes that the Forest Service estimates of need for each major activity have a desirable balance among themselves; it ignores the fact that the political processes of government operate to place a different balance among activities. If "balanced programs" are insisted upon to the extent that no program can be carried out at a relative level higher than the most poorly financed program, this becomes an administration of the national forests to the lowest accepted programmatic level. Moreover, of the major funded activities on the national forests—timber, grazing, recreation, and mining—timber is the least generously and recreation the most generously financed in relation to income generated. The Panel—collectively, and each of its members individually—is fully sympathetic with the idea that conservation, recreation, wildlife, wilderness, and similar values of the national forests shall be conserved and protected; many specific sections of this report deal with this matter. However, as long as reasonable conservation measures are followed in timber management and harvest, the Panel feels that timber programs should not be sacrificed to other, less well-funded programs. The Panel has opposed, in this report, acceleration of timber harvest unless adequate provision is made for financing whatever intensified forest management is needed to support the higher cutting rates.

An ideal system of financing national forest management would include at least the following main characteristics:

1. *Assurance.*—There should be an assured source of funds in the future, to carry to completion programs begun in the present. Timber production is a long-term matter; assured funds to carry out essential measures when needed are indispensable. Annual appropriations have provided substantial sums in the past; quite possibly they will provide larger sums in the future; but continuity of appropriations at the needed level and for the needed purposes is simply too insecure for sound forest management.

2. *Economic rationality.*—There should be some rational relation for each major activity between the amounts of money available and the results expected or planned for. Tests of economic rationality as to level and purpose of expenditure should be applied and used. Such tests are well-known and need not be repeated here. While the appropriation process now considers the expected results, the connection between expenditures and results has been too poorly defined. The discipline of actual monetary returns for those forest programs which produce salable products, or the discipline of estimated values for products not sold in the market, each in comparison with expenditures, would provide a closer check on expenditures than now exists. Such tests should be applied to activities (timber, recreation, etc.), to specific measures (regeneration, stand improvement, etc.), and to site or location.

3. *Incentive.*—The Forest Service should have a built-in incentive for efficiency, which is largely lacking today. The budget review process does indeed include questions about efficiency, but many incentives for the agency lie in avoiding the hard and difficult actions necessary to insure efficiency. Any savings made are likely to cost the agency appropriations in future years, rather than provide it with more funds to do essential tasks. The Forest Service may well be a good deal better than the average Federal agency, but typically has not been good enough for efficient management of highly valuable and productive natural resources.

Any long-range solution to the problem of adequately financing the administration of the national forests must meet these criteria. The Panel is convinced that the longrun solution lies in tying together in some fashion expenditures for national forest management and revenues or values derived from national forest output, at least for the revenue-producing aspects of national forests. Earlier recommendations have made it clear that more of the costs of national forest administration could be met by users in the future, especially for recreation and related activities. Even where charges are not made, an estimate of the probable value of the resultant services should set an upper limit to the level of rational outlays. An immediate separation of variable and fixed costs by major national forest user/benefit is essential. Allocation of common costs to several user categories will be difficult but no more so than cost allocation in other U.S. industries. If cost of operation and values of output were more closely linked, by activities, measures, and locations, the criteria of economic rationality would be more nearly met. If expenditures were more closely linked to revenues, the criteria of assured funds and of incentives for efficiency would also be more nearly met. A linking of revenues and outlays is more easily visualized today for timber growing and timber harvest than for other national forest programs. If linked with a form of capital budget, this might well meet most or all the problems of financing timber production on national forests. A proper accounting of capital investments and of income would reflect the profitability of long-term timber-growing programs as well as of short-term programs. For the other national forest programs, the collection of revenues sufficient to meet the costs is less easily accomplished today, but this does not mean that substantial income could not be produced now, and more later. This could go far toward meeting the costs involved.

The Panel is aware of the complexities of devising a solution along the foregoing lines. Not the least of the difficulties is the fact that a special arrangement for the national forests and/or other Federal forest-managing agencies would create precedents which might be difficult to reconcile with established budgeting and appropriation procedures. The Panel is fully aware that present Federal budgeting and appropriation procedures have evolved over many decades, and that there are substantial advantages to uniformity in Federal financial affairs. *But the Panel is also convinced* that a major modification in Federal appropriation-expenditure processes is essential if the national forests and other extensive Federal lands are ever to be managed to make their adequate contribution to the national economy. Various alternative arrangements are possible that would meet the basic criteria outlined above. In the time available, the Panel has lacked the resources to explore carefully all the possible alternative arrangements, or to make a firm recommendation about which are the better.

The Panel recognizes that considerable time will be required to gain general agreement and for development of procedures for the long-range position it advocates. The Panel is also aware of the stringent budgetary policies the administration finds necessary currently to impose. The immediate pressing problem is that national forest timber output is declining at a time of unprecedented sustained demand for increased lumber and plywood production. The obvious first step in a Federal program to increase timber supply is to get national forest timber sales up to present allowable cut levels wherever there is that volume of market demand. The Federal timber-managing agencies should be financed with accompanying manpower authorizations to a level so that there is no fiscal restraint to attainment of this objective. This is a fiscally sound proposition because the additional sale costs will be less than the increased sale revenues by severalfold. Substantially higher unit costs of sale administration must be accepted in order to meet the environmental pressures for reduction of cutting impacts. Timber revenues from the national forests are also increasing. From a previous high level of about $300 million they are trending toward a $400 million level in fiscal year 1973. OMB should move promptly to determine the additional funds required to meet this sale of the full allowable cut objective. The Panel believes that it will find the amount involved is in the neighborhood of $30 million additional to the amount called for in the 1974 budget.

As a second step for recognition beginning in the fiscal year 1975 budget, the Panel urges a substantially increased appropriation for more intensive management of the national forests and for a start on acceleration of the cut of old-growth timber in accordance with its recommendations in this chapter. The Forest Service has made various recommendations for timber management intensification; without endorsing any of them in specifics, the Panel judges that an increased appropriation for the next few years of the general order of $200 million more than the amounts appropriated in fiscal year 1972 would permit an early regeneration of the presently unstocked or inadequately stocked forests which would repay the investment, would speed up the construction of the permanent road system, would make possible stand improvements of good economic rationality, and would otherwise enable the attainment of the level of management intensity on the national forests needed to support accelerated harvest of the mature old-growth timber. The precise content and cost of such a program must rest upon a more detailed analysis than the Panel was able to make, but the general outline and approximate costs seem reasonably clear.

*1. The Panel recommends:*

That the President direct the Office of Management and Budget, with solicited help of the General Accounting Office, to devise a management and financial plan that will best meet the special needs of good resource management and at the same time conform to the established requirements of good government. Experts may be required from outside the Federal Government.

*2. The Panel recommends:*

That an amendment to the fiscal year 1974 budget be processed to provide sufficient funds for the offering of the full allowable cut on every national forest where there is that volume of market demand.

*3. The Panel recommends:*

That beginning in fiscal year 1975 and for the next few years until a more permanent arrangement is established, the level of appropriations for national forest management be sharply stepped up, as outlined in this chapter. There should be no acceleration of timber harvest unless adequate provision is made for financing whatever intensified timber management is needed to support the higher rate of cutting.

If the Panel's recommendations on management of the national forests in this chapter are adopted by the administration, there should be followup action to see that the Forest Service fully understands and accepts its broadened mission and modifies its manual to get appropriate policies and procedures into practice. Such monitoring and assistance could well be one of the responsibilities of the Forest Policy Board recommended for establishment in chapter 11 of the Panel's report.

## THE FOREST SERVICE

The Forest Service has administered the national forests for nearly 70 years; it has been an outstanding public agency by any standard. It led in the development and application of such widely accepted concepts as multiple-use, sustained yield, and wilderness preservation. For many years, most professionally trained foresters in the United States worked for the Agency, or had worked for it before taking up other duties. The early development of forestry as a profession in the United States was, to a large extent, in its hands. The Forest Service also led in the development and application of many concepts of good government which are so widely accepted today that their origins are often unknown to those who abide by them. It endorsed and used the principles of personnel selection and advancement on merit—civil service—as compared with political support, when this was new doctrine; it has applied principles of careful planning and budgeting. There has never been a major scandal of administrative wrongdoing within the Forest Service.

Most Forest Service men are dedicated to their profession, to their Agency, and to its objectives; they have typically had firm convictions about good forestry and good forest management, and they have been willing to fight for their convictions. As a result, the Forest Service has been engaged in many controversies, from the days of Gifford Pinchot, its first Chief, to the present. The Agency has encountered much criticism as well as received much praise and support.

The Forest Service has protected and defended the national forests against such physical enemies as fire and against those who would have exploited the forests to ends the Service felt were improper. Today, when the permanence of the national forests (and of other types of permanent Federal land reservations) are not seriously in question, it may be difficult to realize the political and other pressures for invasion, if not liquidation, of these vast and valuable forests that the Service withstood. Maintenance of the national forest system virtually intact through 70 years of commercial pressures and bureaucratic infighting is a remarkable feat; maintenance of its timber management policies have kept the national forest timber state on an orderly and conservative track of development.

In recent years the Forest Service has encountered a growing volume and diversity of public criticism. On the one hand, certain conservation groups have attacked it for alleged inadequate attention to the various nontimber outputs and values of the forests. Some conservation groups have sued it to prevent actions deemed inimical to their interests—a type of action unthinkable as well as legally improbable, on the part of conservation groups a generation ago. On the other hand, the forest industry has criticized the agency for its conservatism in timber management, for the low volumes of timber offered for sale, for the restrictive measures in timber purchase contracts, for its slow roadbuilding program, and for other reasons. The Panel does not choose to catalog and analyze these numerous and often conflicting criticisms, nor to further offer its judgment as to their accuracy or relevance; but no one even moderately observant in the natural resource fields can be unaware of the volume, the sharpness, and the general nature of these criticisms.

Foregoing sections of this chapter have emphasized that the national forests must play new and larger roles in the national economy and society in the future than they have in the past. The economic, social, and political environment within which the Forest Service must operate has changed, and this will inevitably throw new responsibilities on and new challenges to the Forest Service. The Service has sophisticated statistical programs such as RAM and INFORM by means of which it can list out the effects of various environmental, economic, and biologic constraints on projections of yield, allowable cut, and effect on national timber supply. These computation tools need to be applied with greater flexibility and encompass broader objectives, directives, and constraints in the interest of optimizing total output potential of the national forests.

It is clearly evident that the Forest Service is not, and cannot be the single, most dominant organization within the resource and conservation fields that it once was. It can no longer win many arguments by sheer force of its position and of its record; it will be increasingly challenged by individuals and organizations to whom its past achievements mean relatively little.

The Forest Service has been fortunate in the past in that new opportunities opened up as rapidly as the Service gained the strength to embrace them: In 1905, management of the national forests; 1911, extension of fire control to private lands; 1917 and 1918, getting out timber and developing new timber uses to support the Armed Forces; 1924–28, forest extension, research, taxation, and nationwide forest inventory launched, also the first wilderness area established; 1932–40, the Civilian Conservation Corps, Prairie-Plains Shelterbelt, New England Timber Salvage programs opened; 1942–45, supporting the Nation's participation in the Second World War; 1946–60, an expanded program of aid to forest owners, and a greatly expanded program of forest research to support the rapidly developing programs of industrial forestry; 1960–64, Multiple Use-Sustained Yield Act extends the principle to management of all national forest resources and to other forests as well. Wilderness program extended; 1965–71, public awakened to the need for environmental protection and the role that forests should play. Now in 1973, the Nation faces its first major timber supply crisis in which intensified management of the national forests offers an effective beginning for immediate resolution of the timber supply problem and for readjusting total timber resources to long-term future needs.

The challenge is clear enough, but the public is deeply divided on what action, if any, should be taken. The situation calls for leadership at the national level. Other materials, energy, and human resources, as well as the timber resource, are involved.

The President has clearly stated his belief that the Nation and its people must learn to become more self-sufficient and certainly this applies to forest resources. We should not as a nation depend heavily upon outside sources for timber that can readily be produced at home, especially now that timber use worldwide is expanding, foreign exchange is tight, and our own lands are producing at less than half capacity.

Certainly a need and an opportunity as great as at any time in the past faces the Forest Service today. A concerned citizenry, a newly oriented timber industry, and a host of people who need better homes await mobilization behind a daring, broadly based new program of intensified management for all the Nation's forest resources. Much of the work that needs to be done on the national forests can be made self-financing.

The Service has much to contribute to all natural resource problems, as well as to the manifold and complex problems on the lands under its direct administration. It may never again be the giant it once was, but it can be a major factor among equals.

The Panel makes no specific recommendations about Forest Service organization and operation. It urges the President and the Secretary of Agriculture to provide the Service with more encouragement, leadership, more political support, and more financial support, while at the same time exercising closer involvement in the Agency's operations.

## RELATIONSHIP OF THE FOREST SERVICE TO THE PUBLIC

Because the resources of the national forests are so important and are used by so many persons, and because the American electorate is an increasingly articulate and informed one with a firm determination to influence public policy, the relations of the Forest Service to the general public are highly important. The Panel notes with approval that the Forest Service has begun to involve the general public more deeply and more closely in the planning and management of the national forests. The Panel believes, however, that greater efforts in this direction will be needed in the years ahead.

Public involvement must be genuine at all stages in the planning process. That is, it is not enough that the Forest Service inform the public about its plans, or seek public endorsement of plans developed within the agency. Instead, involvement implies getting an input from the public in the formulation of goals, in the development of timber harvest programs. National forest planning in the future, more than in the past, must recognize the new uses and new public concerns for the national forest, which are outlined in this chapter. To involve the public deeply in national forest planning, and to some extent in national forest administration, will call for new approaches from the Forest Service and probably for new skills within it.

The Panel strongly urges the Forest Service to greatly intensify its efforts to involve the general public in the planning for and the management of the national forests.

Part of the general public should not be confused with the whole of it. Some sectors of the public are more vocal, and more aggressive, than others. They must be heard, and listened to, and taken seriously, but do not ignore those interests which may be less capable of making themselves heard. The latter may have to be sought out, if they do not come forward on their own. National forest planning which includes public involvement should be conducted fully in the open, with easy access to all parts by any interested public.

The national forests belong to all the people of the whole United States. People from the local community, the local region, the State, and the larger region have important interests in particular national forests, and must be seriously consulted and considered. But distant citizens have an interest in each national forest too. The resident of the remote inner city has an interest in the recreation, wildlife, the wilderness, and the timber output of the forest—not as great or as immediate as does the local resident, but still important.

The Forest Service is responsible to the President and to the Congress, and to their respective designees, for the management of the national forests. The political process provides a system of political responsibility for public action. An informal citizen or business group can advise the Forest Service, can make its attitudes and choices known directly to the Forest Service, and can participate in the political process. But such groups cannot accept *responsibility* for national forest management; that must remain with the Forest Service.

*The Panel recommends:*

That the Forest Service continue and expand its efforts to involve *all* sectors of the public in the planning and management of the national forests, in order that the national forests shall the better serve the whole public, but final responsibility for national forest management must continue to rest with the Forest Service.



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# Public Programs for Private Forests[1]

The American public has long recognized that it has an interest in the capacity of private forests to produce timber and other products, protect soil, watersheds and wildlife and to preserve an attractive general forest environment. This interest has taken tangible form in appropriations for control of fire, insect and disease outbreaks; in aid for tree planting, research on forestry and wildlife, and cost sharing for forest improvement. A forest destroyed by uncontrolled wild fire is unattractive in appearance, may lead to temporary increase in runoff, is unsuitable for many species of wildlife, as well as being at least temporarily unproductive of wood; hence, public programs to provide fire prevention and control have been widely supported for over six decades.

Federal financial support to State programs for forest fire prevention and control was provided for in 1911. In addition to providing needed funds, these Federal programs have been an important stimulus to State and private programs, and have helped to set standards for fire prevention and control. Forest research has been supported directly by Federal agencies and through funds for cooperative research with the States and forest industries. Still another form of public interest in private forestry has been favorable tax treatment for forest owners; income from timber production may be treated as a capital gain rather than as ordinary income for Federal taxation. This tax advantage is available to all forest owners. Without the capital gains treatment applied to timber since 1944, the timber supply problem in the United States would be even more severe than now forecast.

Several States have additional programs useful to both small and large private forest owners and to forest industries. These are described in appendix I and need not be repeated here.

*The Panel recommends:*

1. That Federal programs which support prevention and control of outbreaks of wildfire, destructive insects and tree diseases and which support forest research, be continued at appropriate levels of funding. The Panel believes these programs are in the general public interest as well as being to the advantage of the forest landowners concerned; and
2. In order to stimulate increased timber supply, special Federal income tax provisions should apply to timber because of the growing period, risk, and modest rate of return applicable to forest operations.

## LARGE- AND MEDIUM-PRIVATE FORESTS

For convenience in treatment the Panel uses the definitions of small-, medium-, and large-forest ownerships that the Forest Service used in its 1958 report, "Timber Resources for America's Future." Ownerships of less than 5,000 acres are classified as small, those between 5,000 and 50,000 acres as medium-sized, and those of 50,000 acres and more as large. This classification has its justification in the relatively low economic output of forest land compared with that of cropland and other land uses.

Many of the forest holdings of 5,000 acres or more are owned by forest industry firms or by other owners that have established financial or credit sources. These are referred to as industrial

[1] For further details on the subject matter of this chapter, see "Appendix I: Improving the Productivity of Nonindustrial Private Woodlands," by William R. Sizemore and the Sizemore and Sizemore staff.

forest lands. Owners of such forests are likely to apply the methods of business analysis to their investments and to investigate various management opportunities on their forest properties. If a silvicultural practice offers good prospects for long-term return on investment, owners of large forest properties are likely to adapt it.

Few forest industries own as little as 5,000 acres of forest land for the simple reason that properties of such size are too small to make a significant contribution to a timber processing firm of sufficient size to constitute an economic unit.

The Panel makes no assertion that all medium- and large-forest owners are competent managers, but many have demonstrated a high level of timber production. Moreover, new methods of forest management and new economic conditions may well make future optimum forest management different from present optimum forest management. The Panel does feel that no additional public programs aimed at the medium- and large-forest ownerships are currently necessary. Accordingly, no recommendations are made for special programs directed at such forest properties.

## SMALL PRIVATE FORESTS

The owners of other private forests, mostly less than 5,000 acres in size, are made up of farmers that in 1970 owned 131 million acres and miscellaneous owners holding 165 million acres. During the period 1952–70 forest ownership by farmers declined by 42 million acres while miscellaneous private owners increased their holdings by a similar amount. Most programs to improve timber production on small private holdings in the past have been tied in with agricultural programs. These have not always been attractive to the businessman, professional people, retired folks, and others that make up the miscellaneous class of owners. For them their woodlot is generally held for speculation or as a recreational asset and not as an adjunct to a farm or other business venture.

The importance of these private forests lies in their large area: 296 million acres or 59 percent of all commercial forest land in the United States. The figures for softwood and hardwood forest land are 40 and 75 percent, respectively. Regional differences occur also; in the North and South somewhat more than 70 percent of all forest land is now nonindustrial private land, whereas in the West it is only 22 percent. From table 8–1 it can be seen that, on the average, other private forest holdings are understocked with less than half as much sawtimber per acre as the average of all forest land.

Nevertheless, in 1970 they supplied 29 percent of the softwood sawtimber harvest and 80 percent of the hardwood harvest. They produced 43 percent of softwood sawtimber growth and 72 percent of hardwood growth. These are no minor contributions to the Nation's timber supply.

On the whole, nonindustrial private lands are not the best timber-growing lands in the Nation. Of these lands, 67 percent are in site qualities IV and V as opposed to 55 percent for industrial forests. Also 67 percent of nonindustrial private forests support hardwood forest types that grow but 63 percent as fast as the softwood types.

Another handicap of nonindustrial forest owners is the small average size of holdings, 71 acres.

**TABLE 8–1.—Commercial Forest Land Acreage, Inventory, Growth and Removals by Timber Stocking and Ownership Class—1970**

| Timber stocking and ownership class | Area (million acres) | Growing stock (cubic feet per acre) | | | Sawtimber (board feet per acre) | | |
|---|---|---|---|---|---|---|---|
| | | Inventory | Growth | Removals | Inventory | Growth | Removals |
| Stocked: | | | | | | | |
| National forests | 83. 6 | 2, 599 | 31 | 23 | 12, 220 | 117 | 155 |
| Other public | 41. 5 | 1, 638 | 43 | 22 | 6, 328 | 142 | 116 |
| Forest industry | 65. 8 | 1, 523 | 53 | 53 | 5, 875 | 188 | 278 |
| Other private | 283. 0 | 930 | 38 | 25 | 2, 647 | 113 | 91 |
| All ownerships | 473. 9 | 1, 369 | 39 | 28 | 5, 106 | 126 | 131 |
| Unstocked | 20. 7 | | | | | | |
| All commercial forest land | 494. 6 | 1, 312 | 38 | 29 | 4, 954 | 121 | 13 |

Source: Adapted from Marty, app. C, table 1.

Holdings of less than about 200 acres are generally too small to justify intensive forest management on a commercial basis unless they are of better than average site quality. Intensive forestry on very small holdings is likely to be justified by hobby interests of the owners rather than on a strict investment basis.

The small private forests present many special problems to their owners and to public and private agencies that seek to increase their output. These small forests are inefficient to manage, in the sense that the costs of many operations such as harvest or planting are high per acre because areas are small. Often the cost of moving the necessary equipment to the site is prohibitively high for the volume of work to be done. Problems of uneconomic harvest due to small area are exacerbated by the low volume per acre. One result often is that the log buyer takes off only the logs that he thinks can profitably be converted (one form of selective harvest), even when some of them could more profitably be left for further growth. The small forest landowner often lacks the necessary professional knowledge and skill to make wise management decisions about his forest and to carry out such decisions. He doesn't generally know how to mark his trees for wood production; moreover, he rarely thinks it profitable to hire forest consultants or managers for his forest because it is so small. Even if he knew what to do or could get competent advice, often the amount of the income he could earn by applying the best management practices would hardly be worth his time and thought, again because of the small size of the forest. Thinning of his growth stands and sale of the logs removed might be a good silvicultural practice, but the volume might be so small as not to interest loggers or buyers.

Perhaps the most difficult problems facing small private forests arise from the motives of the forest landowner. In a great many cases, he does not own the forest for its income from wood growing and harvest. Perhaps he has inherited it and has a sentimental attachment to it; or he has bought it for speculation, and expects to make money from early sale of the land, not from growing trees; or he has acquired it as a recreational area, or as a hobby, and regards cutting of trees as undesirable; or for other reasons he does not know the forest management alternatives and the type of economic calculus that the typical industrial owner applies. The small forest owner may lack capital, or have other alternatives for use of what capital he does have that are more profitable; this has often been true of farm woodlots, for instance. The small forest owner generally is not interested in a forestry program that will require 50 years or more to pay off, even though such a return might be quite generous. His planning horizon is shorter, his objectives may not be maximization of annual income from wood growth, and arguments about good forestry are not likely to motivate him.

Although the small private, nonindustry forests have great potential for increased wood growth, and thus in the long run for increased wood harvest, they cannot be expected to provide an increased share of the wood demanded for the remainder of the 1970's. As table 4–1 showed, the wood harvested during the 1970's must be wood already in existence or which can be grown in a very few years on the tree stems already growing. As noted, the small private, nonindustry forests on the whole have low volumes of standing timber; the need of most of them is to increase the volume of good growing stock, not to decrease it. Tree planting, thinning, stand improvement, and other measures will increase the net wood growth on these forests, but little if any of this increased growth can be harvested in the next two decades. Greater wood growth on these small nonindustry forests during the 1970's and 1980's can help to supply increased wood needs at a later date, and hence could be important in justifying accelerated harvest of the national forests—the one major kind of ownership with excessive present inventory—if sustained yield-allowable cut calculations were to be based on all forest ownerships taken together. Barring strict Federal control over timber harvesting on all forest lands, an action the Panel does not recommend, no assurance could be given the Nation that severe periodic timber shortages could be avoided under such a plan. For this reason, and also to sustain local supplies, the Panel has misgivings about pooling all ownerships into a single sustained yield cutting schedule. However, one of the tasks of the Forest Policy Board the Panel proposes would be to propose by various incentives to bring about a gradually rising flow of timber from the Nation's forests as a whole.

Although timber growth for the future can be increased on private nonindustrial forests, it is far more important for the softwood forests than for the hardwood ones. The private, nonindustrial forests are mostly hardwood. As noted in earlier chapters, the supply of hardwoods appears ample in total: growth exceeds cut, and inventories are rising. This does not mean that supplies are ample for all species and all grades of hardwoods; for some, the demand is high relative to the available supply. However, the most serious demand-supply situation exists for softwoods for use as lumber, plywood, and pulpwood. If public programs to increase wood growth from nonindustrial private forests are undertaken, they should be concentrated on softwood forests. To a large extent, this means pine forests in the South. There are extensive acreages of pine forests, or of land capable of growing pine forests, in the South, in relatively small ownerships that are not now producing near their readily attainable output. To the extent that wood growth on these lands can be accelerated during the next two decades, and thus wood harvest increased after that, such public programs would be particularly well suited to help meet the demands for timber. It is also in this region that the pulpwood and paper manufacturing plants are operating on an increased scale, and could well provide a market for increased supplies of softwood.

Throughout the Lake States, the Northeast and the South, much land in small private holdings is now occupied by hardwoods of mediocre and low-quality growing on lands formerly occupied by pines. Converting such forests to conifers is one way to increase substantially the output of softwoods without lowering significantly the output of choice, high-quality hardwoods. Generally such conversion is expensive. However, forest industries in the South have found it often to be a feasible undertaking, and the same could be done in the Lake States. Where sapling sized pines are growing in mixture with low-quality hardwoods, cutting the hardwoods to release the pines from competition is one of the best paying forest investments. Such a practice can be recommended to both industrial and nonindustrial owners.

The small private forests will continue to produce much wood for harvest as long as the rain falls and the sun shines; the problem is to increase their timber growth and ultimately their timber harvest. The problems of small private forests are most difficult of solution; they exist in many countries of the world, and in none has a wholly satisfactory solution been achieved. Not even strict public control of timber harvesting on such lands has raised the level of growth to that of public and large private holdings. Nevertheless, it is essential that some public programs be aimed at these small private forests and that more effective programs be sought.

Over the years, a number of Federal, State, and private forestry association programs have been developed and placed in operation, to aid the small private forest landowner to increase the output from his land. These are described in appendix I. Eight Federal programs provide technical advice and assistance, or direct grants of money or materials for forest planting and timber stand improvement. Such assistance includes credit to forest landowners, direct cash payments for conservation activities, and cost sharing. Some States, as Virginia, have special cost sharing programs to reforest small tracts. The American Forest Institute and various large private forest industry firms have special educational programs and provide technical assistance, planting stock, or other aids to small private forest owners.

It is difficult to appraise the effectiveness of these varied programs. Data are available on acreages, treated or included in technical assistance programs, on seedlings provided and other services rendered on which judgment can be made as to scope of these programs. In general, they have provided help to only a relatively small part of all privately owned, small forests. More seriously, it is extremely difficult to know to what extent the Federal, State, or industry programs have been a net addition; that is, many of the forest landowners who have planted tree seedlings provided from one of these sources might have bought seedlings from commercial sources and planted them, even if the public programs had not been available. No informed person would deny that these public and industry programs have had some effect in increasing total wood production on small private forests, but it is impossible to put a quantitative estimate on the extent of this increase, nor on the results achieved per unit cost.

The timber industries have also entered into various contractual arrangements with owners of small private forests. A company may lease the land and/or buy the timber, under various arrangements; it may also manage the forest, often at no cost to the forest owner. These arrangements can provide the small forest owner with services he would otherwise find it difficult or expensive to get. It may provide him with some annual rental income, assure him of a market for his logs, and have other advantages. A few companies have leased the timber growing rights on a number of small tracts assuring them of some supply of logs, often a volume which would otherwise not be forthcoming. These contractual arrangements have been particularly important in the South between pulp and paper companies and small private forest owners. They have had the further advantage of being more popular with the general public than an aggressive program of forest land purchase by the companies.

In many parts of the United States, competition for forest land has pushed up the price of bare land to levels which make economic production of wood very difficult to justify. Land is in demand for many purposes, in addition to the growing of wood. For instance, demand for land for recreation or second homes results in the bid up of value; or the land may be sought for residential or industrial use, as part of urban or suburban expansion; or it may be used for highway purposes. The effect of increased demand for these purposes is often not limited to the tracts so used, but tends to spread out, to a degree at least, to all forested land in the same general region. For some of these uses, such as highways, further production of trees is impossible; for others, such as recreation, some timber growth may be possible; even harvests of trees may occur, but wood output will almost surely decline.

*The Panel recommends:*

That present Federal and State programs to aid the small private forest owner be continued, at a level of funding more or less the same as in the recent past. The Panel does suggest that more attention might well be given to the forest landowner's objectives. If feasible means could be found to help him achieve his objectives while at the same time encouraging high production of wood supplies from these forests, that would seem a desirable outcome.

The Panel encourages and *supports* efforts to develop new approaches aimed at increasing timber from private lands in small ownerships.

*The Panel does caution*, in view of the record to date, against over-optimism about increasing the output of wood from nonindustrial private forests. Such forests have produced much wood in the past and will do so in the future; but increasing their output, above that which will occur "naturally," is very difficult and efforts in this direction may produce but limited results not worth the public cost required.

## A NEW APPROACH FOR THE SMALL PRIVATE FORESTS

In view of (1) the prospective demand for wood, especially softwood sawlogs, (2) the unrealized growth potential of the very large acreage of small private nonindustry forests, and (3) the limited effectiveness to date of the public programs to improve such forests, the Panel's consultant has proposed a new approach to the problem, in appendix I. The objectives of this new approach are, broadly, two: to increase the wood output of these lands, and to retain for the owner as much use of the land as possible in addition to wood output.

Briefly, this proposal involves aggregating properties through a system of leasing small nonindustry forests by some entity capable of managing them for high-level wood growth and harvest. The leasing entities would be licensed by some Federal agency upon application and investigation based upon conditions described below. Once a lessee had assembled a leasing block, the individual landowners in that block would be eligible for the payment of ground rent by the Federal Government for the period between the execution of the lease and the time when the first commercial thinning becomes feasible. The lessee would be required to enter into a timber purchase contract for all the timber presently existing on each ownership unit within the leasing block and to manage the land for a period at least equal to the appropriate regulatory period plus one rotation.

Under this proposal, any organization capable of reasonably good forest management could serve as a lessee. That is, a local forest consultant could be the lessee, as could various types of organizations. A single large forest owner within the block might serve in this role; so might a cooperative association of several forest owners; so might a conservation organization, such as a local chapter of the Izaak Walton League; so could a unit of local government, such as a county or township. Obviously, some standards of professional competence, of legal responsibility, and of financial capacity would have to be established, and their terms would be important. But great flexibility is possible.

In order for the objective of efficient forest management to be achieved, some minimum size of block would also have to be established. The minimum area would be about 4 square miles; a leasing block could be determined by natural boundaries, not necessarily conforming to the public land survey; for some forest types, possibly larger units would be necessary. Within the minimum area a minimum of 50 percent of the land should be in woodland or be capable of being converted to this use after the program is established. The lessee should be required to have under lease at least half of the woodland (or land capable of growing forests) within the block, not counting his own ownership of forest land. If the lessee is a landowner, he would be limited to 20 percent of the forest land within the block. Obviously, these specific figures might be modified, but they give an idea of the kinds of leasing arrangements deemed to be workable and fair. On the whole, these suggested provisions would permit the assembly of rather small forest management units. While this is desirable, in the sense that it permits greater flexibility to meet local situations and to enable a wider range of organizations to compete as lessees, it might well be desirable in many situations to have leasing blocks far larger than these minimums.

The Federal agency responsible for this program would pay a ground rent to the owner of the forest land, for some period of years (usually more than 10 years), during which the lessee would be getting timber stands built up to a fully productive state. Appendix I uses an illustrative example of a ground rent of $10 annually per acre, but this figure might have to be adjusted to local situations, or provision made in the legislation for its adjustment to economic or other conditions. It might well be varied according to the timber producing capacity of the land. In any case, it would provide the forest landowner with an immediate and significant income, thus encouraging him to enter into such leasing arrangements.

The lessee would be required to contract for all timber standing on each tract at the beginning of the lease and to rehabilitate the tract to its productive potential. Ordinarily, the lessee would contract to buy the timber when it reached harvest age and condition, or to sell it to a processor if he were not a processor himself. In either case, he would agree to pay the owner of the land 10 percent of the fair market value of all timber harvested after the period of the initial rehabilitation (which would also be the period of the payment of ground rent by the Federal Government). During the period of the lease the lessee would meet all costs of timber management, all severance taxes when the timber is harvested, and half of the ad valorem taxes. These terms of the leases could also be varied but the foregoing suggestions are those which the Panel's consultant thought fair and reasonable.

The forest landowner would retain many rights: rights to any mineral exploration and development; rights to use the land for agreed-on personal uses such as recreation (hunting, for instance) and others. Special provisions would have to be made in the leases for the rights of each party in case the landowner wished to sell, or in case he died and the property were inherited by someone else. In general, leases would have to run with the land, instead of with the owner, except as provision was made for their termination. The lessee might well be given the right to purchase the land at the price offered by another prospective purchaser, if the owner wished to sell. These and other provisions of the leases would have to be spelled out with care, but they present no insurmountable problems.

The Panel's consultant suggests that a program such as the foregoing might be applied to about 1.5 million acres of land each year for perhaps 15 years; at the end of that period, about 22 million acres would be included at an annual cost to the Federal Government of about $220 million. A program of this type could clearly be undertaken on a smaller scale, but perhaps would not be practical on a larger scale. In any event, the terms of the program should guide it to areas where the productive potential of the land was high, where there would clearly be a local market for the wood produced, where there were lessees competent to manage a program of the size budgeted for, and where there was interest among small nonindustry forest landowners in participation.

The consultant's report does not include a benefit-cost analysis of this proposal; that is, neither he nor the Panel is able to state how much added wood supply will be produced for any proposed Federal expenditure. It might well be argued that this proposal would be more cost effective, in producing added wood supply than presently existing Federal programs to aid small forest owners.

*The Panel recommends* that legislation be enacted and appropriations made to carry out, on a trial basis, a new public program of financial assistance to small private forest landowners, paying them ground rents for their land for a limited number of years under the condition that their forests be leased to a competent forest manager, as suggested in the discussion in this section.

*The Panel recommends* that this trial be on a scale adequate to fairly test the idea under a number of different forest situations and for landowners and lessees of different kinds and interests, but does not attempt to define the exact acreage or final commitment necessary. It does urge that the trial be undertaken in the most favorable situations, to give the idea the best chance to work. The purpose of the trial program is to acquire some experience with the idea; modifications might be needed as a result of such experience. If the trial were successful, then the program could be expanded. At this stage, the Panel regards this proposal as additional to the presently existing public programs for aiding the small private forest landowners; but it is possible that after fair trial it might replace them.

# Foreign Trade in Wood and Wood Products[1]

The United States is the world's leading importer of wood products, outranking Japan, the United Kingdom, and Western Europe. However, because domestic wood production is high and exports of certain wood products are growing, the Nation depends on imported wood to the extent of 1.5 million cubic meters or about 12 percent of total domestic consumption. Imports in 1971 amounted to about 2.8 million cubic meters (roundwood equivalent) compared to exports of 1.3 million cubic meters.

Although the overall U.S. wood import dependency rate is not large, some wood products are imported in substantial volumes. Imported Canadian softwood lumber, one of the most important materials in residential construction, rose to 20 percent of U.S. consumption in 1971 and continued to a higher dependency rate in 1972. Because the domestic supply of choice hardwood veneer species and grades cannot satisfy at world prices the growing demands for hardwood plywood and veneer, the United States depends on imports from Southeast Asia for at least 55 percent of domestic requirements. The Nation has always depended on Canadian newsprint and presently imports about 70 percent of consumption. All indications suggest that newsprint and hardwood plywood will continue to be imported in substantial volumes.

The export of softwood logs and lumber to Japan has become controversial lately because of the very high demand for construction, especially residential construction. Exports of chemical pulps, kraft paper, and linerboard to Europe and Japan and particularly wood chips to Japan, will increase because overseas markets are growing rapidly. There is a potentially large raw material base for increased chip production from low-grade timber and logging and milling wastes in the Pacific Northwest. Furthermore, U.S. producers appear able to compete with their Canadian counterparts in the production of export pulp and paper products.

Worldwide demands for the higher valued wood products continue to rise. The major wood surplus areas, Canada, the U.S.S.R. and Scandinavia, are now looking to expanded world trade. Canada, the largest wood exporter, has aggressively promoted trade in wood with the United States. Japan, a wood deficit nation, has become an aggressive trader in wood, importing hardwood and softwood logs, and exporting some plywood products. Western Europe, which was once a net exporter of wood, has become, as has the United States, a net importer, especially of lumber and pulp and paper products. Developments in foreign trade in timber products will affect the future U.S. wood products import-export position. The question is by how much and in what directions this effect will be manifested.

Total future domestic consumption of wood products in the United States will depend not only on future domestic production and demand, but also on the opportunities to export competitively in world markets and on the availability of products more advantageous to import rather than produce at home.

This chapter examines the principal external factors which are most likely to influence future U.S. foreign trade in wood, and hence the Nation's wood import-export position.

[1] For more detail on this subject, see appendix J, "Foreign Trade in Timber Products," by Irving Holland.

## UNITED STATES FOREIGN TRADE IN TIMBER PRODUCTS

### Lumber

There has been an active trade in softwood lumber between the United States and Canada for a long time with imports much more important than exports in recent years. Trade in hardwood lumber, while of long standing, has been of small volume.

Rising lumber prices in the United States have encouraged imports during 1972, but Canada has also actively promoted softwood lumber exports to the United States and other parts of the world. This has been especially true of British Columbia as she aggressively supported expansion of her forest industries.

Canadian softwood lumber is indistinguishable from domestic lumber and there are no significant trade barriers. Canadian producers enjoy a transportation cost advantage when lumber is shipped to U.S. markets by water due to the Jones Act, which requires that shipments made between U.S. ports be made in ships of U.S. registry. Furthermore, they are at no disadvantage when lumber moves to eastern and midwestern markets by rail.

U.S. softwood lumber imports reached a record 9 billion bf in 1972 and could surpass 10 billion bf during the 1970's. Softwood lumber exports, primarily from Alaska and also from Oregon and Washington, were 1.3 billion bf in 1972.

### Plywood

Canada and the United States are the only two important producers and consumers of softwood plywood with trade in this product between the two countries restricted somewhat because of tariff barriers. Nor does U.S. or Canadian softwood plywood enter international trade importantly despite large markets for panel products in Japan and Europe. In Japan, the lower grades of luan plywood are used in construction; in Europe, the lower grades of beech and African hardwood plywoods are so used. Also in Europe particleboards and hardboards are popular materials.

Exports of hardwood plywood and veneer from the United States have been relatively low, but imports have reached very high levels. In 1971 imports amounted to 205 million cubic feet, almost 60 percent of total consumption. Almost all of this material comes from Southeast Asian tropical forests after manufacture in South Korea, Taiwan, Japan, and the Philippines. Although the U.S. hardwood timber resource will continue to improve over time and perhaps reduce the need to import to some extent, demands for such items as flush doors, wall paneling and other construction-related hardwood panel products are expected to increase greatly. If prices of these imported products can be maintained at relatively low levels, as they have been since 1950, future U.S. hardwood construction plywood requirements will be met in large part from imports.

### Sawlogs

Sawlog imports into the United States have never been large (84 million bf log scale in 1971) and because most exporting countries are discouraging export of raw wood, it is likely that future imports of logs will be even more restricted. Of all the U.S. forest products involved in the world trade, none has been so controversial as softwood log export, 80 percent of which has come from one State—Washington.

Log exports totaled 2.3 billion bf in 1971, roughly 30 percent of the roundwood equivalent of all timber products exports. The export of logs across the border to Canada (about 20 percent of the total in 1971) is a long-established practice—one not likely to be discontinued soon.

Log exports to Japan have been over 2 billion bf annually over the last few years. These logs are consumed totally in Japanese homebuilding and construction. More than two-thirds of these logs are whitewoods, species more desired by the Japanese than in the U.S. market. The rest of the exported volume is made up of Douglas-fir and cedar. All the logs bring higher prices on the export market than those prevailing on the domestic markets of the exporting regions. Logs for export come from several sources including Federal lands, State forest lands in Washington, lands owned by forest industries and a variety of nonindustry forest land holdings. Because the Morse Amendment to the Foreign Assistance Act of 1968, as extended, limits exports of logs from Federal lands to 350 million bf annually, most exports originate on State and private forest lands.

Proponents of continued log exports point to the potential strength of the United States as a timber grower for international trade, the maintenance of markets for timber of low domestic demand, the added incentive for more intensive forest management and utilization on State and private lands, the economic benefits and stability from foreign markets for the exporting regions, in times of domestic down-cycles, the balance-of-payments benefits, and because of less wood waste, to a better environment generally. Proponents of restrictions on log exports argue that this material is lost to domestic processors, that needed domestic supplies of softwood lumber and plywood are reduced, and that more timber-growing lands could be devoted to wilderness and nontimber uses if exports were reduced.

### Pulp and Paper

In 1971 the United States consumed the roundwood equivalent of almost 80 million cords of pulpwood (about 4.6 billion cf) in the form of pulp and paper products, and almost 90 percent of this was produced domestically. The major import items were newsprint and chemical pulps from Canada (about 1.3 billion cf). At the same time the United States exported substantial volumes of pulpwood (including chips), chemical pulps and paperboard to Japan, and chemical pulps and paperboard to Europe (about 0.6 billion cf).

The United States continues to depend on Canada for about 73 percent of domestic newsprint needs, the most important of the pulp and paper import items. Expectations are that Canadian newsprint exports will be able to keep pace with expanding demands and that the United States will probably continue to rely on Canadian newsprint for 70–75 percent of total consumption.

Wood pulp imports from Canada have increased gradually over the years, despite rising domestic production. However, U.S. exports have risen almost twice as fast as imports since 1960, resulting in a rapid downward trend in net imports, especially bleached sulfate pulp. Rising wood pulp exports from the United States involving special alpha, dissolving, and bleached sulfate pulps have been greatly encouraged by growing demands for these grades in Europe, Japan, and Latin America.

Imports of paperboard and building boards (mainly from Europe) are of minor importance. However, U.S. exports of these items grew to about 3 million tons by 1971. Again the major markets were western Europe, Japan, and Latin America in response to increased demands, especially for container board and kraft papers.

In addition to wood pulp and industrial paper exports, an increasingly important market for wood chips from the Pacific Northwest is developing in Japan. Major increases in chip exports are possible if logging and milling wastes and low-grade timber can be economically concentrated and prepared for shipment. Several firms on the west coast are already preparing for expansion of chip exports, mainly to Japan. The 1972 volume was in excess of 4 million green tons or more than 1 billion fbm for the Scribner, round wood equivalent. Pulp chips are transported in specially built Japanese vessels.

## MAJOR EXTERNAL FACTORS INFLUENCING FUTURE U.S. TRADE IN TIMBER PRODUCTS

### The Canadian World Trade Position

Future U.S. trade in timber products will be influenced in a major way by wood production, consumption and trade in several parts of the world, but particularly in Canada. Canada is the world's most important exporter of wood products; she accounted for fully one-quarter of the total value of world exports in 1969.

Canadians are consuming more wood than ever as her economy expands, but the major proportion of wood cut goes to support a growing export trade. Although Canadian forest products are shipped to at least 50 different countries, the United States is the destination for at least 75 percent in terms of value and is thus Canada's best customer. Exports to the United States accounted for 60 percent of all industrial wood removals, more than twice the volume of wood used domestically.

Historically there has been a strong relationship between the Canadian and U.S. forest products industries. The timber resources and technologies of the two countries are essentially the same, and a number of the same wood processing corporations operate on both sides of the border. With but limited constraints on trade flow either way, the Canadian and U.S. forest economies are, for all practical purposes, a single forest economy. For the future, what the Canadians are able and willing to produce and export could significantly influence U.S. wood consumption. By the same token, the U.S. wood market will likely greatly influence Canadian wood trade and hence the management and utilization of Canadian forest resources.

The Council on Forest Industries of British Columbia estimates that Canada could expand lumber output to 24 billion bf by the year 2000 with up to 12–14 billion bf available for export to the United States. These projections bracket U.S. Forest Service estimates of future imports at rising relative lumber prices.

### The Japanese Position in World Wood Trade

Japan represents a potentially large market for expanded U.S. exports of logs, lumber, chips and pulp and paper products.

A rapidly expanding economy, including a vigorous boom in construction, particularly in housing, has pushed the demand for wood products far beyond the capability of her domestic resource. All indications are that Japan will continue to strive for increased economic growth and trade, but in doing so, will become even more dependent on wood imports.

Japan depends on Canada for most of her softwood lumber imports (in the form of cants which are resawn into small lumber sizes in Japanese mills), although Alaska contributes about 30 percent. However, the Japanese prefer to import logs and do their own processing to Japanese specifications. Southeast Asia (Indonesia, the Philippines, and Malaysia) is the source of Japan's tropical hardwood log imports and the Pacific Northwest the principal source of imported softwood logs. The Soviet Union (eastern Siberia) and New Zealand also export softwood logs to Japan.

Consumption of pulp and paper products in Japan has accompanied industrial expansion and economic growth. At the same time, the need to control pollution from pulp manufacture has recently encouraged higher imports of pulp, paper and board from Canada, and especially linerboard from the United States. However, pulpwood from Siberia and chips from the Pacific Northwest of the United States must still be imported to augment domestic supplies. Chip imports reached 6 million cubic meters in 1971, almost all of this coming from the U.S. west coast.

Wood trade with Japan involves lumber, logs, pulp and paper, and chips, but the future position of the United States as an exporter to this market in competition with Canada and the Soviet Union particularly, is not clear. Southeast Asian tropical timbers will continue to be imported in Japan, but softwood log imports will have to come primarily from the United States and the Soviet Union. Canada already prohibits the export of unprocessed wood (logs and chips). Demand for U.S. softwood logs in Japan is likely to grow and remain high, but U.S. log exports in the long run are uncertain because of possible Government restrictions. Actually, it is likely that in time logs from Siberia will become more important to Japan because the total demand is such that although Russia's logs are small and of inferior quality, they are required in increased quantities.

During trade negotiations during the summer of 1972, Japan agreed to purchase annually from the United States $30 billion worth of products. Wood products were specifically mentioned in the agreement. To improve its domestic housing, Japan set a goal of building 1.9 million units in 1973 and continuing to 1976 when a tentative goal of 20 million new housing units would start over the following 10 years. (This compares with the U.S. housing goal of 26 million units for the decade starting in 1968.) Credit restrictions were relaxed and plans inaugurated to approximate those prevailing for home buyers in the United States.

In December 1972, representatives of Japanese trading companies began extensive log purchasing in Oregon and Washington. Log prices were bid up to over double former levels creating chaos in western markets for domestic producers.

A few west coast producers, already attuned to exporting, benefited generously. At least one sawmill was said to have shut down to devote its entire efforts to log exporting.

The reaction of other American mills and home builders was quick and drastic. An immediate and complete embargo of exports of logs and lumber was demanded.

Legislation to effect this was introduced in the Congress. However, the United States, with trade deficits so great as to cause a second 10-percent devaluation of the dollar relative to leading world currencies within a period of 14 months, was in a weak position to restrict exports. Critics of exports charged that the U.S. housing program would be inhibited and timber supplies drawn down significantly if the demands of both markets were to be supplied. Added pressure was focused on the need to sell the full allowable cut from the national forests.

The outcome remained uncertain at the time the Panel's report was drafted.

## Europe, a Major Market for North America Wood Products

Europe is the world's second most important wood consuming region. In 1969 total industrial wood removals amounted to 192.5 million cubic meters, 16 percent of total world removals.

For a short time after World War II, Europe was actually a net exporter of wood products, but by 1955 had reverted to a net import position. Central and southern Europe has had to import softwood lumber from the U.S.S.R., pulp and paper from North America, and tropical hardwood logs from West Africa to augment imports of lumber. Scandinavia, the only important timber surplus region in Europe, supplied pulp and paper to the importing nations.

According to the United Nations Food and Agriculture Organization (FAO), Europe will continue to face a growing wood deficit and will need to import at least 53 million cubic meters of wood by 1975 and 66 million cubic meters by 1980. Although consumption of lumber and plywood is expected to increase about 15 percent by 1980 over 1965 levels, consumption of paper paperboard, particleboard, fiberboards, and particularly the long-fibered chemical pulps are projected to rise by 86 percent.

Recent studies by the FAO conclude that the U.S.S.R. and Canada are likely to remain the main source of increased softwood lumber imports, even as Scandinavia (particularly Sweden) expands its exports to the region. Cost advantages in pulp and paper manufacture, however, now appear to lie with Canadian and U.S. wood pulps, especially long-fibered pulps that are expected to be the largest item in Europe's increasing wood requirements. Locally grown hardwood pulpwood and short-fibered pulp supplies are expected to be adequate. It is becoming apparent that Canada and the United States are the most likely source of expanded pulp and paper imports, especially of kraft paper and linerboard.

## Other Potential Wood Products Markets

Besides the opportunities in Europe and Japan, potential markets for wood exist in the People's Republic of China, Oceania (primarily Australia; New Zealand to a lesser extent), and the developing countries of Latin America, Asia and Africa. Of these, the most intriguing, and perhaps the most likely of development on a large scale in timber is China. Actually there is very little recent information useful for critically assessing China as a potential world trader in wood. What data exists strongly points to China as an importer, conceivably of some magnitude.

The People's Republic of China is believed to be practically self-sufficient in wood consumption but at very low levels. According to the FAO, total removals in 1969 amounted to 169 million cubic meters, but only 69 million cubic meters was industrial wood; the rest was fuel wood. Wood imports are very low and exports nonexistent.

China's demand for wood is almost sure to rise as industrial and economic development proceed. To meet these needs, China will import wood products (assuming the generation of foreign exchange and the allocation of some part of this to the purchase of foreign wood), even though this may not happen on a large scale for some time. China has reportedly already begun negotiations with Canada for the import of some timber products. She is importing some pulp-based products from the United States now.

Both Australia and New Zealand are highly developed countries with relatively high per capita wood use. However, neither nation figures importantly in total wood requirements because neither has a large population nor an industrial complex to support. Despite a substantial conifierous plantation establishment program (650,000 acres by 1967), Australia is still dependent on imports of softwood timber products, mostly softwood and pulp from New Zealand, Canada, and the United States, and newsprint from Canada.

The conversion of native forests to coniferous plantations has been much greater in New Zealand. By 1967, 1.8 million acres had been planted. New Zealand is essentially self-sufficient in wood products today, with an increasing potential for exports on a small scale, probably to Australia. Australia could also represent a small future market for Canadian and U.S. softwood lumber, chemical pulp, kraft paper, and linerboard.

To complete the overview of potential world markets for wood, some attention needs to be given the so-called developing nations. To date this very large area representing the countries of Latin America, Africa (excluding South Africa), Asia and the Far East (excluding Japan, Australia, and New Zealand), and the Middle East (excluding Israel) accounts for only about 10 percent of total world wood consumption. Despite expectations of rising wood demands, this proportion is not expected to change much by 1985.

## THE MAJOR WORLD SURPLUS AREAS (EXCLUDING CANADA)

In addition to the Canadian timber resource, the Siberian forests of the U.S.S.R., the intensively managed forests of Scandinavia, the fast-growing plantations (particularly those in the warm zones of the world), and the vast reserves of tropical hardwood timber have all been cited from time to time as the sources from which future world wood deficits will be supplied. From a practical standpoint, outside of North America only the forests of the U.S.S.R. and Scandinavia offer significant promise of increased output to supply world trade.

Over the years there has been much speculation about the future wood trade potential of the Soviet Union. It is indeed difficult to ignore the fact that this nation alone has 20 percent of the total forest area of the world, 30 percent of the total growing stock, and 50 percent of the world's softwood timber reserves. However, despite the vastness of these resources, it is necessary to estimate how much progress the Soviet Union will make in their utilization and what proportion of any increased output will actually enter world trade as exports. Most analysts agree that the Soviet Union will continue to increase forest products output faster than in the past if the technical problems of access in Siberian forests can be solved and the necessary investment in processing facilities is forthcoming.

The Soviet Union has been an exporter of wood products for a long time, especially of softwood lumber (over one-half of the total volume). Only since World War II has the Soviet Union exported pulp, paper and paperboard. Most Soviet wood exports have gone to European countries and to Japan. Great Britain and East Germany are the most important markets for softwood lumber. There is also an active export trade in wood pulp with Finland, East Germany, and Japan, with Japan and Taiwan the major destinations for Soviet sawlog exports.

Despite the large Soviet forest base, per capita wood consumption in the U.S.S.R. is relatively low. Because of present low wood use and continued industrial development, it has been argued that most of the country's future production of wood products will go to satisfy growing domestic needs leaving little for export. Whether this argument holds depends on how rapidly the Soviet Union proceeds to develop its forest industries, particularly in Siberia, and whether it chooses to satisfy growing consumer demands for wood products or export these products in order to generate foreign exchange needed to purchase higher priority products.

It is estimated that roundwood and sawnwood exports, as a percent of total Soviet output, should decrease somewhat by 1985 while exports of the more highly processed products like pulp, paper, paperboard and fiberboard should increase. In terms of quantities, exports could increase 40 percent by 1985, although the value increase would be larger because of the export of higher value products. Despite the long transport from Siberia, it is estimated that the U.S.S.R. will be able to compete in European markets at least as well as today. The best opportunities for significantly increased exports lie to the East; i.e., to Japan.

These exports will originate in the Soviet Far East and will likely compete with future export possibilities from Canada and the United States in the Pacific Basin.

The forests of northern Europe have been a source of wood products mainly for the rest of Europe for a long time. In 1969, Norway, Finland, and Sweden together accounted for 48 percent of total timber removals in Europe; Sweden alone contributed 26 percent, Finland 18 percent. Sweden is the largest producer of forest products followed by Finland, Norway, and Denmark.

To a certain extent, the forests of Sweden, Finland, and Norway are also expected to help meet Europe's future wood products requirements. However, it is estimated that output of wood can be increased only moderately. Sweden's forests will be able to produce about 20 percent more wood over the next 20 years, although the longer range outlook is said to be brighter. The cut in Norway and Denmark can also be expanded somewhat, but expansion in Finland over the next 15 years will be more difficult. In all the Scandinavian forests, expansion of growth is centered on such intensive practices as drainage of swamps, fertilization and the planting of genetically superior trees.

Increased output, although possible, will almost surely be forthcoming at rising costs, particularly in Finland, Norway, and Denmark. At best, Scandinavian forests can make only a moderate contribution to Europe's projected wood needs or about 25 million cubic meters by 1975. The very large deficits which remain will have to be filled by sawn-wood imports from the U.S.S.R. and Canada and pulp and kraft paper from Canada and the United States.

Although forest planting is a long-established practice, particularly in the north temperatate zone, there is increasing interest in the establishing of plantations in other parts of the world, especially in the warm zones, as a basis for wood products manufacture and trade. Yields from plantations can be high. Many areas in Africa, Latin America, and Asia are believed to be suitable for planting fast growing coniferous and hardwood species.

The importance of plantation grown wood for local use in the developing countries will most likely increase, and in some nations, as in Chile, South Africa, and New Zealand, it may form a base for limited export. However, the total area of exotic softwood plantations and the total timber so grown is still too limited to be of much significance in the world wood trade. Furthermore, except in a few instances, it is yet to be demonstrated that low-cost raw wood itself can insure success in wood products trade on world markets in competition with already established large-scale producers of mass-grade products in the north temperate zone.

There is little question that the world's coniferous forests, especially those in North America and the U.S.S.R., are going to be of major importance in meeting expanded world wood requirements. Much more uncertainty surrounds the utility of the world's tropical hardwood forest in this role.

Because these forests are as yet little used, information on their content and composition is far from complete. Single species may be represented by only a few trees per hectare, and only a very few of these are presently usable commercially. Along with this abundance of species, there is a general lack of information on wood physical and mechanical properties and very limited experience in their utilization.

To date commercial exploitation of tropical hardwoods has been limited to a few areas where commercially acceptable species are found in reasonable density and volume and where access can be developed. Timber from the tropical forests of West Africa has long been exported, most of the material going to Europe. The forests of southeast Asia containing the world's greatest reserves of usable tropical hardwoods (the luan-type timbers of the *Dipterocarpaceae*) are being opened up increasingly, primarily in Indonesia, Malaysia, and New Guinea. Much of this wood is going to North America after processing in Taiwan, South Korea, Singapore, and Hong Kong. Some increased output from tropical forests is expected by 1985. However, present trade patterns involving tropical hardwood products are not expected to change much.

## OUTLOOK

Total future domestic consumption of wood products in the United States will depend not only on future demands and the success of our timber growing efforts, but also on opportunities for profitable exports and availability of imports.

The United States today is a net importer of wood to the extent of 12 percent of total consumption. Although a 12 percent wood deficit is not a major problem, some particular import and export items are of considerable importance and worthy of concern. For example, 20 percent of all the lumber used in the United States must be imported. Hardwood plywood imports are fully 57 percent of total consumption, and around 70 percent of all newsprint must be imported. Indications are that we face continued heavy importation of these important wood products.

The most important export product in volume terms is softwood sawlogs. Although these exports constitute only about 7 percent of total softwood products consumption, they are, and promise to continue to be, highly controversial in view of the Nation's tight softwood lumber and plywood supplies and rising prices. If all the exported softwood log volume (about 2.0–2.5 billion bf per year) could be processed into marketable lumber and plywood in the Pacific Northwest, domestic supplies would be significantly augmented. However, depending upon the U.S. market demand for the species and grades exported, benefits could accrue from increased incentives for more intensive forest management and utilization, and to the exporting regions through greater economic activity than would be the case if log exports were prohibited.

If the conclusions about world trends in wood production, use and trade reached in this chapter are reasonable, what can be said about import-export outlook? The data suggest that increased imports of softwood lumber, pulp and newsprint from Canada can be expected although there surely is some limit to imports from Canada in view of her commitments to other countries and the possibility that production costs will rise.

Evaluation of future export opportunities is more difficult. There is no question that the Japanese market will be able to sustain more than the 1971 export volume of 1.9 billion bf and perhaps U.S. log exports could reach averages of 2 to 3 billion bf annually. Should stricter U.S. log export restrictions prevail, Japan will look to the Soviet Union for more softwood logs, to southeast Asia for more tropical timber and to both Canada and the United States for increased imports of softwood lumber.

Increased exports of hardwood lumber may be reasonably expected, but they are so low as to be relatively unimportant in the total picture. Whether the softwood export market is likely to grow will depend upon the production of an excess over domestic requirements. However Alaskan shipments to Japan are almost sure to increase, perhaps to as much as 500 million bf per year. A total U.S. export potential of 1.0 to 1.5 billion bf of lumber before the year 2000 is a reasonable expectation.

Exports of 4 to 5 million cords of pulpwood, including chips, may be quite possible in view of the potential Japanese market and supply possibilities, but much closer utilization of logging and milling residues will have to be realized. Significant increases in exports of pulp and paper, are probably attainable in view of the very large expected deficits in Europe and Japan. However, Canada's continued dominance in the pulp and paper export field must be expected.

*The Panel recommends:*

That the United States continue to import and export forest products of all kinds when it is in the best long-term interest of the Nation to do so; but that, until some of the foregoing recommendations for increasing timber supplies can be implemented, arrangements be made with Japan to limit log exports in 1973 and 1974 to levels of 1972.

# Extending the Timber Resource[1]

The Nation faces four major choices for meeting its growing timber needs:

1. Import more and export less;
2. Grow more timber;
3. Use less timber;
4. Make better use of the timber grown.

Choice 1 was dealt with in chapter 9, and choice 2 in chapters 7 and 8. Choice 3 was touched on in chapters 2, 4, 5, and 6. It remains to consider the consequences of following choice 3 and to deal with choice 4.

## ADVANTAGES OF WOOD AS A STRUCTURAL MATERIAL

The widespread use of wood in the United States is due to four major reasons: (1) Its widespread availability at modest cost; (2) its physical properties which make it an ideal material for construction with its high ratios of stiffness-to-weight and of strength-to-weight; (3) its high insulating properties against sound and heat; (4) its esthetic appeal as a decorative material.

Wood is an intricately structured material far more complex than any manmade materials used in construction. Through use by trees of the energy of sunlight, it is built up from two basic elements: water and carbon dioxide, two of the simplest of chemical compounds. These are synthesized by tree leaves into sugars which are polymerized into cellulose and lignin, the two main chemical components of wood as such. Pure cellulose, as exemplified by the cotton fiber, has little or no inherent stiffness. It is the cellular nature of wood and the complex way in which the cellulose molecules are combined with lignin into microfibrils and these in turn into the cell walls, made up of lignin-cemented woody fibers, that account for the stiffness and strength of wood.

Man uses some of the structural principles of the woody stem in box beams, hollow columns, and cord automobile tires. One reason that wood is ideally structured to support weight is because the woody elements are built up in the stem in response to the stress upon the stem at the point the new cells are being formed. Thus, where maximum vertical load bearing capacity is required, wood is used in the round form such as piles, posts, and poles.

## ENVIRONMENTAL IMPACT OF WOOD USE

Buildings constructed of wood can normally be heated in winter and cooled in summer with far less expenditure of energy than can buildings erected of brick, stone, glass, concrete, steel, or aluminum. This is because of the low heat conductivity of wood and the air spaces in wood frame walls. To match the insulating properties of a 1-inch thickness of wood, alternate materials would need to have the thicknesses shown below:

| | *Inches* |
|---|---|
| Cinder block | 4 |
| Brick | 6 |
| Concrete or stone | 15 |
| Steel | 400 |
| Aluminum | 1, 770 |

(Source: National Forest Products Association quoted from the American Society of Heating, Refrigerating and Air Conditioning Engineers.)

[1] For a more complete treatment of this subject see appendix K, "Solving Resource and Environment Problems by the More Efficient Utilization of Timber," by Jerome F. Saeman. The Panel also acknowledges the assistance of Carl Mason of H. C. Mason & Associates, Inc., in explaining the subjects covered.



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Furthermore, the energy required to produce a ton of lumber compared with other materials for construction is as follows:

| | *kWh or equivalent* |
|---|---|
| Lumber | 1,510 |
| Cement | 2,300 |
| Rolled steel | 12,600 |
| Rolled aluminum | 67,200 |

(Source: Appendix K.)

Finally, wood can readily be disposed of by permitting it to decay by biologic action, wherein it returns its nutrient elements to the soil; by reconstitution into paper or particle products; or by burning when the structure is no longer needed.

The American people recognize the value of wood, for they use more pounds of wood annually than the combined weight of steel, cement, plastics, aluminum, and copper.[2] Moreover, its value in construction is considerably greater than is indicated by weight because of its high ratios of stiffness and strength to weight. Most of the Nation's need for wood can be grown within her boundaries whereas national supplies of high-grade iron ore and of other metallic ores are becoming so scarce that reliance on imports is necessary. These are factors to consider when thinking of the impacts on the environment of using alternate construction materials.

The Panel has looked into the possibilities of getting increased usable material from the timber that is grown. It finds that many savings in wood material are possible in the forest, at the logging site, in the sawmill, veneer mill, particle board mill, and building site. How many will prove to be economically and operationally feasible is in the process of being tested. Potential savings in these areas taken together are estimated to be as much as 4 billion bf annually. Estimates of savings through improved utilization are difficult to forecast due to the variability of local conditions and practices in the forest regions of the Nation, and in the wood processing plants.

## SAVINGS IN USE OF MATERIAL AT THE LOGGING SITE

Old-growth timber stands in the West contain an immense amount of defective, dead, and partially decayed timber. When harvested, no matter by what method, large amounts of unusable material remain on the ground following logging; to this are added tops and branches of usable trees cut. The whole creates in the public mind the picture of inordinate waste.

The aim of the logger has been to convert standing trees to usable logs and move logs from the stump to the sawmill as expeditiously and cheaply as possible. Logging equipment manufacturers have constructed powerful machines to enable him to do just that. Actual volumes of partially defective, broken, and small logs may be as high as 50 percent of that of the logs removed. Some companies have found that it is feasible to run material that has a high degree of decay through a combined pulpwood chipper and screen. The decayed portions pass through the screen leaving the usable chips to be conveyed to the pulpwood digester. A number of pulpmills now accept limbwood from the tops of trees for pulp manufacture. Techniques are now becoming available for separating bark from chipped wood to make utilization of branch wood feasible. However, until the Japanese began buying pulp chips on the West Coast, prices of chips at the pulpmill were too low to justify removal of such defective material from the logging site. From logging sites located within hauling distance of West Coast ports, pulp chips from defective logs can now be delivered to Japanese ships or to local pulpmills. Still, incentives are needed to encourage loggers and sawmills to invest in the necessary transporting, sorting, and chipping facilities to make this a feasible operation. A few companies have already done this and find the operation to be feasible in terms of contribution to total income from operations.

The practice of the Forest Service of selling stumpage on a log-scale basis, rather than a lump-sum basis, has many advantages but it does not encourage the logger to pay the bid price for scaled logs for the low-quality material on which he would lose money. The Forest Service is trying to price salvage material to encourage its removal, but additional measures are needed. Appropriate changes in Forest Service timber sale practices are suggested in appendix H that might result in improved utilization of woody material and leave the cutover lands more sightly in appearance and more easily planted to a new forest stand.

Logging debris is a major obstruction to clearing the logging site for planting. A more serious impediment to timber growing in the East is the defective trees that are left standing on the site,

[2] Saeman, app. K, pp. 9–10.

thereby interfering with the growth of trees which would form the next timber crop. Killing such trees by girdling or silvicides pleases the uninformed visitor even less than does unsightly slash on the ground.

Fortunately logging debris is but a minor problem in harvesting managed plantations or even-aged second-growth timber.

A very substantial increase in wood for lumber could be had if sawlog-sized wood going to pulpmills could be diverted to sawmills. It is estimated that between 6 and 8 billion bf of logs 7 to 9 inches in diameter and larger are annually converted into pulpwood chips rather than lumber; the actual volume depends on the local strength of the lumber market relative to the pulp market. This practice is rapidly declining as log and lumber prices have been rising far faster than paper prices thereby making sale of logs to sawmills profitable while using small logs and topwood for pulp. The difficulty involved, especially in the South, is to find enough of such less valuable wood to keep the pulpmills supplied.

## INCREASED USE OF THINNINGS

Under normal forest conditions thousands of tree seedlings may get started on an acre of land but at the time of final harvest the number will be reduced to some 100 trees or less. In the intervening years competition as the trees grow is keen, with scores of trees dying for each one that reaches maturity. This competition not only results in the loss of trees that die but tends to slow down the rate of growth of those that survive. Under intensive forestry, precommercial and commercial thinnings are carried out to maintain a rapid rate of growth for trees from seedling to sawlog sizes. In the process, usable trees for pulpwood and small sawlogs are salvaged. In European practice up to one-half the total cubic wood volume harvested comes from intermediate cuttings, the other half from the final harvest. If some of these superfluous trees are not removed by thinning they will slowly die, yet while alive they impede the growth of the crop trees. Thinning practices are being adopted by many forest industries in the South and the West Coast. A small amount is salvaged on the national forests. Still a large portion of the trees that died and decay could be made available for pulpwood and small-log use. Ultimately, it should be possible to obtain practically all the wood needed by pulpmills from mill residues, thinnings, trees and tops below normal sawtimber size and from low-value hardwoods now barely merchantable. This is, in fact, the case today in most well-developed timber markets. Few forestry measures pay higher returns in timber growth and return on investment than those applied to sapling and pole sized stands, but proximity to a variety of manufacturing facilities is a necessity if costs of the operation are to be met by the products removed.

## SAVINGS IN LUMBER MANUFACTURE AND USE

The lumber and wood products industries play a significant role in the national economy. Among all manufacturing they account for 7.2 percent of all employment, distribute 6.4 percent of all payrolls and create 6.5 percent of all value added by manufacturing. Wood is the main construction material used in the erection of single-family dwellings and low-rise apartments.

Traditionally, lumber manufacturing has been a highly dispersed industry made up of thousands of small and a few medium- and large-sized firms. Up until the early 1900's the industry was a migratory one concentrating first in Maine and successively thereafter in New York, Pennsylvania, the Lake States, the South and later the West Coast. Necessarily these large mills left behind much material in scattered stands and isolated tracts that smaller logging companies and lower output sawmills could use. Though local output decreased in volume radically, the number of mills remained relatively high. Even as late as 1945 it was estimated that some 50,000 sawmills existed in the United States. Many of these were small portable mills that operated intermittently during the year. As of 1967 the U.S. Bureau of the Census reported that there were 10,271 firms that manufactured lumber: 1,465 in the Northeast, 5,560 in the South, 1,669 in the North-Central region, 533 in the western Mountain region, and 1,044 in the Pacific States. Of much more interest than their geographic distribution is their distribution by size classes as shown in table 10–1. Seventy percent of the production is accounted for by the 799 firms that employ 50 men or more.

Nationally, the five largest firms in 1972 together accounted for approximately 17 percent of total production. This means that the larger firms are

**TABLE 10-1.—Statistical Data on Sawmills and Planing Mills for 1967**

| Number of employees | Number of firms | Millions of dollars: Value added | Millions of dollars: Value added cumulative | Cumulative number of firms beginning with the largest |
|---|---|---|---|---|
| 1 to 4 | 5, 697 | 77. 6 | 77. 6 | 10, 271 |
| 5 to 9 | 1, 451 | 74. 5 | 152. 1 | 4, 574 |
| 10 to 19 | 1, 207 | 124. 4 | 276. 5 | 3, 123 |
| 20 to 49 | 1, 117 | 284. 3 | 560. 8 | 1, 916 |
| 50 to 99 | 483 | 300. 6 | 861. 4 | 799 |
| 100 to 249 | 241 | 333. 6 | 1, 194. 0 | 316 |
| 250 to 499 | 49 | 154. 7 | 1, 348. 7 | 75 |
| 500 to 999 | 18 | 206. 8 | 1, 554. 5 | 26 |
| 1,000 to 2,499 | 7 | [1] 296. 0 | 1, 850. 5 | 8 |
| 2,500-plus | 1 | | | 1 |
| Total | 10, 271 | 1, 556. 4 | 1, 850. 5 | |

[1] Estimated.

Source: Bureau of the Census.

not in a position to control prices. Prices are determined in the marketplace in many thousands of daily transactions; not by the sawmills.

From 1900 to the close of the Second World War, lumber manufacture was a labor intensive industry. Compared to its counterpart industry in Scandinavian and other European countries, much lumber manufacture in America was inefficient in use of the raw material in the woods, at the mills and even on the building site. Many of the small mills often had poor equipment that sawed inaccurately, reducing the usable output from logs. Ignorance of the proper handling of green lumber often led to staining, twisting, and warping during seasoning. Dry kilns were often not available. Some mill operators were under contract to sell the output to a concentration yard operator and this practice is still in use today. The latter in turn bought the green lumber, seasoned it and sometimes further manufactured it for sale to wholesalers who in turn sold to retailers. Even this is a relatively simple marketing chain compared with what often took place. Lumber historically has sometimes passed through numerous hands between the manufacturers and the eventual user. The distribution system is complicated but surprisingly efficient compared to that of substitute materials in that the needed variety and amount of grades, species, and sizes are readily available to the user anywhere in the country.

Historically, both the dispersed nature of the industry and the absence of sufficient economic incentive serve to limit lumber industry investment in the type of research and innovation that have been an essential part of the success of industries such as the mechanical and chemical products industries. Converting round logs into square edged lumber in itself produces sawdust, slabs, edgings, and other residues. Sawmills on the average convert less than 40 percent of the dry weight of the log into usable lumber. Expressed differently, their average lumber recovery factor (board feet of lumber per cubic foot of logs sawn) is 6.2. Many mills achieve a recovery factor of 8.2, and some as high as 10.0. The higher ratios are generally achieved by mills that can produce a narrow product line from uniform timber as contrasted with mills that produce the wide variety of products the market requires from older timber that is extremely variable in size and quality. Much of the added lumber recovery is achievable with coventional sawmill equipment; what is needed is improved management, carefully adjusted machinery, emphasis on close utilization as well as on quality control of the daily output.

But this is not the entire story. A millowner must be interested in the dollar return per cubic foot of logs sawn as well as the lumber return. The dollar return depends on the value of product manufactured as well as on the volume. If by simply trimming off a large knot at the end of a board the millman can raise its grade and value significantly, as he often can, he will do so though it reduce his lumber recovery factor. Many much more sophisticated choices for which the consumer will pay a premium price reduce lumber recovery and are known to the experienced mill superintendent and it pays him to fulfill them and remain competitive. Trimming to upgrade lumber is an apparent reduction in lumber recovery built in to the system by the national lumber grading rules but these rules are necessary to the trade and for protection of the consumer.

One company that processes timber from stump through to end use of lumber has been able to increase its lumber recovery factor by 50 percent. In this case lumber grading and pricing based on grade is avoided by transporting the company's sawmill output directly to its own secondary manufacturing plants. Lumber grading and trimming to improve grade is thus unnecessary. This company also avoids the five or more transactions otherwise involved in moving lumber from manufacturer to user. Whenever such vertical integration is possible, unusual physical and economic savings in wood use can be effected.

## RECENT DEVELOPMENT IN THE LUMBER INDUSTRY

Fortunately, the lumber industry in the United States and abroad is now in a state of transition. The lumber industry is becoming much more capital intensive. A small mill could be erected in the 1930's for $50,000. The most efficient modern mills cost about $5 million and of course, process proportionately more lumber. The trend of the 1920's and 1930's to develop portable mills has been reversed in favor of efficient permanent installations.

New high-strain head-saws cut a very narrow kerf, thereby reducing the amount of wood converted to sawdust. New set works can position and hold logs for very precise sawing, thereby reducing the otherwise allowance of one-sixteenth inch on each side of the board for planing.

Other innovations that result in savings of material through more precise control over the utilization of each tree cut are being introduced. Some companies have all material delivered in tree lengths to the mill where it is stacked in the yard. A log carrier delivers the tree-length logs to mechanized slashers where highly skilled operators cut them into low- and high-grade sawlogs, veneer bolts, and pulpwood sticks. The veneer bolts fall automatically onto a conveyer to the plywood mill, high-grade logs to the bandsaw, third grade to the chip-and-saw mill. The pulpwood bolts go directly to the debarker, then to the chipper from whence they are transported to the pulpmill. Such an operation provides for high-level usage of each part of the tree. Another mill uses a scanner and computer to buck tree length stems into logs that will produce the highest total produce value.

The chip-and-saw headrig is in wide use in Canada and the United States for sawing small-sized logs such as might be removed in thinning. These are first run through a debarker, then through a machine that removes slabs and edgings in the form of pulpwood chips. The resultant cant is sawn into 1- and 2-inch lumber in a single continuous pass. The saws used cut a narrow kerf so that high yield of total products results from the use of such a machine. A big advantage, however, is the economy in the use of labor. Once the log starts through the machine it is not handled until the lumber reaches the trim saw where a lumber grader decides the length to which each board is to be cut. Chip-and-saw mills also can be operated by computer so as to maximize lumber recovery.

In the conventional sawmills the head sawyer turns the log to determine which face to cut first. This is done to obtain the optimum volume and value of lumber from each individual log. It has been determined that by use of proper sensors a computer can position logs for sawing much more quickly and accurately than a man can do. Thereby the board feet of usable lumber sawn from a log can be increased by as much as 10 percent. Total mill output per day is also increased by this practice, dubbed the "best opening face" method.

An innovation under study is to dry 2-inch thick lumber and edge-glue it into wide panels. These can then be scanned by ultrasonic devices to locate defects and then ripped into appropriate dimensions so that each piece of lumber is of maximum quality. Such a system eliminates the residue presently resulting from manufacturing lumber in multiples of 2-foot lengths and 2-inch widths. While this system is expected to increase yield by some 15 percent over conventional sawing, the value of the increased yield obtained in tests to date has been insufficient to offset the added costs due to adhesive, equipment, and labor.

Another possible approach is to eliminate sawing by first converting the log to veneer with no loss due to sawdust. The manufacture of structural laminated lumber, currently in the development stage, involves cutting rotary veneer one-sixth inch to one-half inch in thickness. This material is press dried under low pressure and immediately laminated, taking advantage of the high temperature of material as it leaves the press to cure the adhesive. Wood being somewhat plastic at high temperatures, gluing heated wood minimizes the adverse effect on the glue bonds caused by variations in thickness. Laminated veneer lumber is made in a wide panel which is subsequently cut to required dimensions. It can be made into any width, thickness or desired length including vertical laminated beams. The resultant knotty veneer core can be run through a chip-and-saw machine to produce conventional 2 by 4's and chips. Using this laminating process, total yields can be approximately 50 percent higher than are normally obtained by conventional sawing. Here again, however, the increased yield is significant to the extent that the end product can be marketed at a competitive price.

Laminated beams, arches, trusses, forms, and structures have been manufactured for many years. Refinement in such fabrications can be expected.

The ultimate is automated lumber manufacture. A new mill in Sweden uses X-ray scanners to identify defects and position the log for best sawing, A computer receives information from the X-ray and other sensors for diameter and length of log and then programs the log and lumber through the head saw and other machines to the automated stackers. A less sophisticated, but more precisely engineered, computerized mill is operating on the west coast of the United States with highly satisfactory yield and performance. Such equipment requires a substantial capital investment.

The theoretical potential of applying these new techniques is to raise the average lumber recovery factor from 6.2 bf per cubic foot of logs sawn to as high as 11 bf per cubic foot. While such may be possible for a few, highly favored mills, the nationwide improved lumber recovery likely to be achieved within the next decade is believed to be nearer to 10 percent than to 30 percent. Still this could be the equivalent of 4 billion bf.

## IMPEDIMENTS TO ADOPTING INNOVATION

Investment in improved sawmill equipment must be based on the individual mill's timber supply situation, the products being produced by that mill, the cost of introducing new methods into production lines that are presently judged economically optimum for that particular operation, and the location of the timber in relation to integrated manufacturing opportunities.

Many firms are said to be reluctant to make substantial investments in machinery for precision manufacturing because of uncertainty of their future timber supply. In may localities a skilled labor force, trained to operate and service precision equipment, may be lacking. Inspection and quality control must be provided. All of this adds up to need for new management skills and precise recordkeeping to monitor performance.

The added capital investment needed to install a computer activated headrig, or the steaming, veneer cutting, drying, and gluing equipment needed to manufacture glued laminated lumber would generally not be a practical investment for the smaller sized firms listed in table 10–1. Nonetheless, those with less than 50 employees produce almost one-third of all lumber manufactured. Many factors other than mere size of operation or log supply are involved in determining a firm's ability to evaluate, adopt, and utilize innovative processes.

New products, such as edge-glued and ripped lumber, laminated lumber, and structural particle board, are still to be tested in large-scale operation and their product acceptance evaluated in the marketplace. Again, they call for careful inspection and quality control. It can be expected that increased prices of logs and lumber will provide incentive to hasten adoption of these and other innovations.

Money for investment in modern equipment may be tight for some mills, particularly those without an assured log supply. Investment credit and rapid depreciation of equipment investments, when available, are incentives for improving sawmill machinery and equipment. Small business loans may also be helpful.

## FUTURE LOG SUPPLY

Relatively few lumber companies that are independent of pulp and paper companies have an assured long-range log supply. Of the five largest, only one controls enough timberland to supply all company needs. The second largest company has enough forest land to supply approximately 50 percent of the needs of its sawmills and pulpmills, whereas the next three in size are scarcely able to supply one-third of their needs from their own holdings. Many mills are dependent on the national forest for their future log supplies. They are obliged to bid for timber in the open market, often against intense competition. It is partly for these reasons that a number of companies in the South are seeking to obtain long-term leases on land held by nonindustrial owners.

The general volatility of lumber prices has also encouraged conservatism in investment for the future.

It is an interesting observation that a number of the intermediate-sized sawmills, those having an annual output in the range of 50 million bf per year, frequently have innovation-oriented management. Some seem able to compete very well with the large companies of the industry. An alert management can always find ways to effect savings in the ordinary sawmill operation.

## OUTLOOK FOR THE LUMBER INDUSTRY

There is much reason for optimism for the future of the lumber industry beyond that of need for its product. The very fact that it is changing from practices in use as long ago as the 1920's is heartening. Interest in log conversion improvement is evidence of an awakening. The long-range projections of future lumber and plywood needs as well as the potential of the American forests to supply this need, given improved management practices, are causes for optimism. Nevertheless, the lumber industry can expect to pay higher prices for sawlogs in the future. This increase is expected to result from a corresponding increase in the price of lumber. The increasing prices of raw materials and end products should provide added incentives to explore all methods to achieve greater utilization of timber.

## PLYWOOD MANUFACTURE

The softwood-plywood industry of the United States was represented by 179 firms in 1971. These process 16.5 billion square feet of three-eighth's inch equivalent of plywood which was valued at $958.5 million. The softwood-plywood business has been rather innovative from the beginning, in part because the industry is young in comparison with the lumber industry. Structural grade plywood did not come into general use until the 1920's and was not widely used for outdoor purposes until after the Second World War. Substantial improvements have been made in plywood manufacture since 1945. These include new adhesives and equipment in the veneer and plywood plants. Much of the handwork that formerly had to be done in patching veneer has been taken over by machines. Hot presses are now in common use for curing resins that are water resistent, hence suitable for bonding plywood to be used in exterior wall construction.

One of the major reasons for the rapid growth in plywood consumption has been the savings in material cost and uniformity of the product. When used for concrete forms plywood panels produce a tighter surface than 1-inch lumber. Similar advantages exist for use of plywood for shipping containers, fencing for construction sites and a host of other purposes. The industry has expanded to meet new needs and prospered as a result of so doing.

## PARTICLE BOARD

The particle board industry is the newest and the most rapidly developing. Conceived originally as a means of using residue from the sawmill that otherwise went to waste, the industry has shifted somewhat to the use of engineered chips or flakes that make a much superior product.

Even so, the current particle board has a considerable potential for improvement in terms of strength, screw holding ability, and other structural qualities. Recently it has been found that a particle board having qualities closely approximating those of plywood can be constructed by use of large-sized engineered chips. It will, however, be in competition with pulpmills for chips. This development is still in the pilot stage. If, however, it can be placed into production on a practical basis, it offers still another means of extending the wood supply of the Nation and keeping wood a major product in the construction field.

The particle board industry in the United States was represented by 69 separate firms in 1971. It turned out 2.5 billion square feet of particle board, $206 million, in the year 1971. Particle board continues to win wide acceptance as a wood-based panel product having a smooth surface and moderate strength. It competes with plywood in uses not requiring the strength and screw-holding capacity of plywood. It can be extruded in long sheets or pressed into 4- by 8-foot panels. Vast improvements have been made in machinery and processing techniques since World War II when it first began to appear on the general market.

## SAVINGS IN USE OF LUMBER AND PLYWOOD IN CONSTRUCTION

The conventional method of constructing a wood framehouse offers opportunities for savings in use of material. One possibility lies in the use of plywood glued to joists, studs, and rafters for subfloors, wall and roof sheathing. The increase in stiffness imparted by gluing should make possible a significant reduction in size of framing members. Though first demonstrated in the early 1930's, this technique has been adopted very little in onsite construction; it has been used to some extent in prefabricated construction. Such use does require close attention to detail and followup inspection. Builders apparently find it simpler to use conventional construction methods even though their cost of materials may be somewhat higher. Furthermore, they are obliged to meet local building codes which frequently require assurance of the quality of glued products and which may not quickly respond to technological innovation.

Although building inspectors themselves have been accused of delaying the use of modular construction, the problem is generally due to their inability to inspect the quality of prefabricated construction or enclosed piping and wiring. Building codes are being changed and construction techniques on the building site can be modified as buyer-acceptance is developed. Estimates of knowledgeable people indicate that it may be possible to build three houses with the lumber used to build two in the traditional style, if all possible advantages of new design and construction techniques are taken. However, the resulting house may be somewhat minimal by conventional standards. Elimination of excess wood members also requires a higher degree of precision in construction involving better workmanship and additional quality control.

## INTEGRATION IN THE WOOD INDUSTRIES

The brightest outlook for extending the Nation's timber resource is through the rapid development of corporation complexes engaged in manufacturing lumber, plywood, particle board, paper products, fiberboard, and related wood products. Some go even farther to manufacture sash and doors and other planing mill products, and still others manufacture prefabricated houses or modular parts. In some operations all units are owned and operated by a single company. In other cases the sawmill company furnishes chips for a pulpmill company and veneer logs for a plywood manufacturer. A large number of pulp and paper manufacturers that do not themselves operate sawmills sell their sawlogs to nearby lumber mills and buy chips and pulpwood in return. Such practices have grown at a rapid rate since 1950. All of these innovations together have made it possible to convert a higher percentage of the log volume into useful products than could be done before World War II. Such economics in use of wood as a raw material seem destined to increase.

*The Panel recommends:*

That the Forest Service take necessary steps to encourage much closer utilization of dead and defective timber on the logging sites. Use of price incentives in contracts is suggested to obtain removal and use of low-value material.

# Forest Policy for the Future

Implicit in the foregoing chapters is the need for long-term policy formulation and action. Two broad policy issues stand out: First, the problems of timber and the environment need to be dealt with in the broader complex of related land use and natural resource management; second, a mechanism for synchronizing public and private forest management in the interests of nationwide needs and benefits is sorely needed. These and other issues derive from the fact that our Nation has a limited land base. No longer may responsible citizens remain unconcerned about how this land base is used. This is an environmental issue of highest importance.

The genius of representative government is its capacity to recognize critical issues and respond with new measures for dealing with such issues before internal tension rends the body politic asunder. Our own electorate and its governmental institutions have already demonstrated effectiveness in dealing with critical land use adjustments. Agriculture is a case in point. During the First World War, the necessity of supplying our people, troops, and allies with food, draft animals, and fibers led Government to encourage vastly increased agricultural production. The subsequent coming of peace, with concern for domestic affairs, high tariffs, and economic isolationism, resulted in vast surpluses of agricultural commodities causing price depressions and foreclosures on farmsteads. Drought and vast dust storms on the Western Plains spread a pall over all the land dramatizing the fact that the Nation faced a critical land and human use crisis. Under a series of laws, the Secretary of Agriculture was given broad authority to establish commodity production goals and price supports to achieve these goals and at the same time to maintain fair price levels for producers and consumers alike. This was a bold step for government to take in manipulating economic affairs, though not entirely without precedent. The program achieved a high degree of success in that relative economic stability gradually returned to agriculture and food and fiber prices remained reasonable in relation to per capita income.

## THE CURRENT TIMBER CRISIS

In 1973 our Nation faces a no less critical situation in managing its forest resources to meet vastly increased demands at home and abroad. The forest situation contrasts sharply with that of agriculture in the 1930's. Instead of timber being a glut on the market, it has become one of the Nation's scarcest commodities in relation to demand. The United States has become the largest importer of lumber and plywood of any nation. At the same time timber buyers from Japan, and paper buyers from Europe and Japan are aggressively competing for timber products badly needed for domestic use. Our balance-of-payments deficit which has resulted in two devaluations of the dollar within a 14-month period weakens our position to import timber and impels us to increase our total exports.

In 1968 our Nation launched a vast housing program with the objective of constructing 26 million units within a 10-year period. Japan, a major trading partner, just 4 years later launched a housing program of similar scope—24 million units within a 13-year period. Japanese log and lumber buyers on the West Coast have caused an unprecedented rise in prices of those commodities. The situation will doubtless be resolved by one means or another in a time relatively brief compared with that required to grow a crop of timber. The fact stands out, nevertheless, that our Nation faces a serious need to get its forest resources adjusted to both long-term national needs and to growing world competition for timber.

## FOREST POLICY FORMULATION

The United States as a whole lacks an effective and satisfactory way of working out national policy for all its forests. Policy formulation for the national forests of the United States is one thing; but national policy for all of the Nation, public and private, is much more difficult and, in the opinion of some, less satisfactory.

## WHY A NATIONAL POLICY FOR FORESTS IS NEEDED

There are several reasons why the United States needs a national policy for forests, and a mechanism for making such policy. In the first place, as earlier chapters of this report have pointed out, forests are important in the United States: They occupy one-third of the land; they are used, directly and indirectly (in the form of products) by a great many people; and they provide a lot of employment. The lumber, plywood, and pulp from forests enter into the lives of everyone; a large proportion of the population engages in outdoor recreation in a forest setting; and in other ways, forests affect the lives of many people.

Second, forests are owned by many kinds of owners. Some are public agencies, Federal and State, which manage lands for the entire citizenry of their jurisdiction. Some forests are privately owned; private persons have many objectives in forest ownership. Forest policy is partly made in the marketplace, partly made by the political process. The decision making process is now diverse and diffuse, with no one or no group fully responsible for the results.

Third, forests have been, are, and likely will be the focus of many public programs. As a nation, the United States long ago decided there existed a substantial public interest in forests. The nature of the public programs has changed in the past and likely will in the future, but it seems inconceivable that governmental programs affecting forests will cease.

## WHO NOW MAKES NATIONAL POLICY ON FORESTS?

Many public agencies and private groups now have some roles in the formulation of national policy on forests. The chief ones are as follows:

1. The Forest Service has, by law and in appropriations, three major tasks: Research, cooperative forestry with States, and management of the national forests. In each of these activities, to some degree it gets into the formulation of national policy for all forests. For instance, as part of its research program it collects data on acreages, volumes, growing rates, condition, ownership, and other aspects of all forest land. On the basis of these data it makes projections of future timber supply and demand. These projections implicitly include policy recommendations which themselves have been made explicit to some degree in Forest Service publications. The kind of a cooperative program the Service supports helps to influence the supply of timber from private lands. Its convictions about national forest administration have major repercussions on the supply of timber. In each of these activities, the Forest Service often treats many issues of public policy as if they were but technical matters. For instance, its insistence on relatively slow harvest of old-growth timber is justified on the basis of sustained yield constraints when in fact such a harvest rate is a policy determination of great importance. Policy formulation by the Forest Service for all forests seems too much an outgrowth of its philosophic convictions as to what constitutes good forestry, rather than being based on explicit analysis and debate of the policy alternatives available to the nation.
2. The Department of Agriculture, at Assistant Secretary and Secretary levels, plays some role in formulation of national policy on forests; in part as the home department of the Forest Service, in part through other departmental programs.
3. Similarly, the Department of the Interior and its land managing agencies (Bureau of Land Management, Fish and Wildlife Service, National Park Service, and Bureau of Indian Affairs) play some role in formulation of national policy for forests. Although Interior's landholdings are greater in area than are Agriculture's, its volume of commercial timber is materially less; yet its influence on forest policy is not negligible.
4. Likewise, the Department of Defense has considerable acreage of forest and other land under its

control. Defense is a major timber grower and seller. It is also a major purchaser of timber products. It has moderated its lumber and plywood purchases to relieve market pressures during periods of peak civilian demand.

5. The Office of Management and Budget exercises a major role, as an arm of the President, in approving or rejecting legislation proposals and in acting on appropriation requests. Likewise, the Council of Economic Advisers plays a role with respect to timber availability and prices. Other parts of the Executive Office also may, from time to time, be involved.

All of the foregoing, except perhaps the Forest Service, suffer from two major disabilities as far as formulation of national policy for forests is concerned. For each, forest policy is but one, and usually a minor one, of its many interests and activities, with the result that its input into forest policy often does not command the best thought and talent of the organization; for each, its input into national policy for forests is but a minor part of the total Federal input into such policy, so that the input of each tends to get lost, and may not be weighed seriously enough.

6. Congressional committees, both authorization and appropriation, in both Houses obviously exert influence on national policy for forests. But they too have many other interests and functions, and each is conscious that it is but one of several influences on national policy for forests.

7. The forest products industry, which in turn has several branches, also makes a substantial input into formulation of national policy for forests. The industry is concerned with the lands it owns; it buys timber from publicly owned forests, and from private forest owners; and it is vitally affected by many public actions. It naturally tries to influence public policy in directions favorable, or at least not unfavorable, to it.

8. The numerous conservation organizations, which also have both common and specialized interests, exert an influence on national policy for forests. Their concerns are more with the forest environment and its protection, and with the uses of the forest other than wood production, than they are with timber supply. Their influence is greatest on public forests and public programs, but not entirely absent as far as privately owned forests are concerned.

This list could be extended; the description of each actor is purposefully brief, even sketchy. The main point is that today there are numerous organizations concerned, in one way or another, with national policy for forests, but none has a decisive or leading role. The Panel feels that all of the foregoing groups, and others not included in this list, have important roles to play in the formulation of national policy for forests. It thinks none is likely to be replaced or pushed aside, and it does not recommend that any of these agencies or groups be excluded from forest policy consideration.

## WHY THIS POLICY MACHINERY IS INADEQUATE

The very diversity and number of public and private groups involved in national forest policy is one reason why forest policy is inadequate—what is everyone's business is often no one's business. None of the agencies is specifically charged with development of national policy for forests; the Forest Service comes more nearly to this point than any other agency, but its charter here is weak. It has little or no power to draw other public agencies into its deliberations and none to compel them to accept its findings.

In addition to diversity of organizations, there has been a notable specialization of viewpoint, within the public agencies and in the private groups, toward forests and their best use. Foresters have tended to look at forests primarily as producers of wood, wildlife enthusiasts have seen forests primarily as homes for wildlife, wilderness enthusiasts have been primarily concerned with wilderness use and so on. Some of this specialization of viewpoint grows out of technical complexities and technical knowledge. At its worst, specialized interest is likely to propose programs or answers to problems at the cost of exacerbating others. The Panel does not wish to belabor this point, and it recognizes that many men and women in each group have had broad interests, wide concerns, and knowledge over wide fields. Nevertheless, these have been failings in national forest policy attributable to the specialization of viewpoint phenomonon, which it would be a mistake to ignore.

The Panel feels that there has been an inadequate public input into the formulation of forest policy. Much of the total public is concerned but uninformed about forests—as it is about many other aspects of modern living. Although conservation and recreation organizations, as well as forest industry firms and associations, have sought to involve their members in forest policy determination, they have each and all reached only a small part of the total public, and mostly a part of the total public with strong, preconceived ideas. The Panel recognizes that genuine public participation in formulation of national policy is no easier with respect to forests than for any other subject. The lack of a satisfactory policymaking machinery, though, surely has not helped.

The Panel feels that the numerous private and public groups concerned with forests in one way or another have been inadequate to devise, test, and adopt a national policy for forests. The Panel feels that a broader and more explicit approach to forest policy is required.

The fact that resort has been made several times in recent years to special Cabinet committees on forest policy issues, and the further fact that the present Panel has been created, constitute evidence that a broader approach to the making of national policy on forest matters is necessary. The Panel is not so naive as to assume that national policy for forests can be formulated, considered, and adopted in any single place; but it does believe that the scattered threads of forest policy could be drawn together better than they are today, if this were the explicit and sole task of some organization.

## FOREST POLICY BOARD OR COUNCIL

The Panel proposes that the President consider, as one possibility, the establishment by Executive Order of a continuing board or council, of citizen members, to consider and to advise him, and through him the Congress and the Nation, on forest policy matters. This would be its sole responsibility; it would have no executive nor administrative power, only an advisory role. Its influence would be the result of its competence and of the President's confidence in it; its advice would be carried out, if at all, by the President or his designated representative giving instructions to Federal agencies and by private organizations and firms accepting its advice as useful.

The Panel has considered the problems of executive organization and reorganization. It has noted past recommendations for executive reorganization in the natural resources area from the first Hoover commission to the President's own proposal submitted to the Congress in the past session. The Panel has also noted the fate of those recommendations. This Panel does recommend that the Forest Policy Board or Council which it proposes be established, report to an appropriate unit or person in the White House.

The Panel proposes that the Forest Policy Board or Council be composed of citizen members, not officials appointed from the various executive agencies. This would not insure fresher and wider viewpoints, but it should help. Board members would have their personal idiosyncracies and philosophies, no doubt, but they would not have an agency line to sustain. New ideas should have a better chance of emerging; critical looks at old programs would be more easily possible; considerations of the present and of the future should acquire more weight, in comparison with experience of the past.

The Board or Council would require a modest permanent staff—perhaps half a dozen mature, experienced, topflight professional workers and the necessary complement of secretaries and clerks. The Panel judges that the Board or Council would work through existing agencies for the most part, not replace them. It might ask some agency to collect some data or to make some study; and its staff would have to possess the capacity of knowing whether or not the results met the objectives. The Panel would want the Board or Council to undertake studies of its own under unusual conditions.

The Executive Order establishing the Board or Council should spell out its relationship with line agencies in the Federal Government, and their responsibilities to it. In general, it should have the power to call such agencies together to consider problems, to request information within the agencies' fields of competence and activity, to request agency reaction in writing to Board or Council proposals or analyses. In the last analysis, the power of the Board or Council would not depend upon what the Order establishing it said, nor upon formal relationships, but upon the degree to which the President and his immediate staff relied upon the Board or Council for advice. That in turn would depend to a large extent upon the competence and wisdom of that advice.

## FUNCTIONS OF A FOREST POLICY BOARD OR COUNCIL

As the Panel visualizes the Forest Policy Board or Council, it would have several functions:

1. It would constantly review or monitor the forest situation, including the situation as to forest

products, in the United States. In the past, that situation has often changed rapidly; in many cases, an alert group could have foreseen impending trouble. For instance, in late 1972 a forest policy board or panel could have called attention to the rapidly escalating Japanese purchases of logs at very much higher prices, and the consequences this would have for domestic lumber supplies and prices. The extremely rapid price rises in lumber and plywood of the past half dozen years were not unforeseeable. Inherent conflicts between desirable programs, such as increased concern for environmental protection versus increased timber harvest, could be identified and suggestions could be made. Every aspect of forest policy could be kept under scrutiny.

2. The Forest Policy Board or Council could call national attention to forest problems. For instance, the inherent conflict between rising use of wilderness areas and preservation of their quality could be pointed out. Or the private business stake in increased appropriations for management of public forests could be pointed to. On both this and the preceding function, the Panel believes that the executive agencies would often not only welcome help but would often bring situations to the attention of the Board or Council for its consideration. Many persons in public agencies and in private groups are aware of problems but lacking the means to cope with the problems themselves, they do not speak up as they would if there were an appropriate unit concerned with forest policy.

3. The Forest Policy Board or Council should direct executive agencies to collect information to make studies, and it might invite forest industry groups, conservation organizations, and others to do the same.

4. The Forest Policy Board or Council might itself, under unusual circumstances, make original studies of some problem or situation. In general, the Panel feels the Board or Council should rely on other organizations for such studies but there may be times when it is simply unable to get some problem looked at in the way it considers essential and must make its own original analysis.

5. Lastly, and most important of all, the Forest Policy Board or Council would make recommendations to the President on various forest issues or problems.

The recommendations should be made, in the first case, to the President; in most cases, he presumably would make the recommendations public, as the reports of the Council of Economic Advisors are made public; but the Panel visualizes that sometimes the Forest Policy Board or Council should not be precluded from making policy recommendations to the whole country, especially on long-range problems where one major result might be to raise the level of public concern and debate.

*The Panel recommends:*

That the President appoint a permanent Forest Policy Board, to serve at his discretion and pleasure, of outstanding public citizens; this Board to consist of not more than 10 members, with overlapping terms and rotations of members, to be served by a small but highly competent professional staff. The Board would work with Federal and State agencies and legislatures, and with private groups of all kinds, in seeking information and in soliciting viewpoints. Its reports should be made to the President periodically and released on his decision; its prime concern would be the review of forest policy matters, in a manner not unlike the present Panel has done.

# Part III—APPENDIXES

# Appointment of Panel

FOR IMMEDIATE RELEASE

Office of the White House
Press Secretary
(San Clemente, Calif.)
September 2, 1971.

*THE WHITE HOUSE*

The President today announced the appointment of five persons to be members of the President's Advisory Panel on Timber and the Environment. Named as chairman of the Panel is Fred A. Seaton of Hastings, Nebr. Mr. Seaton, who is currently a newspaper publisher, served as Assistant Secretary of Defense for Legislative Affairs from 1953 to 1955, and Secretary of the Interior from 1956 to 1961. Other appointees are:

*Stephen H. Spurr*, of Austin, Tex., president, University of Texas at Austin; formerly dean, Horace H. Rackham School of Graduate Studies, University of Michigan.

*Marion Clawson*, of Chevy Chase, Md., Resources for the Future, Washington, D.C.

*Ralph D. Hodges, Jr.*, of the District of Columbia, vice-president and general manager, National Forest Products Association, Washington, D.C.

*Donald J. Zinn*, of Peace Dale, R.I., professor of zoology, University of Rhode Island, Kingston, R.I.; past president of the National Wildlife Federation.

In his June 19, 1970, statement on the report of the Task Force on Softwood Lumber and Plywood, the President concurred with their recommendation that a panel of outstanding citizens be invited to study the entire range of timber management problems. The Panel will advise the President on matters associated with increasing the Nation's supply of timber to meet growing housing needs while protecting and enhancing the quality of our environment.

The Panel will make recommendations on such matters as the desirable level of timber harvest on Federal lands and methods of accomplishing the harvest while insuring adequate protection for the environment; the costs and benefits of alternative forest management programs; citizen involvement in forestry programs; timber sale procedures; and the possibilities of increasing timber productivity on non-Federal lands.

The President has directed the Panel to report July 1, 1972, on these matters and to deliver copies of their report to the Secretary of Agriculture and the chairman of the Council of Economic Advisors.

PANEL MEMBERS

*Fred A. Seaton*, chairman

President, Seaton Publishing Co., Hastings, Nebr., 1937–present. Member (appointee) American Revolutionary Bicentennial Commission, July 1969. Secretary of the Interior, 1956–61. Assistant Secretary of Defense for Legislative Affairs, 1953–55. Personal Adviser to Eisenhower during 1952 campaign. U.S. Senator of Nebraska (appointee) 1952.

B.A., Kansas State College, 12 honorary degrees.



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*Marion Clawson*

Director of land and water program, Resources for the Future, 1955–present. Director of the Bureau of Land Management, Department of the Interior, 1948–53. Bureau of Agricultural Economy, USDA, 1929–46. Author of numerous books on the American land resource.

B.S. and M.A. (agriculture), University of Nevada; Ph. D. (economics), Harvard University.

*Ralph D. Hodges, Jr.*

Executive vice president, National Forest Products Association, Washington, D.C., May 1972–present. Began at NFPA in 1959 as director of forestry and economics division. Member American Bar Association and has served on ABA natural resources law section's timber resources committee.

B.A., University of California, School of Forestry; LL.B., Catholic University.

*Stephen H. Spurr*

President, University of Texas at Austin, 1971–present. Dean, Horace H. Rackham School of Graduate Studies and vice president of the University of Michigan, 1964–71. Founding editor of Forest Science Magazine. Author of numerous professional papers and books treating forest ecology and management.

B.S. (botany), University of Florida; M.F., Yale University; Ph. D. (forest ecology), Yale University.

*Donald J. Zinn*

Professor of zoology, University of Rhode Island, 1964–present; chairman of zoology department 1960–66; began at the university in 1946. President, National Wildlife Federation, 1968–71. Member Governor's Advisory Council on Natural Resources, 1967–present. Team captain, New England section International Biological Program, 1970–present. Owner and manager of forest property.

B.S., Harvard University; M.S. (zoology), University of Rhode Island; Ph. D. (zoology), Yale University.

# How the Work Was Prosecuted and Acknowledgments

## Description of Procedure

In fulfilling its assigned task, the Panel gathered and evaluated information in several ways. Principal among them were: (*a*) Formation and use of a Washington-based staff; (*b*) preparation of study reports on specific subject areas; (*c*) extensive meetings with people in government, industry, labor, and the conservation movement; (*d*) on-site inspections at several locations representative of forest harvest operations or where public controversy existed with respect to timber harvesting and environmental quality.

## Acknowledgments

The Panel wishes to extend sincere and grateful appreciation to its staff and consultants for their contributions to this report and expresses particular appreciation to the following:

To Dr. John Fedkiw who gave substantive assistance in developing and interpreting economic analyses relating to the Panel mission as a senior staff member while on leave from his post in the Department of Agriculture; and for his continued aid after returning to his duties in that Department.

To Chief Cliff and, subsequently, Chief McGuire who made the considerable resources of the Forest Service available to the Panel in furtherance of its work. The cooperation and assistance of many public employees in the Forest Service and other land-managing agencies, both in Washington and in the field, was critical to the completion of the Panel's task.

Also, to the hundreds of individuals and organizations who contributed their ideas and their advice to the Panel, by phone, by letter, and in person, over the months of deliberations. We believe all concerned interests had opportunities to contribute to the information resources and did so in a responsible and constructive fashion.

### PROFESSIONAL STAFF

*Hardy L. Shirley*, study director

Owner and professional manager of forest properties in New York. Dean emeritus, New York State College of Forestry at Syracuse 1952–66. Assistant dean New York State College of Forestry at Syracuse 1945–52. Consultant to U.S. Agency for International Development and U.N. Food and Agriculture Organization in Asia, Latin America, and Philippines, 1966–67. Director, U.S. Forest Experiment Station, Forest Service, USDA, 1939–45. Author of textbook, "Forestry and Its Career Opportunities."

B.A. Indiana University; Ph. D. (plant physiology), Yale University.

*John Fedkiw*, economist

Deputy Director, Office of Planning and Evaluation, Office of the Secretary, USDA.

B.S. New York State College of Forestry at Syracuse; M.F. New York State College of Forestry at Syracuse; Ph. D. (agricultural economics), Cornell University.

*William C. Jolly*, conservation and resource specialist

Program ecologist, Center for Natural Areas, Smithsonian Institution.

B.S. (wildlife management), Cornell University; Ph. D. candidate (resource planning and conservation), University of Michigan.

*John Milton*, ecology specialist

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*Susan Whisnant*, staff writer and assistant to the study director.

Research scientist, division of natural resources and environment, University of Texas.

A. B. Vassar College; M.F., Yale University.

## ADMINISTRATIVE STAFF

*Henry vanZile Hyde, Jr.*, executive director

Assistant to Secretary, Department of Health, Education, and Welfare, 1969–72. Assistant scheduler, Nixon for President Committee, 1968–69. Financial planner/purchasing agent/branch manager, Illinois Power Transmission, 1965–68. Assistant to President, United Republican Fund of Illinois, 1963–64.

B.A., Hamilton College.

*Kathleen Levan*, administrative assistant

*Susan Sprague*, executive secretary

*Janet Neuberg*, research assistant

*Catherine Gordon*, research assistant

*Sharon Lanier*, secretary

*Debra Simmons*, secretary

*Mary Noll*, secretary

## CONTRACT CONSULTANTS

*Dr. Irving Holland*

Professor of forest economics and associate head of the department of forestry, University of Illinois, began at the university in 1959. Consultant in forest economics to U.N. Food and Agriculture Organization in Rome. Member of the Organization of Tropical Studies in Latin America. USDA, Forest Service, Division of Forest Economics and Market Research, and Foreign Forest Investigation.

B.S. (forestry), University of California at Berkeley; M.S. (range management), University of California at Berkeley; Ph. D. (agricultural economics), University of California at Berkeley.

*Dr. Robert Marty*

Professor of forestry and resource development, department of forestry, Michigan State University, 1967–present. Research forester and branch chief for Economic Research in Washington, USDA Forest Service, 1955–67.

B.S. (forestry) Michigan State University; M.F., Duke University; M.PA., Harvard University; Ph. D. (economics), Yale University.

*Dr. Carl Newport*

Partner, Mason, Bruce & Girard, Portland, Oreg,. forestry consulting firm, 1967–present. Assistant director for economic research at the Pacific Northwest Forest Range and Experiment Station and project leader, USDA Forest Service 1957–67.

B.S. (forestry) University of Michigan; M.F., Oregon State University; Ph. D. (forest economics), New York State College of Forestry.

*Dr. Jerome Saeman*

Associate director, Forest Products Laboratory, Forest Service, USDA, 1969–present. Chief of wood chemistry research activities, Forest Products Laboratory, 1942–69. Vulcan Copper & Supply Co., chief chemist at Willamette Valley Wood Chemical Co., 1946–47.

*Dr. William Sizemore*

Senior partner of Sizemore & Sizemore, Tallassee, Ala., forest appraisal, analysis and management firm, 1949–present. District ranger and district forester 1940–42; assistant State forester, Alabama Department of Conservation, 1949–59.

M.S. (forestry), Louisiana State University; M.F., Duke University; Ph. D. (forest economics and management), University of Georgia.

*Dr. David Smith*

Morris K. Jessup, professor of silviculture, School of Forestry, Yale University, 1948–present. Author of "Practice of Silviculture," classic textbook in the field.

B.S. (biology), University of Rhode Island; M.F., Ph. D. (forest ecology), Yale University.

*Dr. Earl Stone*

Charles Lathrup Pack, professor of forest soils, Cornell University, 1948–present. American-Swiss Foundation Fellow, 1954–1955. Fulbright senior research fellow, 1962. Bullard fellow, 1969–70. Visiting associate professor, University of the Philippines. Junior Forester, Forest Service, USDA.

B.S. (forest ecology and physiology), New York State College of Forestry, Syracuse; M.S. (soil science), University of Wisconsin; Ph. D. (soils science), Cornell University.

*Dr. William Webb*

Dean of graduate studies and professor of forest zoology, New York State University, College of Environmental Science and Forestry, Syracuse, 1965–present. Visiting professor, University of Philippines, instrumental in establishing the forestry college. Minnesota fellow.

B.S. (forestry), University of Minnesota; M.S. (wildlife management), University of Minnesota; Ph. D. (zoology), New York State University College at Syracuse.

These reports were prepared under contract with the President's Advisory Panel on Timber and the Environment.

The opinions, findings, conclusions, and data expressed in these reports are those of the authors and not necessarily those of the President's Advisory Panel on Timber and the Environment.

The contractor reports constitute only one of a number of sources of information utilized by the Panel in the conduct of its work.

By Robert J. Marty

# Softwood Sawtimber Supply and Demand Projections

## CONTENTS



*Author's note:* The basic data and projections used in this study have been provided to the Panel by the Forest Service, USDA. I have tried to indicate clearly when I have extended or modified these data in any way, or applied my own estimates or assumptions about economic factors in their analysis. The analyses, interpretations, and conclusions contained in this report are my own and do not necessarily represent those of the Panel.

## CURRENT CONDITIONS AND CONCERNS

### The Commercial Timber Resource in 1970

There are 495 million acres of commercial forest land in the United States, 42 percent supporting softwoods, 54 percent supporting hardwoods, and 4 percent currently unstocked with trees. The total volume of trees on these lands was 649 billion cubic feet in 1970, and trees large enough to be classified as sawtimber inventoried 2,420 billion board feet.[1] Net growth totaled 18.6 billion $ft^3$ while removals ran 13.4 billion $ft^3$, leading to an increase in the total wood inventory. For sawtimber-size trees, however, the situation was different.

[1] Board-foot volumes for standing trees and logs are estimated on the basis of the one-quarter inch international log rule throughout this report.

TABLE 1.—Commercial Forest Land Acreage, Inventory, Growth, and Removals—the United States—1970

| Ownership class | Area (millions of acres) | Growing stock [1] (billions of cubic feet) | | | Sawtimber [2] (billions of board feet) | | |
|---|---|---|---|---|---|---|---|
| | | Inventory | Growth | Removals | Inventory | Growth | Removals |
| Softwood timber types | 207.2 | 431.9 | 10.7 | 9.0 | 1,905.2 | 40.5 | 46.9 |
| National forests | 66.8 | 199.8 | 2.0 | 1.9 | 982.0 | 8.6 | 12.5 |
| Other public | 21.7 | 48.4 | 1.0 | .7 | 223.3 | 4.2 | 4.2 |
| Forest industry | 36.4 | 73.2 | 2.6 | 2.9 | 317.8 | 10.0 | 16.4 |
| Other private | 82.3 | 110.5 | 5.1 | 3.5 | 382.1 | 17.7 | 13.8 |
| Hardwood timber types | 266.7 | 216.9 | 7.9 | 4.4 | 514.8 | 19.6 | 15.1 |
| National forests | 16.8 | 17.5 | .6 | .1 | 39.6 | 1.2 | .5 |
| Other public | 19.8 | 19.6 | .8 | .2 | 39.3 | 1.7 | .6 |
| Forest industry | 29.4 | 27.0 | .9 | .6 | 68.8 | 2.4 | 1.9 |
| Other private | 200.7 | 152.8 | 5.6 | 3.5 | 367.0 | 14.2 | 12.1 |
| Unstocked areas | 20.7 | | | | | | |
| All commercial forest land | 494.6 | 648.8 | 18.6 | 13.4 | 2,420.0 | 60.1 | 62.0 |

[1] Growing stock volume includes the noncull volume of live trees 5-in. d.b.h. or more of commercial species on commercial forest land, expressed in cubic feet.
[2] Sawtimber is a component of growing stock made up of larger trees containing at least 1 sawlog. Sawtimber volume is the volume of sawlogs in sawtimber trees expressed in board feet.

Source: Forest Service, USDA. Preliminary data.

Removals were 62 billion fbm while net growth was only 60.1 billion fbm (table 1).

### The Timber and Wood Products Industries in 1970

The 13.4 billion ft³ of trees harvested in 1970 provided 11.1 billion ft³ of logs for industrial use. The other 2.3 billion ft³ of material was left in the woods as logging residue or used for fuelwood and for other nonindustrial purposes. A net log export of 400 million ft³ left a residual of 10.7 billion ft³ of logs and other roundwood which was processed in domestic mills. About one-half of this total domestic log consumption was sawlogs, 9 percent veneer logs, 36 percent pulpwood, and the remaining 5 percent was made up of poles, posts, cooperage bolts, and other minor roundwood products (table 2).

This raw material was processed into 34 billion fbm of lumber, 16 billion ft² of plywood, 42 million tons of paper products, and 400 million ft³ of other wood products. Table 3 shows the amount of each of these primary wood products imported and exported during 1970, and their apparent consumption during that year. Construction, printing and publishing, packaging and shipping, and furniture manufacturing firms are the most important industrial users of wood.

TABLE 2.—Timber Extraction—the United States—1970

| | Billions of cubic feet |
|---|---|
| Volume of harvested trees | 13.4 |
| Less logging residues and wood used for nonindustrial purposes | 2.3 |
| Domestic log production | 11.1 |
| Less net log exports | .4 |
| Domestic log consumption | 10.7 |
| Sawlogs | 5.3 |
| Veneer logs | 1.0 |
| Pulpwood | 3.9 |
| Poles, posts, cooperage, etc | .5 |

Source: Forest Service, USDA. Preliminary data.

### Current Concerns

The prices of softwood lumber and plywood rose suddenly and sharply in 1968–69 after a long period of relative stability. After receding in 1970 they once again began to increase in 1971 and now are rising still further. These price increases are signals that not enough softwood lumber and plywood are reaching builders and other users. Table 4 shows how prices for softwood sawtimber, logs,

**TABLE 3.—Primary Wood Products Production, Trade, and Consumption—the United States—1970**

| Product | Unit of measure | Domestic production | Imports | Exports | Apparent consumption |
|---|---|---|---|---|---|
| Lumber | Billions of board feet | 34.0 | 6.1 | 1.3 | 38.8 |
| Softwood | do | 27.0 | 5.8 | 1.2 | 31.6 |
| Hardwood | do | 7.0 | .3 | .1 | 7.2 |
| Plywood | Billions of square feet, ⅜ in. basis | 15.7 | 2.0 | .2 | 17.5 |
| Softwood | do | 13.9 | | .1 | 13.8 |
| Hardwood | do | 1.8 | 2.0 | .1 | 3.7 |
| Pulp and paper products | Millions of tons | 41.8 | 9.6 | 7.6 | 44.7 |
| Other wood products | Billions of cubic feet | .4 | | | .4 |
| Processing residuals | do | 1.7 | | | |

Source: Forest Service, USDA. Preliminary data.

**TABLE 4.—Relative Price Indexes [1] for Softwood Sawtimber, Logs, Lumber, and Plywood**

| Year | Southern pine sawtimber stumpage from national forests | Douglas-fir sawtimber stumpage from national forests | No. 2 Douglas-fir sawlogs in the Pacific Northwest | Softwood lumber | Softwood plywood |
|---|---|---|---|---|---|
| 1960 | 95 | 85 | 91 | 98 | 118 |
| 1965 | 86 | 110 | 97 | 97 | 109 |
| 1966 | 101 | 121 | 96 | 98 | 105 |
| 1967 | 100 | 100 | 100 | 100 | 100 |
| 1968 | 107 | 140 | 117 | 118 | 126 |
| 1969 | 127 | 174 | 138 | 126 | 129 |
| 1970 | 118 | 96 | 128 | 103 | 103 |
| 1971 | 135 | 110 | (2) | 124 | 112 |

[1] Derived by dividing the price index for each commodity group (1967 equals 100) by the all commodity price index. These relative price indices show how prices have risen in comparison with all commodities from the base year of 1967.
[2] No data.

lumber, and plywood have changed during the last decade.

At the same time that demands for commercial timber products have been increasing there has also been an increasing public concern for environmental protection and wilderness preservation. These concerns have led to withdrawals of public commercial forest lands from timber harvest and management, and to the restriction of management on other areas. Currently some 68 million acres of Federal lands either have been withdrawn for wilderness use or are under consideration for withdrawal.

The increasing demand for timber products comes at a time when public lands are being reallocated to nontimber uses, and this leads to considerable question about the adequacy of timber supplies. The situation is particularly acute for softwood sawtimber, and this report examines supply and demand for the softwood timber resource in the years and decades ahead.

## THE OUTLOOK FOR THE SEVENTIES

### The Outlook in Brief

During the balance of this decade supplies of hardwood pulpwood and sawtimber, and of softwood pulpwood should be adequate to meet anticipated demands with little or no increase in relative price. This is not the case for softwood sawtimber however. Demand for this important component of the wood resource will outstrip supply by 25 percent at 1970 price levels. It is likely that prices for softwood sawtimber products will remain about 20 to 25 percent above their 1970 levels through the seventies, and that quantity will increase from 47 to 55 billion fbm equivalent.

It is possible to reduce price levels to some extent by harvesting mature softwood sawtimber on Federal lands more rapidly than now is planned. Expanded Federal harvests also would reduce the pressure on private timberlands and lead to a better balance of inventory among ownership classes. For example, a 4 billion fbm increase in annual harvest from the national forests would tend to reduce the price index to the 115–120 level, and a reduction of harvest on private lands of about 1.6 billion fbm also would result.

## Projections of Demand for Timber Products and for Timber

Timber demand depends on the amount of wood-based final goods, such as housing, furniture, and paper products which businesses, bureaus, and households wish to purchase. This in turn depends on the size of the population, its wealth, and its need for new housing units. The amount of timber necessary to provide a given level of final goods consumption depends on the state of technology in timber harvesting, wood products processing, and final goods manufacturing.

The demand estimates used in this report are based on preliminary Forest Service projections. The following listing shows some specific assumption used by the Forest Service in constructing their medium and high level demand projections.

| Variable | Projected 1980 level | |
|---|---|---|
| | Medium | High |
| GNP—Annual real increase (percent) | 4. 0 | 4. 5 |
| Population, in 1980 (millions) | 228 | 232 |
| Housing units, average annual level (millions) | 2. 31 | 2. 43 |

The actual path the economy will follow during the balance of the seventies is, of course, uncertain. This report assumes that timber demands will fall somewhere between the Forest Service medium and high projections during this period.

The actual consumption of wood products and of timber is further conditioned by price. When prices are low builders and manufacturers tend to use more wood, while high prices cause users to shift to substitute materials. The Forest Service projections assume that a given percentage increase in price causes a reduction in quantity demanded of approximately one-half the price increase. Thus a 10-percent increase in price is expected to cause a 5-percent reduction in demand. Forest Service estimates for 1980 are presented at three different softwood lumber price index levels. The listing below shows the range in quantity demanded used in this report as applying to the balance of the seventies for each of these price levels.

| Price—Relative softwood lumber price index (1967=100): | *Quantity demanded Softwood sawtimber demand for the balance of the seventies (billions of board feet)* |
|---|---|
| 1970 data: | |
| 103 | 47. 1 |
| Projection: | |
| 103 | 58. 7–62. 1 |
| 126 | 52. 2–55. 4 |
| 134 | 48. 7–52. 0 |

## Projections of Timber Supply

Softwood sawtimber is available from the national forests, from timberlands owned by the forest industry, and from other public and private ownerships. In addition, some of our softwood lumber and plywood needs are met through importation from other countries, primarily Canada. Preliminary Forest Service projections indicate a change in supply from domestic sources as shown in this listing.

| Domestic source | Quantity supplied [1] (billions of board feet) | |
|---|---|---|
| | 1970 | 1980 |
| National forests | 12. 7 | 13. 9 |
| Other public lands | 4. 3 | 4. 8 |
| Forest industry | 16. 3 | 13. 8 |
| Other private lands | 14. 3 | 16. 2 |
| All domestic sources | 47. 6 | 48. 7 |

[1] Based on timber removals.

This projection assumes continuation of the 1970 price level (relative softwood lumber price index=103), a 1-percent reduction in commercial forest land acreage, harvests from public lands limited to allowable cut, and harvests on private lands more nearly in balance with growth than is the case today. Harvests from forest industry lands are assumed to go down because growth is only 10 to 11 billion fbm per year. Harvests from other private lands are assumed to increase because softwood sawtimber growth is 18 to 19 billion fbm per year.

Supply is price responsive, just as is demand. Analysis of the supply response to price increases during 1969 and 1971–72 indicate that each 10 percent increase in the relative softwood lumber price index brings forth about a 6-percent increase in the quantity of softwood lumber and plywood supplied from domestic sources. At first an increase in demand is met from mill stocks and wholesale inventories, but in the longer run a commensurate increase in timber harvesting and processing occurs. Assuming this degree of supply responsiveness, the relationship between supply and price is as shown in table 5.

The contribution of net imports to supply also is closely related to price. Increases in softwood timber and product prices tend to reduce exports and stimulate imports. Preliminary Forest Service estimates of imports and exports for softwood timber and timber products are shown below.

| Price—Relative softwood lumber price index (1967=100) | Quantity supplied (billions of board feet) | | |
|---|---|---|---|
| | Imported | Exported | Net imports |
| 1970 data: | | | |
| 103 | 5.9 | 3.9 | 2.0 |
| 1980 projection: | | | |
| 103 | 5.7 | 6.3 | -.6 |
| 126 | 8.4 | 5.9 | 2.5 |
| 134 | 9.4 | 5.3 | 4.1 |

## Demand and Supply Equilibrium

An estimate of the general price level that will prevail for the balance of the seventies can be gotten by comparing the demand and supply estimates developed above.

| Price—Relative softwood lumber price index (1967=100) | Billions of board feet | |
|---|---|---|
| | Quantity demanded | Quantity supplied |
| 1970 data: | | |
| 103 | 47.1 | 47.1 |
| Projection (balance of the 1970's): | | |
| 103 | 58.7-62.1 | 48.2 |
| 126 | 52.2-55.4 | 57.8 |
| 134 | 48.7-52.0 | 61.7 |

These data also are shown in figure 1 as supply and demand curves and they indicate that the softwood lumber price index will fluctuate around the 120-125 level, and that the annual quantity of softwood sawtimber processed will approximate 55 billion fbm. On this basis some reduction in current lumber and plywood prices is to be expected as production rates are further increased and mill stocks and inventories replenished.

A considerable inventory of mature softwood sawtimber is available, particularly on western national forests. This material could be harvested somewhat more rapidly than is now planned and would provide a means of reducing price levels. Larger harvests from national forests would tend to reduce lumber and plywood prices, would lower harvest levels on other lands to some extent, and would cause a reduction in the quantity of timber available for harvest from national forests some decades hence. Figure 1 can be used to estimate the increase in timber output required to achieved any given price level reduction. For example, it would require about a 4 billion fbm increase from the national forests to reduce prices to an index level of 115-120.

## The Impact of Harvest Level on Inventories in 1980

The current inventory of softwood sawtimber is 1,905 billion fbm and removals are running at 46.9 billion fbm per year. Even ignoring timber growth there appears to be a 40-year supply of sawtimber now available for harvest. Some of this large inventory may not actually be available however. Particularly on public lands some of this area and inventory will be withdrawn for other uses. Some portion of the private timber resource is also held by owners who will not allow harvest. Then too, some inventory is on lands where harvest is not economic, the cost of extraction being larger than the value of the timber. And some of the commercial forest land is located in areas where substantial environmental impacts would result from harvest. For these reasons not all forest land classified as commercial from a growth capability standpoint is actually available to supply timber.

Table 6 shows the impact on area, inventory and growth of potential commercial forest land withdrawals and management restrictions. This projection supposes a reduction of commercial softwood forest land acreage of 17 percent, an inventory reduction of 24 percent, and a growth reduction of 16 percent. Of course this is only a guess about what might be the case if withdrawals and restrictions proceed at a rapid pace, and economically inaccessible areas prove to be substantial.

Table 7 projects inventory to 1980 from the post-withdrawal base defined in table 6 under three different assumptions about the level of national forest harvest and the distribution of the balance of the harvest among other ownerships as described in figure 1. Table 7 shows some striking trends. If national forest harvests continue at their current and projected rate of 14 billion fbm per year price levels will approximate the 125 index level and harvests will be larger on private lands than would be the case at lower price levels. This will lead to a much more rapid depletion of available inventory on private lands as compared with national forests,

**TABLE 5.—The Supply of Softwood Sawtimber from Domestic Sources [1]**

| Price—Relative softwood lumber price index (1967=100) | Quantity Supplied (billions of board feet) | | | | |
|---|---|---|---|---|---|
| | National forests | Other public lands | Forest industry | Other private lands | Total |
| 1970 data:[2] | | | | | |
| 103 | 12.7 | 4.3 | 16.3 | 14.3 | 47.6 |
| 1980 projection: | | | | | |
| 103 | 13.9 | 4.8 | 13.8 | 16.2 | 48.7 |
| 126 | 13.9 | 4.8 | 16.8 | 19.7 | 55.2 |
| 134 | 13.9 | 4.8 | 17.8 | 21.0 | 57.5 |

[1] Based on timber removal.
[2] The more recent data included in this row differ slightly from the preliminary data used in table 1.

**FIGURE 1.—Softwood Sawtimber Supply and Demand for the 1970's**

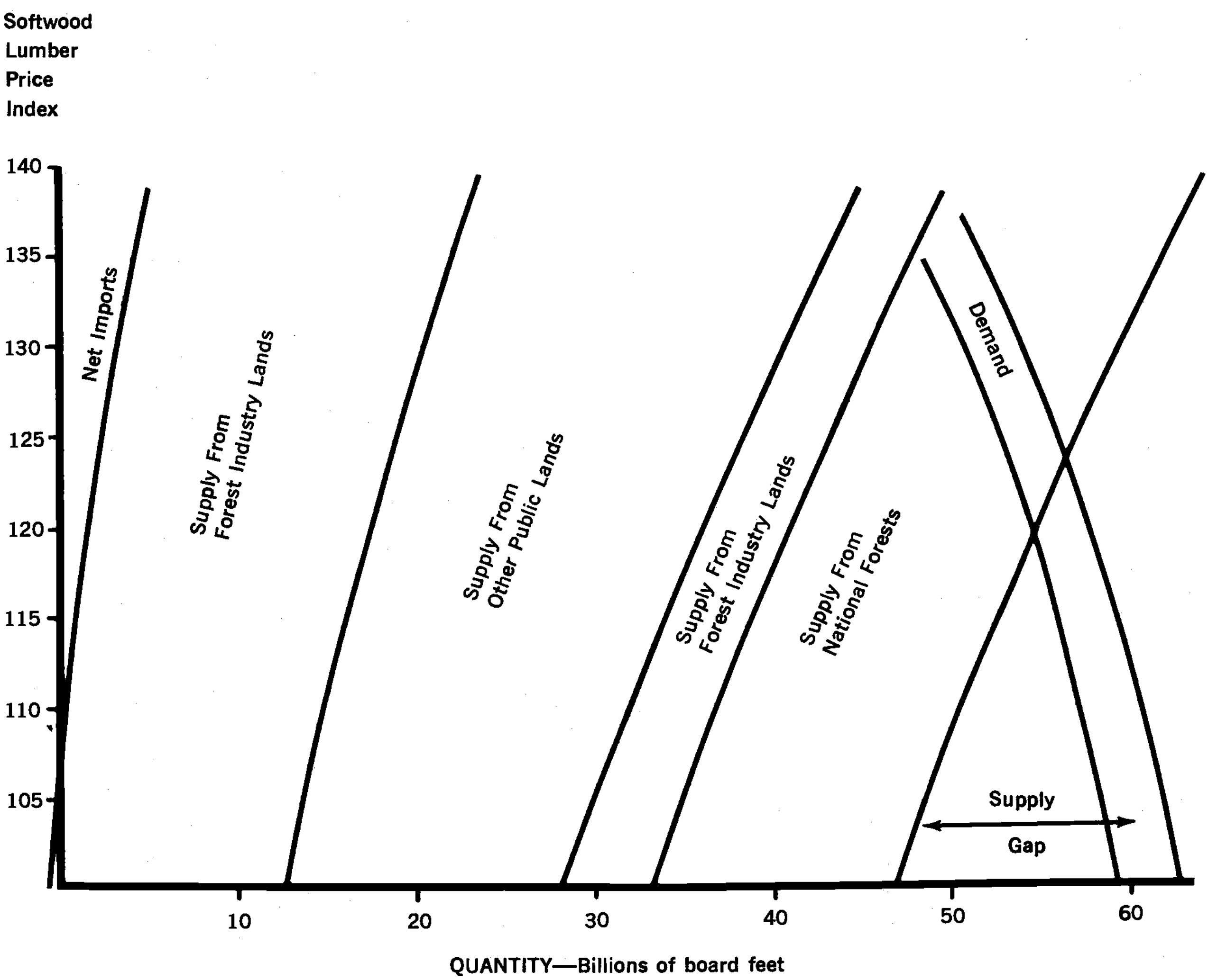


**TABLE 6.—The Effect on the Softwood Sawtimber Resource of Noncommercial Areas, Withdrawals, and Restrictions**

| Ownership | Area (millions of acres) | Billions of board feet | |
|---|---|---|---|
| | | Inventory | Growth[1] |
| 1970 softwood sawtimber resource: | | | |
| National forests | 66. 7 | 996. 8 | 9. 0 |
| Other public | 21. 8 | 209. 8 | 4. 3 |
| Forest industry | 36. 4 | 319. 2 | 10. 3 |
| Other private | 82. 3 | 380. 7 | 18. 3 |
| All ownerships | 207. 2 | 1, 906. 5 | 41. 9 |
| Softwood sawtimber resource for the 1970's after recognizing the noncommercial component and additional withdrawals and restrictions:[2] | | | |
| National forests | 53. 4 | 697. 8 | 6. 9 |
| Other public | 17. 4 | 146. 9 | 3. 4 |
| Forest industry | 34. 6 | 303. 2 | 9. 8 |
| Other private | 65. 8 | 304. 6 | 14. 6 |
| All ownerships | 171. 2 | 1, 452. 5 | 34. 7 |

[1] Midpoint between 1970 and 1980 growth protection. Forest Service. USDA preliminary data.
[2] The area available for commercial timber production is assumed to be 20 percent less than the 1970 inventory base on public and other private lands, and 5 percent less on forest industry ownerships. Proportional reductions in inventory and growth are assumed except in the case of inventory on public ownerships where a 30-percent reduction is assumed.

which probably is undesirable. If national forest harvests are increased the price level will decline and the pressure on private lands will be somewhat reduced. Such increases mean that inventory removal ratios would drop to the 20–22 level by 1980. Probably they should not be reduced below this level so that a reasonable inventory cushion exists for meeting post-1980 growth-removal deficits However, expansion of the national forest harvest seems feasible in the short run, will reduce price levels, and will lead to a more even distribution of inventory among ownership classes.

## THE LONGER RUN

In the short term some flexibility in supply is available because of the large inventories of mature softwood sawtimber which exist today. In the longer run, however, the annual increase in softwood sawtimber inventories—sawtimber growth—sets the limits of supply. Growth can be influenced by management investments both from public and private sectors, and for the private sector at least

**TABLE 7.—Projections of 1980 Softwood Sawtimber Inventory Resulting from Various Levels of National Forest Harvest**

| Domestic source | Billions of board feet | | I/R |
|---|---|---|---|
| | Average annual removals | 1980 inventory[1] | |
| Relative price index: 120–125: | | | |
| National forests | 13. 9 | 627. 8 | 45 |
| Other public | 4. 8 | 132. 9 | 28 |
| Forest industry | 16. 1 | 240. 2 | 15 |
| Other private | 18. 9 | 261. 6 | 14 |
| All ownerships | 53. 7 | 1, 262. 5 | 24 |
| Relative price index: 115–120: | | | |
| National forests | 18. 0 | 599. 1 | 33 |
| Other public | 4. 8 | 132. 9 | 28 |
| Forest industry | 15. 4 | 245. 1 | 16 |
| Other private | 18. 0 | 267. 9 | 15 |
| All ownerships | 56. 5 | 1, 245. 0 | 22 |
| Relative price index: 110–115: | | | |
| National forests | 21. 4 | 575. 3 | 27 |
| Other public | 4. 8 | 132. 9 | 28 |
| Forest industry | 14. 7 | 250. 0 | 17 |
| Other private | 17. 3 | 272. 8 | 16 |
| All ownerships | 58. 2 | 1, 231. 0 | 21 |

[1] Assumes removals as indicated for the 120-price index for the first 3 years of the decade and then as projected for the balance of the period.

the amount of this investment is related to the price expected for sawtimber products.

In the longer run the demand for softwood sawtimber will increase markedly, leading to price increases. Supplies from imports and private domestic sources will increase as prices advance. Public investments can add enough more growth to dampen the rate of price increase substantially, but cannot eliminate these increases entirely.

### Long-Term Demand Projections

Long-term demand projections for softwood sawtimber are shown in the listing below and in figure 2. These estimates are based on Forest Service preliminary projections at the medium and high level assumptions about economic activity, as before. Forest Service projections have been extended to 2020 on a judgment basis.

Price—Relative softwood lumber price index (1967=100):

| | Quantity demanded (billions of board feet) Softwood sawtimber |
|---|---|
| 1970 data: | |
| 103 | 47.1 |
| 1980 projection: | |
| 103 | 58.7–62.1 |
| 126 | 52.2–55.4 |
| 134 | 48.7–52.0 |
| 2000 projection: | |
| 103 | 72.5–84.3 |
| 134 | 62.5–73.5 |
| 172 | 55.1–66.5 |
| 2020 projection: | |
| 103 | 85.0–105.0 |
| 134 | 74.5–93.5 |
| 200 | 59.0–77.0 |

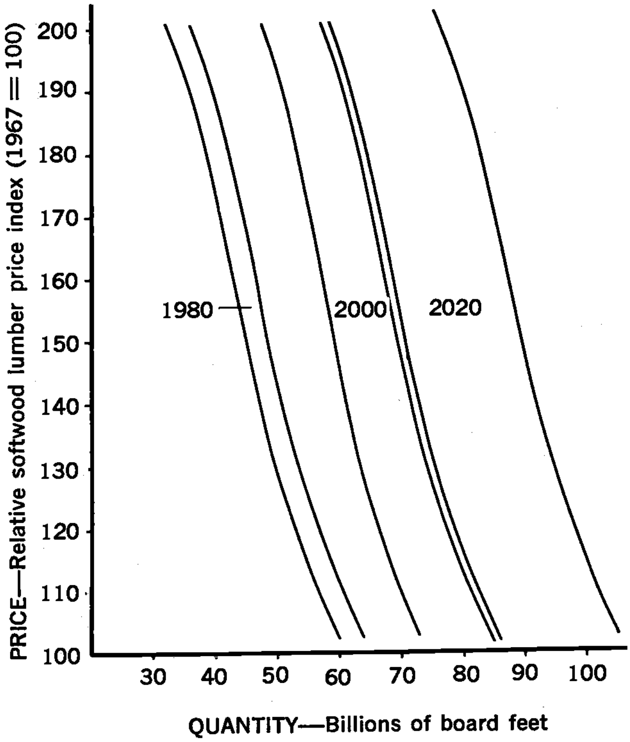
These projections clearly demonstrate that the range in demand estimates broadens rapidly with time, reflecting an increasing difficulty in pinpointing the underlying demographic, economic, and technical conditions likely to prevail decades hence. In spite of this uncertainty, however, demand is virtually certain to increase with time.

Shown below are some of the year 2000 demographic and economic assumptions upon which these projections are based.

| Variable | Year 2000 level | |
|---|---|---|
| | Medium | High |
| GNP, billions of 1967 dollars | 2,860 | 3,300 |
| Population (millions) | 281 | 301 |
| Housing units (millions) | 2.66 | 3.03 |
| Index of manufacturing (1967=100) | 340 | 410 |

The projections also embody assumptions about the effect of changes in price, and of technological progress, on quantity demanded. Once again, at any given time an increase of, say, 10 percent in price is assumed to result in a reduction of 5 percent in the quantity of sawtimber products demanded. The Forest Service projections of demand also reflect anticipated changes in the quantity of sawtimber required to provide each unit of final goods. For example, lumber yield is expected to increase 12 percent by 2000, and the board feet of lumber and plywood required for each square foot of floor area in housing units is expected to decline from 11.54 in 1970 to 10.63 in 2020. These estimates of the effect of technological advances on timber demand are based in part on historical changes and in part on specific anticipated changes and their particular influence on wood use. A faster rate of technological advancement was assumed for demand projections at higher price levels, since this factor is price responsive. There is a possibility of fostering more rapid adoption of wood-saving processing technology through economic incentives to the industry. However, this possibility is not studied further in this report.

FIGURE 2.—Projected Demand for Softwood Sawtimber




## The Supply of Softwood Sawtimber to 2020

Table 8 summarizes Forest Service preliminary projections of softwood growing stock and sawtimber supply to the year 2020, by ownership class. This projection is based on 1970 levels of protection and management which are shown in the listing below, and assumes that commercial forest area will decline about 5 million acres per decade.

| Activity | Treatment level (millions of acres) | Expenditure (millions of dollars) |
|---|---|---|
| Forest fire control (area burned) | 1.2 | 320 |
| Insect and disease control | (1) | 12 |
| Forestation | 1.5 | 80 |
| Timber stand improvement | 1.4 | 25 |
| Harvesting assistance | 3.8 | (1) |

(1) no data.

**TABLE 8.—Projections of Softwood Growing Stock and Sawtimber Growth by Ownership Class—Current Management Levels**

| Year | National forests | Other public | Forest industry | Other private | All ownerships |
|---|---|---|---|---|---|
| Softwood growing stock growth (*billions of cubic feet*): | | | | | |
| 1970 | 2.0 | 1.0 | 2.6 | 5.1 | 10.7 |
| 1980 | 2.2 | 1.1 | 2.7 | 5.5 | 11.6 |
| 1990 | 2.3 | 1.2 | 2.8 | 5.5 | 11.8 |
| 2000 | 2.4 | 1.2 | 2.9 | 5.3 | 11.8 |
| 2010 | 2.5 | 1.2 | 2.9 | 5.2 | 11.8 |
| 2020 | 2.7 | 1.2 | 3.0 | 5.1 | 12.0 |
| Softwood sawtimber growth (*billions of board feet*): | | | | | |
| 1970 | 8.6 | 4.0 | 10.0 | 17.7 | 40.3 |
| 1980 | 9.5 | 4.7 | 10.7 | 19.0 | 43.9 |
| 1990 | 10.2 | 5.0 | 11.4 | 19.9 | 46.5 |
| 2000 | 10.8 | 5.1 | 12.0 | 19.9 | 47.8 |
| 2010 | 11.4 | 5.1 | 12.2 | 19.6 | 48.3 |
| 2020 | 12.0 | 5.1 | 12.4 | 19.2 | 48.7 |

Source: Forest Service, USDA. Preliminary data.

This projection shows moderate improvements in softwood sawtimber annual growth on most ownership classes, as old growth harvesting and current levels of protection and management are continued and have their effect. By the end of this period annual production will have increased to 48.7 billion fbm.

Table 9 shows a projection of softwood sawtimber growth assuming intensified public investment in timber culture on the national forests and on nonindustrial private ownerships. These estimates are based on a Forest Service projection modified to some extent as indicated below. This program of intensified timber management adds 2.4 billion fbm to annual growth on the National Forests, and 8.9 billion fbm to the softwood sawtimber growth on nonindustrial private lands, by the end of the projection period.

**TABLE 9.—Projections of Softwood Growing Stock and Sawtimber Growth by Ownership Class—Accelerated Public Programs**

| Year | National forests | Other public | Forest industry | Other private | All ownerships |
|---|---|---|---|---|---|
| Softwood growing stock growth (*billions of cubic feet*): | | | | | |
| 1970 | 2.0 | 1.0 | 2.6 | 5.1 | 10.7 |
| 1980 | 2.2 | 1.1 | 2.7 | 5.7 | 11.7 |
| 1990 | 2.4 | 1.2 | 2.8 | 6.7 | 13.1 |
| 2000 | 2.6 | 1.2 | 2.9 | 7.4 | 14.1 |
| 2010 | 2.9 | 1.2 | 2.9 | 7.5 | 14.5 |
| 2020 | 3.2 | 1.2 | 3.0 | 7.5 | 14.9 |
| Softwood sawtimber growth (*billions of board feet*): | | | | | |
| 1970 | 8.6 | 4.0 | 10.0 | 17.7 | 40.3 |
| 1980 | 9.5 | 4.7 | 10.6 | 20.0 | 44.8 |
| 1990 | 10.6 | 5.0 | 11.4 | 24.2 | 51.2 |
| 2000 | 11.7 | 5.1 | 12.0 | 27.2 | 56.0 |
| 2010 | 13.0 | 5.1 | 12.2 | 28.0 | 58.3 |
| 2020 | 14.4 | 5.1 | 12.4 | 28.1 | 60.0 |

Source: Forest Service, USDA. Preliminary data modified as indicated in text.

These programs are taken here to represent permanent increases in the intensity of management on these lands. Therefore, the effect of this intensification on growth is presented in table 9 as continuing rather than terminable increments in growth. The average annual cost of these programs between 1974 and 2000 for the basic silvicultural treatments is $30 million for cost-sharing and technical supervision on nonindustrial private ownerships, and $53 million for the national forest program. These data make it obvious that the nonindustrial private land program is the more cost-effective of the two.

The contribution of imports to supply is shown in the listing below. Once again, the preliminary Forest Service projects for the year 2000 have been extended to 2020 on a judgment basis.

| Price—Relative softwood lumber price index (1967=100) | Quantity supplied | | |
|---|---|---|---|
| | Imported | Exported | Net imports |
| 1970 data: | | | |
| 103 | 5.9 | 3.9 | 2.0 |
| 1080 projection: | | | |
| 103 | 5.7 | 6.3 | -.6 |
| 126 | 8.4 | 5.9 | 2.5 |
| 134 | 9.4 | 5.3 | 4.1 |
| 2000 projection: | | | |
| 103 | 5.4 | 7.3 | -1.9 |
| 134 | 10.7 | 5.4 | 5.3 |
| 172 | 11.1 | 4.7 | 6.4 |
| 2020 projection: | | | |
| 103 | 5.0 | 8.3 | -3.3 |
| 134 | 13.0 | 5.0 | 8.0 |
| 200 | 15.0 | 4.0 | 11.0 |

There are other means of increasing softwood sawtimber supplies in the longrun in addition to these public programs. In particular, some private timberland owners can be expected to respond to higher sawtimber product prices in at least four ways: By acquiring additional land for timber production, by increasing management intensity, by holding stands longer so that a greater proportion of harvest volume will be in the form of saw-

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logs, and by harvesting smaller and more defective trees and logs.

Most forest industry ownerships and some nonindustrial private ownerships are price responsive. In all, perhaps 40 million acres of private timberlands supporting softwood timber types currently fall in this category. The current level of management on industrial lands indicates that about one-fourth or 10 million acres in this class are being intensively managed. A companion study dealing with the economic effectiveness of silvicultural investment indicates that intensification would return 8 to 12 percent on 30 percent of this forest area with increases in the softwood lumber price index of one-half to 1 percent per year. If prices are expected to increase more rapidly than this then intensification becomes profitable on 65 to 85 percent of the area. This assumes that price responsive holdings have an array of softwood types and sites similar to that for all ownerships. It is probable that types and sites actually are better than average on these ownerships so the estimates below are likely to be conservative. The effect of intensification on growth declines as such programs are expanded and less productive sites and types are included. The listing below shows the increases in annual growth that would be forthcoming under these assumptions and also shows the increase in the acreage base anticipated at various rates of price increase.

| Price—average annual rate of increase in the relative softwood lumber price index (percent) | Growth added by management intensification | | | |
|---|---|---|---|---|
| | Year 2000 acreage in price responsive ownerships (millions of acres) | Additional proportion of area to which intensification is extended (percent) | Added growth (billions of board feet) | |
| | | | 2000 | 2020 |
| 0 | 40 | | | |
| ½ | 40 | 5 | 0.6 | 0.9 |
| 1 | 42 | 7 | .8 | 1.3 |
| 1½ | 44 | 40 | 2.2 | 3.3 |
| 2 | 45 | 60 | 2.9 | 4.5 |

Forest Service projections assume that sawtimber product prices will advance more rapidly than pulpwood prices. Under these conditions there is a wider and wider price spread between these products as price levels advance. This will lead many price responsive owners to consider using fewer sawtimber sized trees for pulpwood and to lengthen rotations so that a larger proportion of their production is suitable for plywood and lumber production. On a purely judgment basis it is assumed that price responsive owners will increase sawtimber output approximately 2 percent of growth at current management levels for each 10 percent increase in the relative softwood lumber price index to a maximum of 10 percent. After this much diversion of production from pulpwood to sawtimber, pulpwood prices are likely to increase enough to remove most of the incentive.

Increases in the proportion of stumpage actually utilized also are occasioned by price increases. Higher prices encourage closer utilization on all harvest operations. Smaller and more defective trees and logs pay their way out of the woods, and logging residuals are reduced. On a judgment basis it is anticipated that sawtimber output will be increased by one-half of 1 percent for each 10 percent increase in the relative softwood lumber price index, due to closer utilization in logging, to a maximum of about 4 percent.

These increases in timber supply from prices responsive private growers are summarized in table 10. Increases range from 1.1 to 5.2 billion fbm for the year 2000, and 1.9 to 7.6 billion fbm for 2020.

## Long-Term Demand and Supply Equilibrium

The listing below shows the quantities of softwood sawtimber supplied and demanded at various prices in the years 2000 and 2020 at the first approximation.

| Price—Relative softwood lumber price index (1967=100) | Billions of board feet | |
|---|---|---|
| | Quantity demanded | Quantity supplied |
| 2000 projection: | | |
| 103 | 72.5–84.3 | 45.9 |
| 134 | 62.5–73.5 | 53.1 |
| 172 | 55.1–66.5 | 54.2 |
| 2020 projection: | | |
| 103 | 85.0–105.0 | 45.4 |
| 134 | 74.5–93.5 | 56.7 |
| 200 | 59.0–77.0 | 59.7 |

The supply shown above is the table 8 projection of growth at current management levels, plus net imports. It is the supply that would be available if no acceleration in government timber production programs were undertaken, and before taking into account private production responses to price increases.

If no additional public investment is forthcoming prices for lumber and plywood will tend to rise rapidly. The private response would be to expand output about 4.6 billion fbm per year. The

**TABLE 10.—Additional Softwood Sawtimber Growth Anticipated from Responses to Increasing Prices by Private Producers**

| Price—Relative softwood lumber price index (1967=100) | Additional quantity supplied (*billions of board feet*) | | | |
|---|---|---|---|---|
| | Total | Management intensification | Longer rotation | Closer utilization in logging on all lands |
| 2000 projection: | | | | |
| 120 | | | | |
| 133 | 1. 1 | . 6 | . 2 | . 3 |
| 146 | 1. 8 | . 8 | . 5 | . 3 |
| 162 | 3. 8 | 2. 2 | . 8 | . 8 |
| 178 | 5. 2 | 2. 9 | 1. 2 | 1. 1 |
| 2020 projection: | | | | |
| 120 | | | | |
| 146 | 1. 9 | . 9 | . 5 | . 5 |
| 179 | 3. 6 | 1. 3 | 1. 1 | 1. 2 |
| 217 | 6. 4 | 3. 3 | 1. 2 | 1. 9 |
| 486 | 7. 6 | 4. 5 | 1. 2 | 1. 9 |

net result would be an output of 60 billion fbm per year at a price index of about 175 by the year 2000.

If some additional public programing were undertaken, say enough to provide an additional 5 billion fbm of annual growth by the year 2000, then prices would rise somewhat less rapidly. This would evoke a private increase in output of about 4 billion fbm per year of additional growth and lead to a total output in 2000 of about 62 billion fbm at a price index of about 165.

The full potential for additional sawtimber from public programs is about 8 billion fbm of annual growth by the year 2000. If this full program were undertaken prices would tend to rise less rapidly still, and the private response would provide an additional yield of about 2.5 billion fbm for a total in 2000 of 64 billion fbm at a price index of 155. These estimates for 2000 are summarized in the following listing.

| Supply source | Public investment increase (billions of board feet) | | |
|---|---|---|---|
| | None | Partial | Full |
| Imports | 7. 0 | 6. 2 | 5. 7 |
| National forests | 10. 8 | 10. 8 | 11. 7 |
| Other public lands | 5. 1 | 5. 1 | 5. 1 |
| Forest industry | 17. 0 | 16. 0 | 14. 5 |
| Other private lands | 19. 9 | 23. 5 | 27. 2 |
| Total | 59. 8 | 61. 6 | 64. 2 |
| Equilibrium price index | 175 | 165 | 155 |

A similar analysis of the possible supply-demand equilibria for the year 2020 is displayed in this listing.

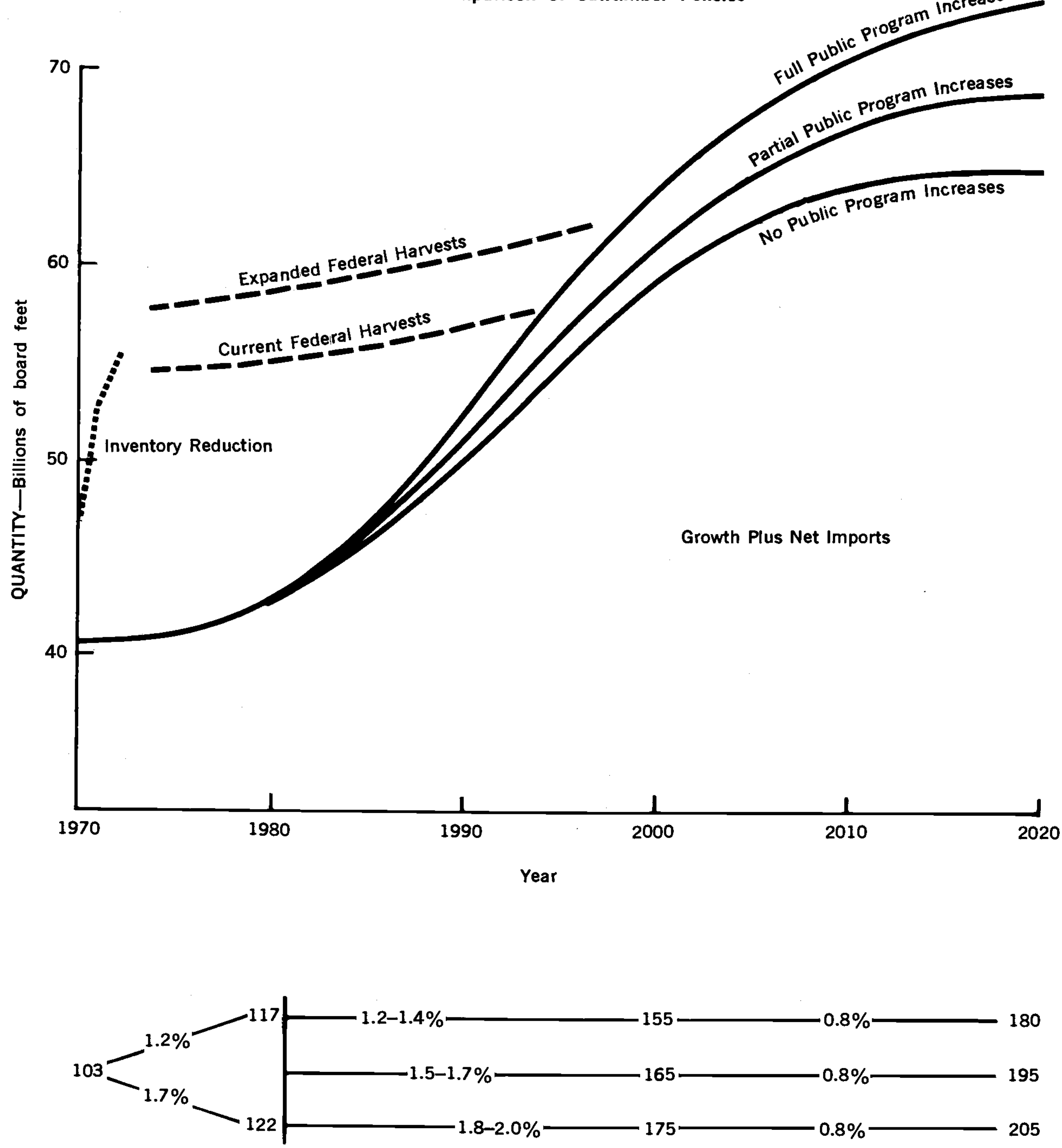
| Supply source | Public investment increase (Billions of board feet) | | |
|---|---|---|---|
| | None | Partial | Full |
| Imports | 11. 2 | 10. 8 | 10. 1 |
| National forests | 12. 0 | 12. 0 | 14. 4 |
| Other public lands | 5. 1 | 5. 1 | 5. 1 |
| Forest industry | 17. 9 | 17. 3 | 16. 2 |
| Other private lands | 19. 2 | 23. 7 | 28. 1 |
| Total | 65. 4 | 68. 9 | 73. 9 |
| Equilibrium price index | 205 | 195 | 180 |

## AN APPRAISAL

Figure 3 summarizes the courses of action examined in this report and their effect on production of softwood sawtimber products and on their prices. In the near-term the quantity of softwood products offered the market can be increased by accelerating harvests of mature sawtimber on Federal lands. If harvests remain at current levels the softwood sawtimber price index will approximate 122 by 1980, and the inventory of mature sawtimber will be seriously depleted on some private ownerships. If Federal harvests are accelerated by 4 billion fbm per year the 1980 price level will be about 117, and private timberlands will have better sawtimber inventories. In either case it is clear that there will be substantial inventory reductions through the balance of the seventies and the eighties. Figure 3 shows this coming to an end by 2000 when inventories probably will have reached a level on most ownerships where no further reduction is possible and output essentially is limited to growth.

In the longer run three levels of public investment in timber growing are examined: Continuation of current program levels, a partial increase in public programs that will create an additional 5 billion fbm per year of softwood sawtimber growth by 2000, principally on nonindustrial private ownerships, and a full increase that willl create 8 billion fbm of additional annual growth by 2000. The 1980–2000 period will be one of rapid price increases for sawtimber products because demands will be increasing more rapidly than sup-

FIGURE 3.—A Comparison of Sawtimber Policies




Price Index Values and Rates of Price Increase

plies. With no public program expansion prices will rise 1.8–2 percent per year to a price level of 175. With the fully public program increase the price index level will be about 155 by 2000, representing a 1.2–1.4 percent increase per year.

In summary it would seem feasible to increase Federal harvest levels at least to some extent to reduce pressures on private stumpage inventories and ameliorate the increase in product price levels to some degree. And some increment in public timber growing investments also appears to be effective in providing additional quantities of timber in the longer run and moderating price level increases.

By Robert J. Marty

# Economic Effectiveness of Silvicultural Investments for Softwood Timber Production

**CONTENTS**



## PRÉCIS

This study attempts to estimate the physical productivity of U.S. commercial softwood timberland for sawtimber, the economic effectiveness of silvicultural treatments in softwood timber types, and the potential economic supply of softwood saw-timber in future decades.

The 207.2 million acres of commercial forest land in softwood timber types are capable of producing at the rate of about 100 billion fbm per year if all this land were intensively managed. The economic efficiency of silvicultural investments varies depending on type of treatment, timber type, site quality, and anticipated future price level. In general, forestation investments are less effective than sapling stand improvement investments, but both promise reasonable returns in many instances. A comprehensive silvicultural program, called management intensification, is more effective in most instances than either of the single silvicultural practices examined.

The supply of timber it would be economic to provide from these forest lands, when no other impediments are considered, ranges from 43 to 91 billion fbm per year depending on the minimum acceptable rate of return set for siliviculturaI investment and the level of lumber and plywood prices anticipated in future decades.

## TIMBER GROWTH POTENTIALS

### Ultimate Timber Growth Potential

In the long run the continuing volume of industrial wood available from domestic sources depends on four factors: The amount and productivity of land devoted to timber production; the genetic characteristics of the trees which become established on these lands; the degree of protection and silvicultural care they are afforded; and the efficiency with which mature trees are extracted and processed into lumber, plywood, and other primary products.

Currently 495 million acres of forest land are classified as unreserved, commercial timberland, and these acres now produce 18.6 billion $ft^3$ of additional wood each year, an amount somewhat larger than the 14.1 billion $ft^3$ now being used.[1] The ultimate capacity of commercial timberlands is not known, but we are aware that current net annual growth is much below capacity. The two most important reasons for this are overstocking on some lands and understocking on others. When the number of trees existing on an area is too large little net increase in volume occurs from year to year. The problem of overstocking is particularly prevalent in old-growth stands and in densely stocked young stands of such species as lodgepole pine where mortality and stagnation reduce net growth markedly. Understocking also is widespread. Forest areas denuded by catastrophe or harvest do not always regenerate naturally to tree species. Instead these areas may support a preponderance of grass, brush, or weed trees and contribute little to the commercial wood supply. Large acreages of unstocked or understocked lands occur in all ownership classes.

One estimate of timber growth potential indicates that "* * * if the average growth rate of the most productive timber stands known today for each forest type and site were extended to all the forest land in each type and site class * * *, an annual growth of 50 billion $ft^3$, including 200 billion fbm of sawtimber, might be attained."[2] This estimate does not mark ultimate productive capacity since it does not take into account the substantial contribtuion that could be made to growth through the use of genetically superior trees, by site improving treatments like fertilization and drainage, and by more efficient harvesting and processing procedures.

Ultimate capacity, then, easily may be 3 to 4 times current growth. However, the growth increase that is practical to consider or aim at is much less, first because the area economically accessible for commercial timber production is less than the 495 million acres designated as commercial forest land on a growth capacity basis, second because there are many situations in which treatment to improve timber growth is too expensive per unit of additional wood produced to warrant consideration, and third because other uses sometimes limit the achievement of full growth potential.

[1] Forest Service, USDA. Preliminary data for 1970.

[2] Forest Service, USDA. 1958. "Timber Resources for America's Future." Forest Resource Report No. 14, p. 476.

## Softwood Timber Growth Capacity

A somewhat more tempered estimate of practically attainable growth capacity for softwoods is shown in tables 1 and 2. Table 1 provides some generalized estimates of the net mean annual growth that might be anticipated for various softwood timber types. These estimates are based on forest survey site productivity classifications. They are meant to represent the average growth rate attainable over broad areas when such areas receive prompt and effective protection and silvicultural treatment as the need arises. The growth estimates generally are 25 percent or more below research estimates of maximum growth for small areas, to reflect the fact that even with intensive management it is not possible to keep all stands producing at their maximum rates throughout the production period.

**TABLE 1.—Average Annual Timber Yield Obtainable Over Broad Areas Under Intensive Management—by Timber Type and Site Class**

| Timber type | Site productivity class | | | |
|---|---|---|---|---|
| | 120 or more | 85–120 | 50–85 | 20–50 |
| Growing stock productivity potential (cubic feet per acre per year): | | | | |
| Hemlock—spruce | 200 | 115 | 80 | 45 |
| Duglas-fir and fir-spruce | 150 | 105 | 60 | 35 |
| Ponderosa and lodgepole pines | 130 | 90 | 55 | 30 |
| Southern, red and white pine | 160 | 110 | 70 | 40 |
| Other softwood types | 130 | 90 | 55 | 30 |
| Sawtimber productivity potential (board feet per acre per year): | | | | |
| Hemlock—spruce | 1, 200 | 700 | 500 | 250 |
| Douglas-fir and fir-spruce | 900 | 600 | 400 | 250 |
| Ponderosa and lodgepole pine | 750 | 550 | 350 | 150 |
| Southern, red and white pine | 1, 000 | 650 | 450 | 250 |
| Other softwood types | 750 | 550 | 350 | 150 |

Source: Adapted from Robert J. Marty, 1967. "Opportunities for Timber Management Intensification on the National Forests." Review draft. Forest Service, USDA mimeographed, unnumbered report. 67 pp. tables 9-20, pp. 22-37.

Table 2 applies the growth rates in table 1 to the acreages classified by the Forest Service as commercial forest land in each softwood timber type. If all the 207 million acres now in softwood timber types were placed under intensive management annual production would rise to 17 billion ft³ of roundwood, including 103 billion fbm of sawtimber. This represents about a 70-percent increase in growing stock growth from the 1970 rate of 10.7 billion ft³; and more than doubling of sawtimber growth. The effect on the sawtimber component is more striking because intensive management will shift a greater proportion of total growth to sawtimber-size material. The conversion of hardwood stands in the East to softwood timber types also could increase softwood production beyond table 2 levels but is not considered in this report.

Table 2 shows that the 82 million acres supporting softwood timber types in the highest two productivity classes (40 percent of the softwood acreage) could provide 60 billion fbm of softwood sawtimber per year if intensively managed, 25 percent more than the current level of national use, and 50 percent more than the current level of national growth.

**TABLE 2.—Softwood Timber Yield Capacity—the United States**

| Timber type | All classes | Site productivity class | | | |
|---|---|---|---|---|---|
| | | 120 or more | 85–120 | 50–85 | 20–50 |
| Area (millions of acres): | | | | | |
| Hemlock-spruce | 10.8 | 5.4 | 3.1 | 1.9 | 0.4 |
| Douglas-fir and fir-spruce | 48.6 | 12.1 | 9.4 | 16.2 | 10.9 |
| Ponderosa and lodgepole pines | 41.2 | 2.8 | 6.7 | 13.5 | 18.2 |
| Southern, red and white pines | 83.3 | 7.0 | 26.0 | 38.3 | 12.0 |
| Other softwood types | 23.3 | 4.1 | 5.0 | 7.2 | 7.0 |
| All types | 207.2 | 31.4 | 50.2 | 77.1 | 48.5 |
| Annual growing stock yield capacity (billions of cubic feet): | | | | | |
| Hemlock-spruce | 1.7 | 1.1 | .4 | .2 | ---- |
| Douglas-fir and fir-spruce | 4.2 | 1.8 | 1.0 | 1.0 | .4 |
| Ponderosa and lodgepole pines | 2.3 | .4 | .6 | .7 | .6 |
| Southern, red and white pines | 7.2 | 1.1 | 2.9 | 2.7 | .5 |
| Other softwood types | 1.6 | .5 | .5 | .4 | .2 |
| All types | 17.0 | 4.9 | 5.4 | 5.0 | 1.7 |
| Annual sawtimber yield capacity (billions of board feet): | | | | | |
| Hemlock-spruce | 9.8 | 6.5 | 2.2 | 1.0 | 0.1 |
| Douglas-fir and fir-spruce | 25.7 | 10.9 | 5.6 | 6.5 | 2.7 |
| Ponderosa and lodgepole pines | 13.2 | 2.1 | 3.7 | 4.7 | 2.7 |
| Southern, red and white pines | 44.1 | 7.0 | 16.9 | 17.2 | 3.0 |
| Other softwood types | 10.2 | 3.1 | 2.8 | 2.5 | 1.8 |
| All types | 103.0 | 29.6 | 31.2 | 31.9 | 10.3 |

## JUDGING THE EFFECTIVENESS OF SILVICULTURE

### Investments in Silviculture

Treatment of stands of trees can augment net timber yield substantially. Such treatments are investments from a financial point of view when they are made at a net cost and will bring an additional income at some later time when harvest occurs. Whether or not silvicultural investments are worthwhile depends on: (1) the yield response achieved, (2) the period before the additional growth is harvested and used. (3) the cost of treatment, and (4) the value of the additional yield produced. Investment efficiency varies a good deal from one situation to another.

Silvicultural investments commonly are made (1) for site preparation to create acceptable conditions for natural or artificial forestation, (2) for planting of seeds or seedlings when natural regeneration is inadequate or delayed, (3) for intermediate release or thinning in sapling and pole stands to promote vigorous growth of selected trees, (4) for fertilization to increase growth rates, (5) for pruning of the lower branches of crop trees to improve log quality, and (6) for improvement and sanitation cuttings in older stands to salvage volume otherwise lost and to promote faster growth and less mortality in the residual stand. In addition to these silvicultural investments there are the very important commercial thinnings, salvage cuttings, and regeneration harvests which are carried out at no net cost since the merchantable timber extracted more than pays for the operation.

### Single-Practice Silviculture Versus Management Intensification

Two basically different approaches are used in investing in timber management: General management intensification and single-practice silviculture. Management intensification refers to the dedication of a timber production unit to continuing production and professional management. Not all acres in the unit will require treatment during the rotation, but those that do will receive prompt and effective attention. In a typical production unit 30 to 60 percent of the area may need some treatment following the regeneration harvest to insure the initial establishment of adequately stocked stands of trees. Perhaps a similar proportion of the acreage will require one additional treatment during the sapling stage to release overtopped or overcrowded crop trees. Smaller areas within the unit may require sanitation or improvement treatments. Investments in roads and in other physical facilities are made as required to allow boundary maintenance, inventory, protection, treatment and harvest. As stands begin to develop merchantable stumpage, commercial thinnings are made to remove merchantable material and maintain high growth rates. Final harvest is carried out in such a way that minimum disruption to the area occurs consistent with prompt regeneration.

General management intensification requires a continuing dedication to timber production and an ability to finance the substantial investments required. It is now applied to only a small proportion of the commercial timberland acreage in any ownership class. Intensive timber management is the only means of achieving substantial and lasting increases in timber production. And because of the reinforcing nature of the sequence of management actions applied to the unit it tends to be more effective economically than is single-practice silviculture.

Single-practice silvicultural programs involve treatments of individual stands or compartments rather than larger production units, and there is no commitment to further treatment. Necessarily single treatments often are less effective in generating growth response over the lifetime of a timber stand than is a program of continuing management. Any single intrusion, while it may have a substantial immediate effect, has less and less impact as time goes on. In a fair number of instances, for example in planting without subsequent release, treatment provides little or no additional yield beyond what would have been developed on the site in any case. Yet single-practice silviculture is reasonably productive in many circumstances.

Effectiveness is measured in this report by an internal rate of return. This is an average annual rate of value increase between the cost of treatment and the value of additional yield produced. Return rates sometimes are calculated taking into account an allowable cut effect. This is consistent with cashflow analysis of investments when current output is in part determined by investment level. Briefly, the effect of a silvicultural treatment is taken to be an increase in the allowable or even-flow harvest, that will be taken from the production unit, equal to the additional mean annual increment the treatment is expected to provide. It assumes that the additional volume and income will be taken in a series of small annual increases beginning at once and lasting until the treated stand is harvested.

The allowable cut effect is a valid approach to the analysis of silvicultural investments under some circumstances. It is used in this study in computing returns to management intensification but not to single-practice silviculture. Management intensification programs normally are undertaken on large public and corporate properties partly for the purpose of increasing current harvests. Here the intensification does result in an allowable cut effect.

## THE INVESTMENT OPPORTUNITIES

The return rates computed in this study are based on specific assumptions about the yield impact of silvicultural treatments, the cost, and the timing and value of the resulting yield additions. There is a very wide range of costs, yields, and prices that might materialize at different times and places. Those selected for analysis here are meant to represent typical or average outcomes for each treatment and type-site class.

Table 3 shows the estimated average yield response to the single-practice treatments of forestation and sapling stand improvement, and to management intensification. For forestation treatments it was assumed that 70 percent of the stands in the West and 80 percent of the stands in the East would be successfully established and would not be lost by subsequent catastrophe or land use change. And that forestation without subsequent treatment would bring 65 percent of the table 1 yield potential in the average case. Sapling stand improvement yield was estimated on the basis of 92 percent stand survival to harvest, and a response once again of 65 percent of table 1 yield potential for surviving stands. Yield additions for these single-practice silvicultural treatments apply only to the acres actually treated, whereas management intensification was judged to add 40 percent of table 1 yield potential to all the acres in the production unit. The rotation lengths assumed also are shown in table 3 and are shorter for productive sites where timber growth is most rapid.

Treatment costs are meant to represent the direct, marginal cost of undertaking treatment in

**TABLE 3.—Sawtimber Average Yield Response to Single-Practice Silviculture and to Management Intensification—by Timber Type and Site Class**

| Type and site | Assumed rotation length (years) | Sawtimber yield additions during the rotation[1] (thousands of board feet per acre) | | |
|---|---|---|---|---|
| | | Single-practice silviculture | | Management intensification |
| | | Forestation | Stand improvement | |
| Hemlock-spruce: | | | | |
| 120 or more | 50 | 27.3 | 25.1 | 24.0 |
| 85 to 120 | 60 | 19.1 | 18.8 | 16.8 |
| 50 to 85 | 70 | 15.9 | 16.4 | 14.0 |
| Douglas-fir and fir-spruce: | | | | |
| 120 or more | 50 | 20.5 | 18.8 | 18.0 |
| 85 to 120 | 60 | 16.4 | 16.1 | 14.4 |
| 50 to 85 | 70 | 12.7 | 13.2 | 11.2 |
| Ponderosa and lodgepole pines: | | | | |
| 120 or more | 50 | 17.1 | 15.7 | 15.0 |
| 85 to 120 | 60 | 15.0 | 14.8 | 13.2 |
| 50 to 85 | 70 | 11.1 | 11.5 | 9.8 |
| Southern, red and white pine: | | | | |
| 120 or more | 50 | 26.0 | 20.9 | 20.0 |
| 85 to 120 | 60 | 20.3 | 17.5 | 15.6 |
| 50 to 85 | 70 | 16.4 | 14.8 | 12.6 |

[1] See text (p. 8) for assumptions. Yield additions for single-practice silviculture apply only to the acres receiving treatment, while yield additions for management intensification are an average increase in production for all acres in the production unit whether treated or not. Thus, the gains on individual areas shown in cols. 2 and 3 can be augmented by an amount up to that shown in col. 5 by intensified management.

**TABLE 4.—Stumpage Price Assumptions**

[Dollars per thousand board feet]

| Type and site | Stumpage price[1] when softwood lumber price index (1967=100) is— | | | |
|---|---|---|---|---|
| | 115 | 144 | 180 | 225 |
| Hemlock-spruce: | | | | |
| 120 or more | $30 | $45 | $68 | $102 |
| 85 to 120 | 25 | 38 | 56 | 84 |
| 50 to 85 | 25 | 38 | 56 | 84 |
| Douglas-fir and fir-spruce: | | | | |
| 120 or more | 45 | 68 | 101 | 152 |
| 85 to 120 | 40 | 60 | 90 | 135 |
| 50 to 85 | 40 | 60 | 90 | 135 |
| Ponderosa and lodgepole pines: | | | | |
| 120 or more | 30 | 45 | 68 | 102 |
| 85 to 120 | 25 | 38 | 56 | 84 |
| 50 to 85 | 25 | 38 | 56 | 84 |
| Southern, red and white pines: | | | | |
| 120 or more | 45 | 68 | 101 | 152 |
| 85 to 120 | 40 | 60 | 90 | 135 |
| 50 to 85 | 40 | 60 | 90 | 135 |

[1] Approximate observed levels of stumpage price when the relative softwood lumber price index was 115, projected to other levels assuming a given percentage increase in lumber price index would generate twice that percentage increase in stumpage prices.

each case. It was assumed that the average forestation cost would be $50 per acre treated, the average sapling stand improvement cost would be $25 per acre treated, and the average cost of management intensification would be $1 per acre per year for all acres in the production unit. Table 4 shows the various stumpage price assumptions made.

The first column in table 4 shows approximate average stumpage prices as they existed when the softwood lumber price index was at the 105–115 level (1967=100). The difference in stumpage prices among types and sites reflecting differences in logging access, timber size, distance to markets, and timber quality. The other columns in table 4 are projections of stumpage prices when the softwood lumber price index is higher than the 115-point base. These projections assume that a given percentage increase in the softwood lumber index will cause twice that percentage of increase in stumpage prices. Actual stumpage prices differ a good deal within the type groups used here. These groupings are used to simplify analysis and the prices in table 4 represent a composite or average situation for each type group and were arrived at on a judgment basis.

Tables 5, 6, and 7 show the average or typical rates of return to forestation, sapling stand improvement, and management intensification for each type and site and for the four different lumber price index-stumpage price levels of table 4. The return rates for management intensification assume that there will be a sustained yield effect and are higher than they would be without this consideration. The return rates for single practice silviculture do not include a sustained yield effect.

Tables 5 through 7 give reasonable indications of economic effectiveness in regions and types where additional timber will find a ready market and in treatment locations already provided with access.

## Harvesting Assistance in Older Stands

Silvicultural treatments in softwood poletimber and sawtimber stands usually take the form of commercial harvest operations. Much of the science of forestry concentrates on designing commercial harvests in such a way that stand growth continues unabated. Left without professional guidance commercial loggers tend simply to take any material which is merchantable. This often results in a postharvest stand condition that is

**TABLE 5.—Rates of Return to Forestation Investments**

[In percent]

| Type and site | Rate of return[1] when the softwood lumber price index (1967=100) at harvest is— | | | |
|---|---|---|---|---|
| | 115 | 144 | 180 | 225 |
| Hemlock-spruce: | | | | |
| 120 or more | 5.8 | 6.6 | 7.5 | 8.4 |
| 85 to 120 | 3.8 | 4.6 | 5.2 | 5.6 |
| 50 to 85 | 3.0 | 3.6 | 4.2 | 4.8 |
| Douglas-fir and fir-spruce: | | | | |
| 120 or more | 6.0 | 6.9 | 7.7 | 8.6 |
| 85 to 120 | 4.4 | 5.1 | 5.8 | 6.5 |
| 50 to 85 | 3.4 | 4.0 | 4.6 | 5.2 |
| Ponderosa and lodgepole pines: | | | | |
| 120 or more | 4.8 | 5.6 | 6.5 | 7.4 |
| 85 to 120 | 3.4 | 4.1 | 4.8 | 5.5 |
| 50 to 85 | 2.5 | 3.1 | 3.7 | 4.3 |
| Southern, red and white pines: | | | | |
| 120 or more | 6.5 | 7.4 | 8.2 | 9.1 |
| 85 to 120 | 4.8 | 5.5 | 6.2 | 6.9 |
| 50 to 85 | 3.7 | 4.3 | 5.0 | 5.6 |

[1] Based on table 3 yield responses and rotation lengths, table 4 stumpage price assumptions, and an average treatment cost of $50 per acre.

**TABLE 6.—Rates of Return to Sapling Stand Improvement Investments**

[In percent]

| Type and site | Rate of return[1] when the softwood lumber price index (1967=100) at harvest is— | | | |
|---|---|---|---|---|
| | 115 | 144 | 180 | 225 |
| Hemlock-spruce: | | | | |
| 120 or more | 10.2 | 11.5 | 12.2 | 14.1 |
| 85 to 120 | 6.7 | 7.7 | 8.7 | 9.7 |
| 50 to 85 | 5.2 | 6.0 | 6.8 | 7.6 |
| Douglas-fir and fir-spruce: | | | | |
| 120 or more | 10.6 | 11.3 | 13.2 | 14.5 |
| 85 to 120 | 7.5 | 8.5 | 9.4 | 10.4 |
| 50 to 85 | 5.7 | 6.5 | 7.3 | 8.1 |
| Ponderosa and lodgepole pines: | | | | |
| 120 or more | 9.0 | 10.3 | 11.6 | 12.9 |
| 85 to 120 | 6.2 | 7.2 | 8.1 | 9.1 |
| 50 to 85 | 4.5 | 5.3 | 6.0 | 6.8 |
| Southern, red and white pines: | | | | |
| 120 or more | 11.6 | 12.9 | 14.2 | 15.6 |
| 85 to 120 | 7.7 | 8.7 | 9.7 | 10.6 |
| 50 to 85 | 6.1 | 6.9 | 7.7 | 8.5 |

[1] Based on table 3 yields, investment periods 15 years less than table 3 rotation lengths, table 4 stumpage price assumptions, and an average treatment cost of $25 per acre.

decidedly unproductive. Professional harvest design and control adds to harvest costs. In this sense it is an investment or cost which results in better postharvest growth, just as does silvicultural treatments in young stands. Professional timber har-

**TABLE 7.—Rates of Return to Management Intensification**

[In percent]

| ype and site | Rate of return[1] when the softwood lumber price index increases during the rotation from 115 to— | | | |
|---|---|---|---|---|
| | 115 | 144 | 180 | 225 |
| Hemlock-spruce: | | | | |
| 120 or more | 14.4 | 18.0 | 23.5 | 31.7 |
| 85 to 120 | 7.0 | 8.8 | 11.3 | 15.3 |
| 50 to 85 | 5.0 | 6.3 | 8.1 | 10.9 |
| Douglas-fir and fir-spruce: | | | | |
| 120 or more | 16.2 | 20.3 | 26.3 | 35.5 |
| 85 to 120 | 9.6 | 12.0 | 15.6 | 21.0 |
| 50 to 85 | 6.4 | 8.0 | 10.4 | 14.0 |
| Ponderosa and lodgepole pines: | | | | |
| 120 or more | 9.0 | 11.2 | 14.7 | 19.8 |
| 85 to 120 | 5.5 | 6.9 | 8.9 | 12.0 |
| 50 to 85 | 3.5 | 4.4 | 5.7 | 7.6 |
| Southern, red and white pine: | | | | |
| 120 or more | 18.0 | 22.6 | 29.2 | 39.4 |
| 85 to 120 | 10.4 | 13.0 | 16.9 | 22.7 |
| 50 to 85 | 7.2 | 9.0 | 11.7 | 15.7 |

[1] Calculated as a simple average between the rate earned during the first and last years of the rotation. Mean annual yield additions are based on table 3 volumes and rotation lengths. Return rates reflect an average intensification cost of $1 per acre per year. Stumpage values are from table 4.

vesting assistance, then, can be viewed as a silvicultural investment that may make an important contribution to greater productivity particularly on nonindustrial, private timberlands that are not under professional supervision.

Studies indicate that such assistance often costs between $10 and $20 per acre. It involves owner education, examination and marking of the sale area, and arranging the sale and supervision of harvesting in some cases. The benefits of this activity relate more to customary commercial harvesting practices in the area, and stand condition at harvest, than they do to timber type and site. Harvesting assistance is most effective where loggers are not used to working on professionally designed and controlled sales, and where stand condition at harvest is such that the timing, extent, or nature of harvest is critical to postharvest productivity. Unfortunately, there is no adequate information base upon which to develop a factual appraisal of the economic effectiveness of this activity at this time.

## SOFTWOOD SAWTIMBER ECONOMIC GROWTH POTENTIAL

Potential economic growth is the quantity of timber that could be profitably produced through intensive forest management. This depends on two factors: The minimum acceptable rate of return on timber growing investments and the price anticipated for stumpage in subsequent decades. Table 8 shows the economic growth potential for several minimum acceptable rates of return on investment and future price expectations. Table 8 is based on tables 2 and 7, and shows the annual yields available under intensified management from those timber types and sites where intensification yields at least the indicated percentage return. Table 8 assumes an annual yield of 100 fbm per acre from timberlands not under intensification.

Table 8 shows, for example, that if the minimum acceptable rate on timber investments is 8 percent and if the anticipated increase in softwood lumber prices were one-half of 1 percent per year, then growth of about 47 billion fbm per year is potentially available from softwood types and sites where intensification returns at least 8 percent, with an additional 15 billion fbm from other timberlands. The economic growth potential increases as lower minimum rates of return on investment are demanded, and as higher future prices are anticipated. Table 8 represents once again, a potential or maximum growth that could be made available under stated conditions.

**TABLE 8.—Softwood Sawtimber Supply Potential**

| Minimum acceptable return rate (percent) | Anticipated 2020 softwood lumber price index [1] | Area where intensification is profitable (millions of acres) | Average annual yields (billions of board feet) | |
|---|---|---|---|---|
| | | | From intensified areas | Total [2] |
| 12 | 115 | 24.5 | 24.4 | 42.7 |
| | 144 | 59.9 | 46.9 | 61.6 |
| | 180 | 62.7 | 49.0 | 63.5 |
| | 225 | 127.0 | 78.6 | 86.6 |
| 8 | 115 | 62.7 | 49.0 | 63.4 |
| | 144 | 120.3 | 74.9 | 83.6 |
| | 180 | 128.9 | 79.6 | 87.4 |
| | 225 | 128.9 | 79.6 | 87.4 |
| 4 | 115 | 128.9 | 79.6 | 87.4 |
| | 144 | 142.4 | 84.3 | 90.8 |
| | 180 | 142.4 | 84.3 | 90.8 |
| | 225 | 142.4 | 84.3 | 90.8 |

[1] These price levels represent average annual percentage increases of approximately 0.0, 0.5, 1.0, and 1.5, respectively.

[2] Total annual yield assumes 100 fbm per acre per year on the average from commercial forest land acreage not under intensive management, and total softwood acreage is assumed to remain at 207.2 million acres throughout the period.

# appendix E

**By Carl Newport**

# Factors Affecting Forest Industry Lands as a Timber Supply Source



The purpose of this report is to broadly identify the factors which control both the shortrun and longrun level of timber output from industrial holdings. This will provide a background for discussion of the problems of, and opportunities for, undertaking measures which might influence these levels of output favorably with respect to national lumber and plywood demands.

Two primary concerns of PAPTE are to reduce the fluctuations in lumber and plywood supply and prices and to generally improve the supply situation to alleviate general upward pressure on prices now and in the long run. Of the several broad categories of forest land owners the forest industry category normally can be expected to, and does, perform favorably with respect to both of these.

Forest industry owners, by definition, own forest land for the purpose of providing timber supply to their own conversion plants which produce lumber, plywood, and other products. There are many of these owners throughout the United States as well as in each major timber supply area, and in no case does one single industrial owner control supply or the lumber and plywood markets.

The competitive situation in the forest industry is such that responses are more or less automatic to shortrun changes in price as well as to the longrun trends. In my opinion, no major actions are needed to improve the existing shortrun response mechanisms. There are, however, some measures that might be taken to improve the climate for investing the large amounts of capital required to grow new timber crops. These will be discussed after a presentation of the conditions and characteristics of the forest industry and its lands.

## THE INDUSTRIAL FOREST RESOURCE

The industrial forest land owners are private companies that manufacture lumber, plywood, pulp, and paper, and other wood products. They own forest lands primarily for the production of timber crops to be used in their own conversion plants. They may also sell timber or logs to other companies and they often purchase additional timber supplies for their own mills from other private and public sources. These lands held by wood-using industries are largely in holdings of more than 50,000 acres.

Forest industries own 13.7 percent of the commercial forest land in the United States, including some of the most productive timber lands. The South has 52 percent of the total industrial forest holdings, while the Pacific coast has 18 percent. These industrial holdings make up about 18 percent of the total commercial forest land in each of these two sections of the Nation.

These industrial forests contain 16 percent of the Nation's sawtimber volume, and this is over 80 percent softwoods. About 53 percent of the total industry-owned sawtimber is in the Pacific coast section. The South, which has 52 percent of the industrial forest land, has only 30 percent of the sawtimber inventory. Obviously, the most important sections of the Nation with regard to forest industry timber supply are the South and the Pacific coast. Within the Pacific coast section the Douglas-fir region (western Washington, western Oregon, and northern California) has the greatest concentration of forest industry ownership. About 11 percent of the total forest industry land ownership in the United States is in the Douglas-fir region. However, in terms of sawtimber volume, the forest industry on the Pacific coast has over 40 percent of the total in the United States.

Virtually all of the forest industry owners in the Douglas-fir region, as well as on the Pacific coast, are corporations. In some of the small, closely held corporations the timberlands are owned and managed by a separate company whose principal officers are the same as those of the related wood processing company.

Industrial land ownership is relatively permanent. Changes in ownership are infrequent compared to the small individual type of private forest ownership. Ownership changes within the forest industry class are usually in the form of consolidation with some other industry-owned property or by small additions to industrial ownerships by purchase from other private owners. The tendency has been for these industrial forest land holdings to increase. However, recently this trend has slowed down or stopped.

The timber growing conditions on industrial forest lands are generally good. These owners have the technical resources to carry out intensive forest management. Although the timber removals may currently exceed net growth, particularly on Pacific coast holdings, regeneration of stands is relatively prompt, the protection is very good, and cultural measures such as thinning and fertilization are being carried out.

In the South, where the net growth of sawtimber on forest industry lands currently exceeds the removals because of the predominance of young stands just reaching maturity, the forest practices are particularly intensive. Based on the observed trends, the Forest Service projects that most of the industrial forest lands in the South will be under intensive management by 1980.

## TRENDS IN GROWTH AND HARVEST ON THE INDUSTRIAL LANDS

The total industrial harvest in the United States in 1970 was 30 percent higher than 1962, although it was only 4½ percent above 1952. Both the Pacific coast region and the South contributed to this increased level of harvest. The 1970 harvest from industrial lands in the important Douglas-fir region was up 34 percent above the 1962 level.

In terms of their share of the national softwood harvest the forest industry lands provided 34 percent of the total from 13.7 percent of the commercial forest land in the United States. This is also a relatively high level in relation to the industrial sawtimber inventory. However, nationwide, the rate of growth on industrial forest lands has also increased. The rate of growth of sawtimber on industry lands has increased about 13 percent nationwide since 1962. Much of this increase in the rate of growth occurred in certain areas of the South, while the important Douglas-fir region had a growth rate increase of 7 percent.

The stocking and age-class conditions of the industrial forest lands vary widely throughout the United States. The South is now growing its so-called "third forest," while the Pacific coast industrial lands are only beginning to provide sawtimber crops on "second" growth lands. In terms of sawtimber volume per acre in 1970, only 22 percent of the industrial lands in the South had volumes over 5,000 fbm per acre, while in the Pacific Northwest the industrial lands with 5,000 fbm per acre or more were 56 percent of their total lands.

Companies in the South are managing their forest lands intensively to build up their growing stock of the desirable softwoods. Western industrial lands have been characterized by an excess of overmature growing stock. This picture in the West is rapidly changing due to the continued high level of timber harvest on these industrial lands aimed at reducing the burden of large investments in mature timber.

## FUTURE OUTPUT FROM INDUSTRIAL LANDS

Broadly speaking, the shortrun future level of output of softwood sawtimber from industrial lands is controlled by the amount of remaining mature inventory on the western industrial lands and the rate of additions to sawtimber inventory on the southern industrial lands. Very little can be done now to influence these sawtimber inventory conditions. The harvest from these lands during the next 5 to 10 years will respond to the market demands for lumber and plywood within the limits of the softwood sawtimber inventory and of the industry capacity in each local area.

During the next few years on the Pacific coast the overmature inventory on numerous industrial land holdings will be exhausted. On those with larger inventories, the rate of liquidation is already scheduled to be rather rapid to recover the large investment, to maintain cash flow, and to generate funds for reinvestment in intensive reforestation and culture of young stands. Although sizable market responses are possible from these industrial lands, they are likely to be for very short durations of 1 year or less to avoid too rapid depletion that might jeopardize timber supply to their own manufacturing facilities 5 or 10 years later. The Pacific coast industrial lands should be at a low point in their sawtimber harvest in the second and third decades from now because their overmature inventory will be depleted and the young growth stands will not yet be sufficient to support the past rate of harvest. However, these young growth lands, especially in the Douglas-fir region, are growing rapidly and will do much to keep the level of output from falling as low as otherwise would be the case.

Southern industrial forests have been built up primarily to provide an assured supply for protection of large investments in pulp and paper plants. There is little inclination to use up this insurance now if there are alternative sources from other private lands.

Furthermore, to capture strong lumber and plywood market opportunities requires new manufacturing investments in the South as well as softwood sawtimber availability. In the South, the current excess of growth over harvest should make it possible for the industrial forest lands to increase their sawtimber harvest substantially in the period from 10 to 20 years from now, but not so much so if it is cut heavily in the next few years to satisfy shortrun demand.

On the Pacific coast the industrial owners are finding it necessary to rely much more heavily on public and other private lands for raw material for their conversion plants. In the South much reliance will have to be placed on the nonindustrial owners if the industry's level of output is to be sustained.

The output from both western and southern industrial lands in the second decade and beyond will be determined by the intensity of management which the industrial owners have recently been applying and that which they will apply during the first and subsequent decades from now. As will be shown later, their ability to justify the increased investments for management is limited by the low expected earning rates.

## FACTORS INFLUENCING PRODUCTION ON INDUSTRIAL LANDS

Industrial forest land owners are companies, primarily corporations, whose goals are profit-making. These companies play a dual role as processors of timber into wood products and as timber growers.

As timber growers, they manage their lands for the purpose of growing timber for a profit. Consequently, industrial forest owners are continually under pressure to produce high value wood at as low a cost as possible. However, timber growing, per se, is not a very profitable enterprise. Overall, it has been estimated that the annual income return on investment in all commercial timberland and timber in the United States is only 2½ to 3½ percent.[1] Industrial owners with their better than average forest land holdings could be expected to do better than this. In the Douglas-fir region an average forest property which is managed intensively and has the right amount of growing stock for sustained yield probably would have an annual net revenue from timber sales before taxes of not more than 5 percent return on the investments made at current land and timber prices. Even if such a property could be purchased at, say, one-third less than current market prices, the annual net income would represent only about 8 percent return on investment before taxes or less than 6 percent after capital gains income taxes.

[1] Yale University. "Financial Management of Large Forest Ownerships," Bulletin No. 66, New Haven, 1960.

Few industrial owners have enough timberlands to sustain timber supply to their own mills. But, if they did have, the investment required in land and timber would be $1\frac{1}{2}$ to 2 times the investment required in completely integrated lumber, pulp, and plywood plants. If, within a corporation the growing of timber is done at little or no profit on these large investments required, then raw material for their plants from this source would be relatively expensive. Sooner or later this situation would adversely affect the total profits, including manufacturing profits and discourage timber growing.

In timber growing, profit has been made in one or both of two ways: From holding mature timber and from growing new crops of timber. These processes of timber holding and growing depend primarily on large investments in land and standing timber, including that in the very young immature trees. The capacity of industry owners to make and hold these investments is a primary factor which will influence their timber output. Specifically, the profit in holding mature timber and/or in growing new crops of timber may come from two basic sources: Increases in the relative value per unit of volume and increases in merchantable volume due to physical growth.

Increases in physical volume due to growth occur slowly even under the best of circumstances and requires relatively long periods of time. Rapidly growing stands of trees just reaching maturity may show extremely high rates of growth in terms of the annual percent of additional merchantable volume relative to the existing merchantable volume. However, this occurs for relatively short periods of time in the life of a stand. Soon the trees all become of merchantable size and the annual additions in merchantable volume are then small relative to the total volume in the stand, probably about 1 to 3 percent of volume growth per year. Similarly, stands of trees whose life cycle is just beginning have no merchantable volume and 30 years or more may be required to bring them to a merchantable size, during which time there is no merchantable volume growth. Most forest owners aim to maintain a full range of the age-classes of timber extending from land which is just newly stocked up to the optimum size of merchantable timber needed in their particular manufacturing facilities. It is this need to have sufficient land area and the full range of timber ages that leads to the large investments required relative to other productive processes.

For sustained annual yield by a forest owner in the Douglas-fir region, for example, the owner will need approximately equal areas, say 1 acre, of each timber age class from seedlings to mature timber. To grow an acre of 70-year-old mature timber for harvest each year, 70 acres are required. A reasonable estimate of today's market value of such an investment would be at least $50,000 for the various ages of immature timber and the land required. Each year the thinnings and the final harvest from the 1 mature acre might yield this owner as much as $2,500 in gross stumpage return. This is 5 percent on the market value of the investment, certainly not very attractive within corporations whose other investment opportunities generally have much higher expected rates of return. This, of course, depicts the situation in which an investment would be made to obtain an instant managed forest on a regulated yield basis which is seldom the case.

Actually, forest owners have put together their investments in land and growing stock over periods of many years and during times at which the purchase cost may have been much less than the current market value. Nevertheless, when comparing other investment alternatives, companies are inclined to compare the rate of earning with the market value of the investment in the forest property if an outright sale were made. Even when earnings are compared to book value or original purchase costs, it is necessary to consider the interest cost on the investments made earlier and other carrying costs, all of which are high.

In the South where merchantable softwood sawtimber can be grown in as little as 30 years, some industrial owners have asembled large forest properties primarily from purchases of land and immature growing stock. Although modest profits are expected under these circumstances, a primary motive has been to provide an assured future supply to protect the long-term investments in pulp and paper plants. On the Pacific coast most industrial forest properties were put together by the purchase of land and mature timber available for immediate harvest. When these have been purchased at or near the market value in recent years, profits on holding this mature timber have often been limited to the shortrun increases in the relative value per unit of volume which occur while the mature timber is being liquidated.

Some western companies purchased timber and timberland many years ago at relatively low cost.

It is a common belief that timber bought many years ago at low prices have yielded high returns to the owners. This is not so when account is taken of the long period of time during which the original cost has been tied up without interest returns and when the accumulated annual costs of protection, taxes, administration, and the losses due to wind, fire, insects, and disease are considered.

Based on actual stumpage price trends in constant dollars, Douglas-fir standing timber purchased in 1950 and sold as stumpage in 1970 would have yielded a gross return on investment of only about 3 to 4 percent before taxes and without inflation. This gross return does not consider the annual costs of protection, taxes, and administration, nor the risks of loss. For ponderosa pine for a similar period the gross return would have been only about 1 percent.

Some profits on investments in holding mature timber for later harvest have been made as a result of improvements in utilization which have the effect of increasing the future harvest volume. Over periods of 5 to 10 years or longer the trends in utilization have been such that more products in terms of lumber, plywood, and pulp can be made from the same stand of trees by better utilization. Weyehaeuser Co. has estimated that in 1948 about 20 percent of the cubic volume harvested from 1 acre of their Douglas-fir lands was recovered in wood products, mostly lumber; in 1962, about 53 percent was made into all products and 47 percent was used for fuel or wasted; and in 1972, about 81 percent was utilized for products and only 19 percent used for fuel or wasted.

For the nonindustrial private owners profits from these utilization improvements are captured with no additional cost above the cost of holding the standing timber. For the forest industry these utilization improvements had to be brought about by investments in research, in development and in new harvesting equipment and manufacturing plants.

Today's concern for the environment is resulting in regulations and new laws which place restrictions on the harvesting of timber or on the cultural practices necessary for intensive management of private lands. These tend to reduce the profiitability of timber growing. Most of the industrial private owners are active in the management of their lands to provide for future crops and genuinely concerned for the protection of the soil and environment. However, recent overzealous attempts by the public to regulate forestry practices threaten to impose constraints beyond those needed to assure rapid growth of new timber crops.

Generally the industrial owners are deeply involved in the efforts to develop sound forest practice rules which are both practical and effective at the State and local level. Local rules are necessary because of the wide variation in the forest conditions and the practices required to achieve these conditions. Forest practice regulations, the primary purpose of which is to improve the appearance of the forests, are generally going to result in an increase in the cost of growing timber and thereby reduce its profitability. On the other hand, improved forestry practices, more widely applied on all private lands, can make timber growing somewhat more profitable in the long run.

## PROBLEMS AND OPPORTUNITIES

As has been pointed out earlier, the average level of output of timber from the industrial lands during the next decade is primarily a function of the availability of existing merchantable timber. However, the annual or shorter period fluctuations in the rate at which this is harvested will be responsive to the strengths and weaknesses of the markets for those wood products which can be made from this existing timber inventory. The highly competitive profit-maximizing characteristics of the industrial forest owners will insure prompt response to the lumber and plywood market demands within the limits of the sawtimber inventory and of the manufacturing capacity of these industry owners.

The extent to which industrial forest output fluctuates to these shorter run demands will depend also on the availability and cost of timber from other sources. Public timber sale policy can have a particular effect in the Pacific coast area where public timber is a major source of supply. The interrelationship between public supply in the West, the western industrial forest output in the short run, and the South's industrial forest output in the longer run is an intricate and important one. Generally speaking, it is particularly important that the public timber supply in the West be maintained or increased in the next decade or so in order that the western timber industry can continue to produce its major share of the Nation's lumber and plywood demands, while the southern forests are building softwood growing stocks which will become increasingly important in the second decade and beyond.

Timber is a bulky product with high transportation costs. Broad regional and national analyses of shortrun supply-and-demand problems must recognize the inability of timber output increases in one locality to replace decreases in another area which is beyond economical hauling distance. For instance, additional output (in the short run) from industrial or public lands in the Puget Sound area of Washington cannot be used to supply lumber and plywood mills in southwest Oregon where public timber supply may be fixed or decreasing. Likewise, industrial owners are not likely to supply timber of the kind which they can utilize to other manufacturers in their area, but will save it for their own use later. Both of these situations tend to limit the extent to which industrial lands will respond with changes in timber output when lumber and plywood demands change.

With this background of the situation on the industrial forest lands certain problems and opportunities can be discussed for the purpose of identifying some conditions which are important to the maintenance of a good climate for timber growing on the important industrial forest lands throughout the United States.

### Land Diversions to Nontimber Producing Uses

Total commercial forest land in the United States has been declining since 1962. This has been primarily due to the pressure from recreational uses in the West and to the demand for agricultural land and to other encroachments in the South.

During this same period industrial forest lands have been increasing through acquisition. However, there are signs that the rate of increase is slowing in the face of the demands for land for other uses.

Land diversions to other uses threatens to make serious inroads on the land available for intensive management by the industrial owners. Some of these diversions are to higher uses while the land remains in industrial ownership. Other diversions occur away from forest use by changing from industrial ownership to other ownership. Regardless of their nature, these diversions have the effect of reducing the forest land base and/or increasing land holding costs. While these other needs for land are important, nevertheless, some diversions are not in the best interests of the Nation. Some of these are due to shortsightedness, such as the failure to consider alternatives that do not divert highly productive forest lands from the timber growing purpose of the industrial owners. In many instances, better land use planning at State and local levels would help to avoid needless or shortsighted decisions to divert forest land to other uses.

### Property Taxes

Anything that increases the costs of holding land and growing stock will reduce the already low earning capacity of forest land. Increases in the property tax does that. County and local government expenses have been increasing steadily and property is increasingly burdened with taxes. To the extent that the increasing burden falls on all property owners with some equity and some reasonable relationship to benefits received, the property tax problem is one of limiting the rate of increase in local and State government expenditures. However, property tax burdens tend to fall inequitably on property owners, particularly in relation to the timing and amount of their income-earning ability. Property taxes have been particularly burdensome to private forest owners, primarily due to the high investment relative to income and the long holding periods involved for tree growth.

The property tax is an ad valorem tax. Forest land and young submerchantable trees have value because they will eventually produce timber of a merchantable size which can be utilized. Consequently, the value of these for timber growing purposes is based on the prospective future income from the sale or use of merchantable timber. Timber of merchantable size may have an immediate market value because it might be cut and sold right now. However, in most areas there may be more merchantable timber than the market can absorb at one time. Furthermore, some merchantable timber is needed for next year's harvest and must be held while the young trees become merchantable. Therefore, most stands of merchantable timber must be cut gradually over a period of years.

The deferred nature of incomes from forest property has been taken into account in many States in the levying of the property tax. But, the continuing need for more local revenue has increased the pressure for establishing valuations as high as possible on all types of property. Because



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of the deferred nature of the incomes for forest property, valuation is difficult and the quality of the job being done varies greatly from place to place.

In numerous States the property tax is becoming an even more serious burden on forest property because extensive areas of merchantable timber are being assessed at full market value; and forest land and young trees are being assessed as if they were high valued recreational and subdivision properties. With these kinds of high values and today's millage rates the property tax on forest land and timber can become confiscatory.

The burden of the property tax on the forest owner is difficult to measure. It differs from one tax district to another and from one condition of forest property to another. For industrial owners with widespread holdings the high may tend to average with the low so that the overall burden, under a forest property tax law which recognizes the deferred forest income situation, may not be excessive. In other cases, industrial owners may have most of their holdings in a local area where changes in valuation and/or millage rates can seriously increase the burden and thereby decrease their ability to gain a reasonable profit from timber growing.

Industrial owners are especially vulnerable to the local property tax because local voters seldom represent the interest of the corporate-type industrial owners. Local governments tend to levy, and voters tend to permit, tax increases that will fall on others, particularly if the others are corporations. Given the same forest conditions and the same tax districts, corporate industrial owners are treated the same as other private forest owners. However, if there are few other forest owners in the district, there may be a tendency to shift taxes to industrial forest properties.

Frequently, the property tax burden is measured in terms of its effect on the rates of return on investments in the forest land and timber. Numerous studies of the property tax burden have been made throughout the United States. Several of these studies have indicated that the rates of return range from one-half of 1 percent to 2 percent lower with the ad valorem tax than with no tax. Such reductions in rate of return from growing timber tend to reduce the value of forest land thus shifting it to other uses. It also tends to lead the owners to choose shorter rotations than would otherwise be the case. Both of these tendencies will reduce the total output of wood from private lands.

The property tax particularly discourages the holding of mature timber. This may affect the nonindustrial private forest land owner more than the industrial owner, because the industrial owner often feels compelled to hold at least some of his timber to fill the more uncertain future needs for raw material in his manufacturing plant.

In several States yield taxes are being proposed and adopted to replace the property tax on timber. Yield taxes are a tax levy directly on the income produced from the forest property. A primary advantage of the yield tax is that the tax payment occurs at the same time as income, while the property tax is an annual tax even on properties in which the income mav occur only at wide intervals of time.

High levels of either the property tax, or its substitute the yield tax, can discourage the holding of land and timber. In the long run such discouragement will reduce timber output. In the short run, the property tax, but not the yield tax, may cause continued timber cutting even when timber markets are weak, thus contributing to fluctuating prices for timber.

There is need to encourage the replacement of the property tax with the yield tax on forest properties and to keep these taxes reasonable relative to the income-earning ability of private forest properties. It must be recognized that timber growing is basically a slow process requiring relatively large areas of land and large numbers of immature trees. Increases in the forest owner's costs for taxes will not make the timber grow faster. Such increases will only tend to reduce the intensity of management which the owner can afford and, in turn, will reduce his total yield.

### Income Taxes

In growing timber for a profit one of the more important factors is the income tax benefit of the capital gains treatment on timber profits. The original purpose of this tax system was to encourage owners of large blocks of mature timber to hold onto it rather than liquidating it as quickly as possible and to encourage people to invest in growing timber as a crop. It gave recognition to the fact that timber production requires a very large capital investment in growing stock whose rate of growth is determined by biological limits that are only partly within the owner's control.

Under this law an increase in the value of timber which results from a rise in stumpage prices or from growth in volume is considered a capital gain. When a forest property is purchased, the value of land and the value of the timber must be kept in separate accounts. Any other expenses that occur during the holding period and which must be capitalized, such as the costs of regeneration, are added to the timber account. When the owner sells some of his timber, the differences between the original cost—depletion cost—plus capitalized costs and the net price he receives for the timber sold is his capital gain for tax purposes. The land account reflects the book value of the land and cannot be recovered—depleted—until the land is sold.

The effect of this law is to tax income received from holding and growing timber at a substantially lower rate than ordinary income. A typical industrial forest property in the Douglas-fir region which is earning at a rate of 6 percent on current market value on an after-capital-gains-tax basis would be earning 4 percent or less if the ordinary corporate tax rate were applied to the income.

To obtain capital gains tax benefits requires that there be capital gains income which, in turn, requires that there be an income attributable to the sale price of the asset being higher than the cost of that asset. As mentioned earlier, this can result from a rise in stumpage prices or growth in volume. But one must remember that these changes do not always take place. Recent experience has conditioned us to believe that stumpage is always increasing. In the short run, stumpage has gone down as well as up. Capital losses can occur as well as capital gains. A loss is a loss no matter how it it is treated from the tax standpoint, and losses do occur in the business of growing timber, both from price declines and from volume losses.

Prospective long-term capital gains from holding standing timber must compete with short-term ordinary income-producing assets for investment funds. The interest cost of money is high, whether it is equity capital or borrowed funds, when long-term investments are required such as timber holding to realize volume growth or upward price trends. Volume growth itself is slow in relation to the timber volume one must hold on which to accumulate merchantable growth. Over the long-term stumpage prices have trended upward, but only about 1½ to 3 percent more than the rate of inflation. Such slow increases in value can easily be reversed by temporary low prices when the owner must sell or by losses in volume due to fire, wind, insects, or disease.

Another, less often mentioned, way in which capital gains occur in timber is for the purchaser to strike a good bargain by buying standing timber at much less than its fair market value from an uninformed owner and selling it shortly after the end of the required holding period. Based on evidence of this kind of capital gains some observers have concluded that capital gains treatment of timber is not necessary nor desirable. Unfortunately, eliminating this kind of gain from capital gains treatment requires either elimination of all timber capital gains from timber-growing efforts based on full-value, long-term investments or a careful rewriting of the law. But, it is these latter types of risky long-term investments that deserve capital gains treatment so that a favorable climate for encouraging investments in timber growing can be maintained.

If the Nation has the objective of growing more timber for its future needs, one good way is to maintain and enhance the profit outlook in an otherwise low earning rate venture for all private owners, including industrial forest owners. Capital gains treatment of income from forest properties is of considerable help in improving that profit outlook.

### Sources of Forestry Investment Funds

Industrial forest ownership gained 13 percent in area from 1952 to 1970. Much of this increase was financed by borrowing from large lending institutions using the merchantable timber on the purchased property as collateral. General requirements of the lenders were that the liquidation value of the merchantable timber over a short period be sufficient to recover most of the capital investment; i.e., pay off the loan. The ability of corporate industrial owners to purchase rather large holdings at wholesale or discounted values served to make these investments attractive to lenders.

Although large investments still reside in merchantable standing timber on industrial forest holdings, most of the new and continuing unrecovered investments are in land and young growing stock and in capitalized expenditures for intensive cultural measures to speed timber growth. The relatively low earning rates in these latter investments (limited by biological growth rates and slow relative increases in unit value) do not attract investment capital as readily as the short-term earning prospects from holding merchantable or almost merchantable timber purchased at bargain prices. Nor do these long-term investments attract capital as readily as prospective earnings in many nontimber investments, even where capital gains are not a factor.

Corporate industrial forest owners do have the ability to raise capital, often from retained earnings within the company. Nevertheless, the earnings outlook for reinvestment of these funds must be good relative to other opportunities if this capital is to be allocated to growing new timber crops. Often industrial foresters may be inclined to think that funds retained from income earned from liquidating merchantable timber should be automatically reinvested to grow more timber. This is not, and should not be, automatic. Investments to grow more timber must compete with other capital requirements or opportunities within and outside the company. Industrial owners do find such reinvestments in timber growing more easily justified than nonindustrial owners because of the reliance of their own manufacturing plants on the raw material and because of corporate industry's longer term outlook. Nevertheless, the Nation should not rely on this and therefore expect continued industrial reinvestments in intensive timber growing regardless of the profit outlook.

A few fortunate industrial forest owners are liquidating large mature timber inventories to sustain earnings and to generate income for reinvestment in high-yield forestry programs. Often these forestry investments appear attractive as a separate enterprise not subsidized by manufacturing or other profits. But in some cases, these forestry investments are made on the basis of some kind of faith in the future in spite of the unattractive outlook for low returns on the dollar investments.

Two different long-term investments with the same projected rates of return may differ in that one promises steady annual returns, while the other may have more widely fluctuating net annual incomes. Given these to choose between, investors will generally select the steadier net income prospect. The historical record reveals that timber and wood products markets fluctuate widely over relatively short periods. This tends to discourage investments in timber growing, even where the average earning rate might be otherwise acceptable. Although industrial forest owners have the ability to respond rapidly to market changes and thus tend to dampen the fluctuations, as noted earlier in this report, the wide amplitude of fluctuations in residential construction and housing starts has been too much to cope with in the past. Greater stability in these sectors of the wood products markets would help to encourage investments in timber growing.

## CONCLUSIONS AND RECOMMENDATIONS FOR FEDERAL ACTION

The basic ingredient for continued high level of timber output from industrial forest lands is a favorable outlook for return on the large investments required for timber growing. Prof. Albert Worrell of Yale University has stated: [2]

> The necessary condition of intensive management of the wood-using industry lands appears to be a favorable economic environment and freedom from discouraging public pressures and actions. The problem is not so much one of encouraging them as it is of not discouraging them.

The Federal Government by action or policy declaration could assist greatly in not discouraging industrial forest owners. One way would be to retain the timber capital gains provisions of the Federal income tax laws. These provisions have helped these companies justify more investments in timberland and timber growing than otherwise would be the case.

The Federal Government could assist the State and local governments in their search for sources of funds in order to relieve pressure on the property tax. Concurrently, they could encourage the substitution of a yield-type tax for the property tax on timber. The total yield tax revenue can equal or exceed that of the property tax with much less impact on timber growing and timber output.

In the West, the Federal Government could give much greater consideration to maintaining or increasing the level of timber output from public lands during the next two decades in order to sustain the dependent wood-using industry, while private timberlands are developing growing stock sufficient to sustain greater output in the more distant future. This would also help the industry

[2] Worrell, Albert C., "Forest Resources, Private Enterprise, and the Future—an economic study of the Douglas-fir region." Industrial Forestry Association, Portland, Oreg. 1967, 70 pp.

in the South by holding down the pressure of timber demand which may otherwise force premature cutting of rapidly growing young stands, particularly of softwoods. The existence of available wood conversion capacity on the Pacific coast near the large public forest inventories also lends efficiency and practicality to this proposed action.

The Federal Government could also take action to further assist nonindustrial private forest owners to increase their intensity of management. These owners are an especially important source of softwood sawtimber in the South and during the period 10 to 20 years from now.

The Federal Government could encourage local land use planning to slow down or halt those unnecessary diversions of forest land to other uses. Greater consideration to public land diversions and to diversions of private forest land to Federal uses would help industrial forests to provide greater timber output.

Lastly, any action by the Federal Government to stabilize the important residential construction market would help industrial owners and other private owners to justify timber growing investments that already have discouragingly low returns and high risks.

By Carl Newport

# The Availability of Timber Resources From the National Forests and Other Federal Lands



## BACKGROUND

A key to the Nation's timber supply problem of this and the next few decades is the rate of timber harvest on the national forests and other Federal lands. Over 52 percent of the Nation's inventory of softwood sawtimber is on the national forest lands. Existing sawtimber inventory is, of course, the only source of timber supply currently and in the shortrun future. The rate at which this inventory is harvested is controlled by laws, regulations, policies, procedures, and administrative decisions of the Forest Service and other Federal agencies. Because the national forests are by far the most important Federal lands, attention will be directed to factors controlling the rate of harvest on those lands with references, where appropriate, to other Federal forest lands and their administration.

### Laws

The basic law for national forest lands is the Organic Administration Act of 1897. This act established the national forest system and provided the authority for the Secretary of Agriculture to sell timber from these lands. In part, the act says that

No national forest shall be established except to improve and protect the forest within the boundaries, or for the purpose of securing favorable conditions of water flows, and to furnish a continous supply of timber for the use and necessities of citizens of the United States.

In addition, the Multiple Use-Sustained Yield Act of 1960 directed that the national forests be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. It directed that these lands are to be developed and administered for multiple use and sustained-yield of the several products and services.

Multiple use was defined to mean

the management of all the various renewable surface resources of the national forests so that they are utilized in the combination that will best meet the needs of the American people; making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions; that some land will be used for less than all of the resources, and harmonious and coordinated management of the various resources, each with the other, without impairment of the productivity of the land, with consideration being given to the relative values of the various resources, and not necessarily the combination of uses that will give the greatest dollar return or the greatest unit output.

Sustained yield of the several products and services was defined as

the achievement and maintenance in perpetuity of a high level annual or regular periodic output of the various renewable resources of the national forests without impairment of the productivity of the land.

## Policies and Regulations

Within the framework of these and other laws the Forest Service has established policies for determining the allowable timber harvest or allowable cut on each national forest. The allowable cut for each national forest is determined and documented in a 10-year timber management plan. The Secretary of Agriculture has instructed through regulations (Reg. 36 CFR 221.3) that these plans will:

1. Be designed to aid in providing a continuous supply of National Forest timber for the use and necessities of the citizens of the United States.
2. Be based on the principle of sustained-yield with due consideration to the condition of the area and timber stands covered by the plan.
3. Provide, so far as feasible, an even flow of National Forest timber in order to facilitate the stabilization of communities and of opportunities for employment.
4. Provide for coordination of timber production and harvesting with other uses of National Forest land in accordance with the principles of multiple use management.
5. Establish the allowable cutting rate which is the maximum amount of timber which may be cut from the National Forest lands within the unit by years or other periods.

## Procedures

The Forest Service has recently issued revised instructions for calculating and reporting the allowable cut in its Forest Service manual, "Chapter 2410: Timber Management Plans," May 1972. The major revision was incorporation of the following procedures and/or format of the management plan report.

1. Distinction is to be made between potential yield and programed allowable cut.
2. Calculation and control of the cut will be by type of cutting and by categories of commercial forest land.
3. Provision is made for determining and reporting the opportunities for increasing the per-acre yields and the allowable cut through additional funding of certain cultural activities. As a minimum the Manual (2415.43, item 1) requires that the extra yields be shown for reforestation of the backlog of nonstocked areas and for timber stand improvement opportunities that cannot be covered by K–V funds.

Another revision provides for using the national forest as the planning unit rather than working circle. Previously, some national forests had as many as four or more working circles with independent plans and allowable cuts for each. Although the national forest is the planning unit, most regions follow a pattern of having the regional office staff make the calculations while the forest staff advises on various aspects and writes the plan report.

Selection of the specific method for computing the national forest allowable cut has been left to the local forest or region. However, the Manual does specify that

these calculations should employ a form of tabular scheduling through time by stand condition, size or age and that the use of allowable cut formulas should be avoided except as rough checks on tabular methods.

In a later section below the results of actual application of the new manual instructions will be examined and methods of calculation will be discussed.

Another smaller planning unit of area is also being used on the national forests. These are the units of area used by the so-called multidisciplinary planning teams.

Each forest is subdivided into as many as 20 or more of these small planning units, each composed of one or more drainage basins. The objective is to make intensive land use plans for each of these over the next 10 years. Priorities for this planning are established so that areas where critical management decisions are needed will be planned first. This is a relatively new planning function in the Forest Service and, as yet, the procedures for coordinating decisions made on these small unit plans with the prior or pending decisions regarding plans for the entire forest have not been spelled out.

### Relationship of Allowable Cut to Timber Supply

The annual allowable cut on each national forest controls the annual timber sale program. This is done through the 5-year timber sale action plan which translates the broad management direction and the annual allowable cut from the 10-year management plan into a timber sales program for the next 5 fiscal years. On those national forests where demand is sufficient and timber sale funds are adequate, the annual sales program generally equals the allowable annual cut. This sale program may fluctuate somewhat from year to year for such reasons as the need to speed up salvage sales, to get more timber under contract, etc. The Forest Service takes from 1 to 3 years of advance work for the preparation and offering of each timber sale. In some years they have fallen behind and during others have caught up.

The forests have generally had from one to three times the allowable cut under contract at any one time. Although all of this timber could theoretically be cut in 1 year or less at the discretion of the purchasers, the facts are that it cannot be cut that rapidly due to lack of full development of access on the most recent sales, contractual rate-of-cutting limitations, length of operating season, and insufficient equipment and manpower at the disposal of each purchaser.

Annual cutting in excess of the allowable cut is possible and does occur. However, this is partly controlled through the sale program in subsequent years and more fully controlled at the 10-year intervals, when any existing overcuts or undercuts are wiped out at the time a new allowable cut is determined and approved.

For more on this subject see Mason, Bruce, and Girard report to PAPTE entitled "Timber Sales Policies and Procedures on National Forests in Relation to Short Run Timber Supply."

### Relationship of Timber Supply to National Wood Products Supply

To be effective additions to the current and short-run future output of lumber, plywood, and other wood products for the Nation, the national forest programed allowable harvests must be:

1. In timber size, quality and species that can be economically converted to the products desired by the consumers;
2. In amounts and flows which justify continued and long-term capital expenditures for conversion facilities suited to those species, sizes, and qualities;
3. In locations where the timber can be economically transported from the forest to existing conversion facilities.

Therefore, in the short run, large increases in allowable cut of low-grade, small-size, and less common species such as from salvage and thinnings and from less developed national forest areas will have little positive effect on lumber and plywood supply.

In the longer run of the late 1970's and beyond, this kind of material and these less-developed national forests can contribute to lumber, plywood and other wood product needs. However, this result will require some assurance from the Forest Service that such timber supply will be offered in sufficient quantities and for long enough to justify conversion plant and equipment investments. This is especially required in locations where supplemental or basic private or other public sources of timber are not available. In well-developed regions such as western Oregon, the existing ability of the wood conversion plants to use low grade and small logs must be attributed to the availability of an assured supply of this material from private sources other than the national forests during the past few years.

## CURRENT STATUS OF ALLOWABLE CUTS

Softwood sawtimber of sufficient size to be made into lumber and plywood in existing mills is in most critical supply. Over 95 percent of the national forest softwood harvest comes from the western national forests. Therefore, attention is directed toward the national forests in the seven western regions, including Alaska.[1]

Table 1 in appendix I is the latest published summary of timber accomplishment and allowable cut on the national forests for fiscal year 1971. The situation in summary for fiscal year 1971 was:

| | Millions of board feet of sawtimber (Scribner) | |
|---|---|---|
| | All regions | 7 western regions |
| Total allowable cut | 11, 544. 2 | 10, 642. 4 |
| Actual harvest | 9, 372. 2 | 8, 658. 0 |
| Volume sold | 9, 673. 0 | 8, 949. 4 |

Each national forest is directed to revise its timber management plan every 10 years, based on a new timber inventory. Therefore, at any one time, some plans are as much as 10 years old while others are new. Although a few individual forests have had large relative increases in allowable cuts the total for the western regions has increased slowly in recent years as shown in the following:

| Fiscal year | llowable cut (millions of board feet of sawtimber (Scribner)) | |
|---|---|---|
| | All regions | 7 western regions |
| 1966 | 11, 093. 9 | 10, 246. 5 |
| 1967 | 11, 292. 4 | 10, 410. 9 |
| 1968 | 11, 330. 7 | 10, 464. 1 |
| 1969 | 11, 429. 2 | 10, 553. 8 |
| 1970 | 11, 532. 4 | 10, 641. 8 |
| 1971 | 11, 544. 2 | 10, 642. 4 |

The increase from 1966 to 1971 was 4 percent in all regions and on western national forests, or about three-quarters of 1 percent per year. On those forests with allowable cuts over 100 million fbm and which had revised allowable cuts during this period, the changes ranged from down 22 percent to up 43 percent and averaged about an 8 percent increase.

The principal reasons for the changes, whether up or down, were changes in the commercial forest land base and/or the timber inventory, changes in assumptions about rotation and utilization limits and the inclusion of thinnings and mortality in the allowable cut. Little, if any, change was attributed explicitly to intensified cultural practices in the revised management plans during 1966–70. One notable exception was the Flathead National Forest in Montana. This plan was revised in 1969. The recalculation of the allowable cut included the presentation of a wide range of possible levels of cut, each dependent upon the management program level assumed for it. A level of cut was chosen to match the expected level of funding on the Flathead Forest during the 10-year period of the plan. However, the plan stated that,

> Preparation and implementation of this plan is unique in Region One. It provides for an adjustable allowable cut. The allowable cut can be increased or decreased as the level of management is increased or decreased. The plan provides for adjustment of the allowable cut at specific times within the plan period.

Subsequently, other plans have been based on this concept and the May 1972, revised Forest Service manual instructions provided for this procedure on all national forests. This is discussed in greater detail in a later section of this report.

As noted above, a significant portion of the recent increases shown in revised national forest allowable cuts was due to the inclusion of commercial thinnings and mortality salvage. For the most part these have always been available timber supply but were not included nor regulated as part of the allowable cut. This portion of the increase in allowable cut and actual harvest is a result of increased timber demand and improved harvesting methods, and is not the result of more intensive cultural practices. However, sales of these kind do require increased agency funding for sales preparation and administration. It must also be realized that large increases in allowable cut of small trees and salvage cannot become a part of short-run timber supply unless local industry has the type of facilities and capacity to use this extra raw material.

Because the level of the allowable cut does control the timber supply from national forests, the schedule for revision of allowable cuts is important

[1] Alaska is included because of the magnitude of the harvest there and because of its relationship to imports and exports. The allowable cut is 824 million fbm and the actual cut has been about 480 million fbm recently. About three-quarters of the Alaska actual timber harvest is currently used for pulp, while one-quarter is exported to Japan as cants or logs and a small amount is used locally for lumber. However, considerably more than one-quarter of the timber harvest is suitable for lumber manufacture, particularly now that western hemlock lumber finds good markets in the lower 48 States.

with respect to shortrun timber supply. Table 2 in appendix I lists the national forests by region and shows the approval date and amount of the currently effective allowable cut and the planned date of revision. It is highly significant that more than half of the western national forests will have revised management plans and allowable cuts as of July 1, 1973. Many of these revisions will be made without new timber inventories. However, they will incorporate changes resulting from recent classification of the commercial forest land for multiple use. Thus, the effects of wilderness study areas, roadless areas, landscape management areas, critical soils, steep slopes, and other special considerations will be reflected in the revised allowable cuts.

The National Environmental Policy Act of 1969 and the implementing Executive orders and agency directives require that environmental impact statements be prepared and be given public review for any proposed revisions in timber management plans and allowable cuts. Apparently this will be done for all the forests scheduled for new or revised plans listed in table 2. One national forest, the Six Rivers in California, has gone through this procedure and has a new plan approved in November 1971. However, this administrative decision is being challenged in an appeal by the Sierra Club to the Board of Forest Appeals. The appellant contends, among other things, that the planned harvesting is three times greater than can be sustained. Indications are that, failing in this appeal, the Sierra Club will go to the courts.

This procedure of formal public review of proposals for revisions of allowable cuts will make it difficult for the Forest Service to meet its deadlines shown in table 2. It will be especially difficult to justify increases in allowable cuts because the general public has a strong tendency to equate decreases in allowable cut with improvements in the environment and vice versa.

Some examples of pending proposed revisions of allowable cuts will serve to indicate the nature and magnitude of the changes to be expected. The Flathead National Forest has released a proposed revision in allowable cut for public discussion. The revision was made using the same timber inventory data as the 1969 plan but reflects

changes in areas where timber can be harvested and new legislation, such as the Environmental Policy Act of 1970, as well as our intention to give full consideration to all resources and values.

The 1969 plan established an allowable cut of 194.6 million fbm per year. In 1970 this was reduced 13 million fbm for the moratorium of cutting in the Middle Fork of the Flathead River which was being studied for Wild River designation. Thus, the current allowable cut is 181.6 million fbm, including thinnings and mortality salvage. The proposed revised allowable cut is 159.8 million fbm or a reduction of 21.8 million (12 percent). However, 31.2 million fbm is scheduled from marginal areas which will require modified logging techniques such as skyline, balloon, or helicopter. Therefore, the proposed allowable cut with conventional logging techniques is 128.6 million fbm or a 29-percent reduction. This includes the expected yield from the currently controversial roadless areas of 5,000 acres or more. It also includes 7- to 9-inch-diameter logs which are not included in the current allowable cut.

The multidisciplinary planning procedure is also underway on the Flathead Forest concurrently with this proposed new timber management plan for the entire forest. Recently, a multidisciplinary plan for the Swan Lake unit on the Flathead was presented to the public for consideration prior to a decision about land use in that area. The plan proposed two alternatives; plans A and B. Among other things, these alternatives propose 22- and 55-percent reductions in allowable timber harvest from this portion of the forest relative to the current allowable harvest allocated to this area under the existing timber management plan. Thus, the situation is one in which a new overall plan for the entire Flathead Forest proposes a 29-percent reduction, while this Swan Lake unit of the forest may be reduced 22 or 55 percent and for different reasons based on different data. Proposed plans for other similar small units are being prepared by multidisciplinary planning teams. A recent study of the Flathead Forest was critical of this procedure and of other aspects of the proposed plan. A copy of that study's recommendations are in appendix III.

The Gallatin National Forest is proposing a reduction from the current allowable cut of 56 million fbm to 29.7 million. This is attributed to the same kinds of reasons as on the Flathead National Forest.

The Kaniksu National Forest is proposing a reduction from the current allowable cut of 153.1 million fbm down to 125 million fbm of programed allowable cut. This is partly the result of classifying 39 percent of the commercial forest land as marginal.

Indications are that other forests in Region 1 will have similar revisions and reductions proposed by July 1, 1973.

In Region 6 (Oregon and Washington) several new revisions are forthcoming. On the Rogue River National Forest the current allowable cut is 176.4 million fbm, not including thinning and mortality salvage. The pending proposed cut is 174.2 million fbm, of which 38.8 million are in thinnings and mortality salvage.

On the Umpqua National Forest in Region 6 the current annual allowable cut is 357 million fbm, not including thinnings and mortality salvage. The proposed new cut is 343.3 million fbm, of which 48.8 million fbm are thinnings and mortality salvage. A detailed review of this proposal was made by Mason, Bruce, and Girard and is reproduced in appendix IV with permission of the clients.

A preliminary plan for the Siskiyou National Forest in Oregon proposes a new allowable cut of 193.9 million fbm, of which 16.8 million fbm is thinning and salvage. The current allowable cut is 190.9 million fbm, not including thinnings and salvage.

In Region 3 (Arizona and New Mexico) the relatively small allowable cut on the Cibola National Forest is being revised. The current allowable cut is 17 million fbm per year and the proposed new cut is 7.4 million fbm. The actual average annual harvest for the past 10 years has been 7.1 million fbm. Therefore, this reduction is in potential supply, not actual supply.

Currently, at least eight Western national forests have preliminary new proposed programed allowable cuts under public consideration. Below is a tabular comparison of these.

| National forest | Millions of board feet, Scribner | | | Proposed new programed allowable cut (percent) | |
|---|---|---|---|---|---|
| | Current allowable cut Jan. 1, 1972 | 5-year average actual cut fiscal year 1966–70 | Volume | Change from previous allowable cut | Change from actual cut |
| Flathead | 194.6 | 150.0 | 128.6 | −34 | −14 |
| Gallatin | 52.0 | 33.5 | 29.7 | −43 | −12 |
| Kaniksu | 153.1 | 135.6 | 123.8 | −19 | −11 |
| Cibola | 17.0 | 9.2 | 7.4 | −56 | −20 |
| Rogue River | 176.4 | 180.9 | 174.2 | −1 | −4 |
| Siskiyou | 190.9 | 235.1 | 193.9 | +2 | −18 |
| Umpqua | 357.0 | 425.4 | 343.3 | −4 | −19 |
| Wallowa-Whitman | 167.7 | 208.0 | 186.0 | +11 | −11 |
| Total | 1,308.7 | 1,377.7 | 1,186.9 | −9 | −16 |

The proposed new programed allowable cuts on these eight forests are, on the average, 16 percent lower than the recent 5-year average harvest and 9 percent less than the current allowable cuts. While these are not purported to be a scientific sample, they do account for over 12 percent of the total allowable cut on western national forests.

One of the most significant facts about the above examples of pending revisions in allowable cuts is that the potential yield shown in each of these proposed plans is equal to the programed allowable cut for all the land classed as standard area. (See FSM 2412.15 in app. II.)

The following tabulation shows a summary of each proposal.

| National forest | Millions of board feet per year, Scribner | | | | | | |
|---|---|---|---|---|---|---|---|
| | Standard | | Special | | Marginal | | Maximum extra cut [1] |
| | Potential yield | Programed allowable cut | Potential yield | Programed allowable cut | Potential yield | Programed allowable cut | |
| Flathead | 128.6 | [2] 128.6 | | | 31.2 | 0 | 15.0 |
| Gallatin | 28.2 | 28.2 | 1.5 | 1.5 | 6.4 | 0 | 0 |
| Kaniksu | 123.8 | [2] 123.8 | | | 46.0 | 0 | 0 |
| Cibola | 5.6 | 5.6 | .4 | .1 | 1.7 | 1.7 | 0 |
| Rogue River | 139.3 | 139.3 | 42.7 | 34.9 | 4.8 | 0 | 6.0 |
| Siskiyou | 150.2 | 150.2 | 76.5 | 43.7 | 21.0 | 0 | 11.0 |
| Umpqua | 276.0 | 276.0 | 88.4 | 67.3 | 2.9 | 0 | 5.6 |
| Wallowa-Whitman | 137.0 | 137.0 | 20.0 | 16.0 | [2] 62.0 | [2] 49.0 | 10.0 |
| Total | 988.7 | 988.7 | 229.5 | 163.5 | 156.0 | 50.7 | 47.6 |

[1] These extra yields were shown in proposed plans as available if nonstocked backlog acres were stocked and if extra timber stand improvement were done where K-V was not available.
[2] Includes Special.

Only for special and marginal areas do the above example national forest plans show potential yields which are higher than the programed allowable cut. The major reason given for the programed allowable cut being lower than the potential yield on the marginal areas is the low probability that sales for harvest under the special constraints on these areas will be acceptable to prospective purchasers. Or, in other words, the specific effort necessary to raise the programed cut to the potential yield on the marginal areas must be made by the industry and little, if any, increased Federal funding is required, except for sale preparation and administration when and if industry is able to purchase and harvest these kinds of sales. Access roads has been cited by the Forest Service as the reason for the difference on marginal areas on only 1 of the 8 forests reviewed. The main reason has been the lack of economical logging systems for steep slopes and to keep logs off the ground during yarding. The Forest Service is expending funds in the FALCON research program to develop such methods. The manual (See FSM 2415.4—1 in appendix II) specifies that the marginal component of potential yield will be calculated to include potential yield opportunities that exist on "standard" areas and these are said to:

> include (1) poletimber thinning yields, (2) earned yield increases on standard areas resulting from activities on marginal areas, such as reforestation of nonstocked backlog areas not covered by K–V funds, and (3) earned yield increases on standard areas from activities, such as timber stand improvement that cannot be accomplished under the Knutson-Vandenburg (K–V) Act.

Elsewhere the manual states (see FSM 2415.43 in app. II) that these potential increased yields will be determined by calculating the potential yields as if the activity would be accomplished. It also states that these will be explained in footnotes to the potential yield and programed allowable harvest statements such that when accomplished in full or part the resulting increased yield will become part of the programed allowable cut and can be harvested from standard areas. The manual requires as a minimum that the potential yield be stated (under marginal category) for the extra yield expected from reforestation of the nonstocked backlog acres and for timber stand improvement opportunities not covered under the K–V act. (See FSM 2415.45—2 and 2415.46—2 in app. II)

Of eight proposed new plans currently available for review and whose current (programed) allowable cuts are 1,186.9 million fbm, about 47.6 million fbm are specified as being extra potential yields on marginal areas which could be had by reforesting nonstocked backlog areas and by timber stand improvement where K–V funds are not available. This is only 4 percent and falls far short of the 39-percent increase (7 billion fbm) possible according to the Forest Service if increased funding were available for more intensive practices. This is strong evidence that the actual planning and methods of cut calculation are not providing an adequate basis for the Forest Service to respond with increased harvest immediately if cultural funds were made available—even though their manuals do provide for such responses.

On the example forests reviewed the differences between potential yield and programed allowable cut on special areas are entirely due to special silvicultural practices, such as salvage only, no thinnings, partial cuts, and long rotations required to protect scenic, recreational, and streamside environments. These do not conform to the manual definitions of what constitutes valid reason for differences between potential and programed cut. As will be noted later, the manual defines the differences as being subject to elimination by removal of the barriers. The current plans under development do not indicate that any barriers could be removed to make it possible to raise the cut on these special areas which are managed for landscape and streamside protection. However, some forests may have special areas where timber harvest is temporarily delayed pending some administrative decision. Generally, these will not be influenced by funding of any sort but simply depend on the administrative decisions.

In all examples the potential yield was found to be equal to programed allowable cut for the standard areas which are the major portion of the total available commercial forest land. The new Forest Service manual defines "potential" yield as follows:

> The potential yield for the next 10 years is the maximum harvest that could be planned to achieve the optimum perpetual sustained-yield harvesting level attainable with intensive forestry on regulated areas considering the productivity of the land, conventional logging technology, standard cultural treatments, and inter-relationship with other resource uses and environment. As used here, conventional logging technology and *standard cultural treatments include all applicable developed and*

*proven systems for intensive management of the area whether or not they are currently economical or in general use in the area.* Excluded are the effects of intensive activities that, at this time, remain speculative or with unquantified benefit over a large portion of the country such as genetics, fertilization, and irrigation. (Italic provided for emphasis.)

The manual defines "programed allowable harvest" as follows:

The programed allowable harvest is that part of the potential yield that is scheduled for a specific year. It is based on current demand, funding, silvicultural practices, and multiple use considerations. Annually, a programed allowable harvest statement will be prepared and submitted to the Chief reflecting the expected level of financing and showing the scheduled mix of yield components. Where components of the programed allowable harvest are less than the potential yield, it will be a continuing objective to remove the barriers and work the programed allowable harvest up to the full potential yield.

The new manual instructions provide a very adequate procedure for reflecting the efforts of intensive management and improved technology on the first decade programed allowable cut. However, the plans thus far prepared under these new instructions fail to take full advantage of this opportunity to document the case for increased funding, especially on the standard area.

It would appear from current trends in actual national forest plans being proposed that lack of logging technology and the existence of multiple use and environmental constraints are the only factors that, if changed, would permit significant increases in the allowable cut during the coming decade. Likewise, it appears that increased funding for standard cultural treatments using developed and proven systems will not permit any significant increases in the allowable cut during the coming decade based on the management plans now being prepared.

Under such circumstances, from where and how are any needed increases in timber supply from the national forests to come? The alternatives implied in proposed national forest plans seem to be: (1) that the industry will have to develop suitable harvesting methods for the special and marginal areas[2] (this may require increasing log, lumber, and plywood prices), or (2) that the Forest Service's environmental and multiple-use constraints will have to be relaxed or violated, and/or (3) the standard areas will have to be overcut.

### Conclusion

The current trend in application of the Forest Service timber management planning guidelines on each national forest as reflected in plans now being prepared indicates that the Forest Service will be unable to respond with any significant increase in timber supply (allowable cut) from the national forests during the coming decade even if they were given increased funds for investment in more intensive management to increase timber growth as they requested in the House appropriations hearings for fiscal year 1971. This is true in spite of the fact that the new manual instructions provide for documenting such response whenever possible. Changes are necessary in the current methods of calculating allowable cuts if a sound framework is to be established for relating the level of intensive management (funding) and the level of the allowable cut on national forests.

## CURRENT METHODS FOR DETERMINING ALLOWABLE CUT

### Even Flow

Until recently the Forest Service was using methods of calculating allowable cut which, when applied to most western national forests, resulted in increases in the current allowable cut whenever a cultural practice was planned that increased future timber growth and yield. The specific elements of the procedures which caused this were called even flow and volume regulation. A decade ago, when the so-called Duerr report was in controversy, even flow was not a stated policy but nevertheless was followed in the strictest sense of the word in allowable cut calculations. Partly due to the controversy over the Duerr concept of more rapid and early liquidation of overmature timber, the Secretary of Agriculture issued the revised regulations quoted earlier in this report including even flow as a stated policy. As will be shown later in this report, this policy is not now being applied uniformly nor in an explicitly controlling manner.

A more recent and sophisticated explanation of the even flow and volume regulation phenomena is referred to as the "allowable cut effect." An article under this title was published in the July

[2] Forest Service research in the FALCON program could assist in bringing programed allowable cut up to potential yield on marginal areas. However, the anticipated success of this program is not reflected in the programed allowable cut for this coming decade.

1972, Journal of Forestry.[3] The process is one in which future gains in timber production are averaged to the present. It requires some degree of, but not strict, even flow. The calculations must be based on volume regulation and there must be an available reserve of merchantable timber within the planning unit. The authors point out that there is no allowable cut effect under the area regulation methods.

The area regulation method calculates the allowable cut by dividing the total area in the planning unit by the rotation age (or conversion period), and multiplying this area to cut each year by the volume per acre in the oldest timber stands to be cut first. The volume to be cut each year in the future depends on the volume per acre expected to be on the oldest acres available at that time. Thus, the annual cuts may vary considerably over the rotation. (See the example in fig. 1 of the Umpqua report in app. IV.) The effect of cultural practices on young stands is to make their volume higher at some future harvest date (when they are the oldest stands available). Therefore, the current allowable cut is not affected. Academically, the authors of the journal article are correct. However, in actual practice area regulation is often applied using only the stocked and easily restockable acres. In such cases the addition of hardcore nonstocked acres to the total area as a result of a reforestation program can give increased cut now. Similarly, any reduction in rotation due to cultural practices will increase the cut now. This area regulation procedure determines the final harvest or regeneration cut levels. The cut of commercial thinnings and mortality salvage must be determined based on the amounts available on thinnable age classes or in the form of salvageable mortality.

It is pertinent here to note what the Bureau of Land Management did recently in computing a revised allowable cut for lands under its management in western Oregon. A computer simulation model was used to calculate a strict even flow of total harvest for 400 years into the future. Based on this procedure they were able to reflect in today's cut improvements in future growth from cultural treatments. They used this to justify investment programs. This procedure was recently reviewed and the results reported by the Pacific Northwest Forest and Range Experiment Station.[4] Other calculation methods were also reviewed.

Volume regulation methods of calculating the allowable cut are ones in which, as the name implies, volume is the controlling element. In these methods, the area to be harvested is a result of the calculation. Volume regulation is obtained by application of a formula or by a scheduling calculation which may be based on an arbitrarily selected volume to be harvested or on a trial and error calculation under the constraining limit of even flow of volume for some long period, such as a rotation.

Hanzlik's formula is a typical volume regulation formula. It states that:

$$\text{Allowable annual cut} = \frac{\text{Volume of mature timber}}{\text{Length of rotation}} + \text{Average annual growth}$$

The allowable cut effect takes place directly through the addition of the average annual growth and also directly, but less obviously, through any influences of expected future growth on shortening the rotation. This and other formulas, when applied with and without assumed increases in future growth will indicate possible increases in current cut immediately from cultural practices. It is significant that the new Forest Service Manual specifically prohibits the use of formula calculations.

The trial and error volume regulation method is used to calculate the cut when (a) the only harvest to be regulated is the final harvest and (b) when an even flow of final harvest is desired. In this method the calculations involve repeated trials of levels of harvest starting with the oldest or largest timber first until a level is found which, as growth of new timber is added over time, will permit continuation of the same volume of final harvest throughout at least one rotation. If this process is repeated using higher assumed growth rates for new timber, the level of harvest is generally found to be higher; i.e., the mature timber can be cut faster because young timber will become available and merchantable sooner to sustain the cut in

[3] "Allowable Cut Effect-Some Physical and Economic Implications," by Dennis L. Schweitzer, Robert W. Sassaman, and Con H. Schallau, Journal of Forestry, July 1972, pp. 415–418.

[4] "An Analysis of Selected Assumptions Basic to an Allowable Cut for Western Oregon," by Dennis L. Schweitzer and Roger D. Fight. A report to the Bureau of Land Management dated Aug. 4, 1972.

the latter part of the rotation. This volume regulation method was computerized in a program called ARVOL for use by the Forest Service and others.

It is significant to note that the new manual permits either area or volume regulation methods but emphasizes the advantages of area regulation. Even more significant is the fact that new allowable cuts for several important timber producing forests (Siskiyou, Rogue River, Umpqua, Wallowa-Whitman), are now being proposed based on strict area regulation calculations. Although an allowable cut effect can occur, it is limited to changes in rotation and additions of nonstocked area resulting from cultural measures.

Obviously one needs to know much more about the current Forest Service allowable cut calculation procedures to learn whether increases in national forest timber supply based on increased funding can be justified under those procedures or whether they will need revision. Following is a discussion of the current procedures in use.

## Current Cut Calculation Methods

Table 2 in appendix I indicates that most of the allowable cuts for western national forests are currently being recalculated. Plans now under public review and discussions with the western regional staffs reveal that most of these are being calculated using a computer program called timber RAM.[5] This is a mathematical model for resource allocation or, more precisely, for timber harvest scheduling. It utilizes the linear programing technique for maximizing or minimizing the desired objective within specified constraints. The user can specify one of several objectives such as: (1) Maximize harvest volume during some period such as a decade or a rotation, (2) maximize the present total worth of the sale value of future harvests at a given interest rate over a specified period, (3) maximize present worth of net income (sales less management costs), (4) minimize the present worth of all future management costs over a period of time.

Thus far, the Forest Service applications have been limited to maximizing total harvest during some period of time.[6] The total harvest includes final harvest, thinnings, and mortality salvage.

During the period of maximization of volume (and beyond), the user can specify the degree of even flow desired by specifying the amount of percentage increase and decrease acceptable from one decade to another. The Forest Service has tended to specify very small percentages of permitted decrease such as 1 percent or even one-tenth of 1 percent and to specify large or no limit on increases. These restraints result in even or increasing flows of total timber harvest over time.

The RAM program also permits restraints on the change from the current allowable cut to that determined for the first period under the new schedule being computed. The Forest Service has tended to permit wide limits, thus permitting the new allowable cut to be considerably lower or higher than the old cut.

This model provides for adding growth to any and all timber stands over time. It also provides for special growth effects such as that from planting genetically improved stock, reforesting old cutovers and precommercial thinning. These special cultural methods for increased growth on stands to be harvested in future decades do not affect the first decade of harvest unless these future decades are included in the period over which harvests are maximized and unless very small limits are placed on the percent of decrease permitted from one decade to another (degree of even flow). In other words, the allowable cut effect of even flow and volume regulation may or may not occur in Timber-RAM.

The actual and/or expected accessibility of timber stands is a limiting factor which may be specified in Timber RAM calculations of cut. Consequently, the effects of changes in the rate of roading a national forest can be measured by successive RAM calculations, one at present rate and one at an increased rate. However, if the percent of decrease in harvest permitted from one decade to another is specified to be very small an increased rate of roading will have little or no effect on the first decade harvest level.

[5] See Navon, Daniel I. "Timber RAM—A long-range planning method for commercial timber lands under multiple-use management." USDA Forest Service, Research Paper PSW-70, 22 p., illus., Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif., 1971.

[6] The only approved plan based on timber RAM is for the Six Rivers National Forest. Work on that plan included the analysis of other maximization objectives and numerous alternatives.

In order to keep its complexity within bounds, Timber RAM was designed to apply area regulation during the second rotation. The user must specify the amount of variation he will permit between the areas in each age class of timber after the conversion of existing stands to new stands. This is done by specifying the percent of increase or decrease permitted between decadal harvests during the second rotation or post conversion period. This has the effect of controlling the rate of regeneration cutting during the first rotation or conversion period.

Mason, Bruce, and Girard has had considerable experience in using Timber RAM and has applied it to several national forests and to private timberlands. Based on this experience, we have concluded that an allowable cut effect can only be shown if strict even flow constraints are used. Those Forest Service staff members who have experience in using Timber RAM have come to the same conclusion. This experience has mostly been gained during calculations in which the objective specified was to maximize total harvest volume during the first decade. If this objective is retained, but with the even flow constraints relaxed, say from 1 to 3 or 5 percent, the Timber RAM calculation will show relatively large increases in the first-decade cut—exceeding considerably any increases possible from extra growth on young stands due to cultural measures with the even flow constraints applied. The tendency of the Forest Service is to reject such increased first-decade harvests, either on the basis that these would be environmentally undesirable or that these would result in unacceptable reductions in harvest in later decades.

In summary, Timber RAM is a very sophisticated tool for allowable cut calculation and requires detailed knowledge of the possible interplay of input data, objectives, and constraints to be able to capture all of its advantages. It requires the same kind of input data as are and have been used by all other methods of calculation. Therefore, the same factors control the level of the calculated allowable cut. However, Timber RAM requires, and thereby forces the user to specify the objective, the constraints and all other assumptions. The major significance of RAM to PAPTE is that it permits rapid and easy recalculation of the allowable cut under revised policies affecting objectives, constraints, assumptions, and management intensity. It does not solve the problem of what these objectives, constraints, and other policies should be.[7]

Region 1 is now in the process of recalculating the allowable cut on each of its national forests using the Timber RAM method.

Region 2 reports that they will use Timber RAM to calculate allowable cuts from national forests in the Rocky Mountain region that are scheduled for revision. They will use a simulation computer model to estimate future yields from managed stands for input in the Timber RAM model.

Region 3 will revise existing plans which have not expired by adjusting them to the new format which requires reporting and controlling the cut by the components; standard, special, marginal and unregulated. For new plans based on new inventory they will use several methods, such as formula and trial and error methods but will always also calculate using Timber RAM as a check on the other methods.

Region 4 will update the plans based on old inventory using the original calculation methods, mostly Kemp's formula. For all new plans based on new data they intend to use a tabular method which is now being developed. Their trial experience with Timber RAM raised difficulties, primarily due to their lack of easy access to adequate computer services.

Region 5 was the first to use Timber RAM to calculate the allowable cut. This was done on the Six Rivers National Forest and the results were approved in 1971, including the filing of an Environmental Impact Statement under section 102 of the National Environmental Policy Act of 1969. Currently Region 5 is computing all new allowable cuts using Timber RAM.

Region 6 has recently begun using Timber RAM and work is underway on six or more national forest plans at this time. For some of these plans hand calculations of allowable cut using area regulation have already been completed, but will be recomputed using RAM.

Region 10 in Alaska has no specific plans for recalculating their allowable cut.

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[7] For a comparison with traditional forest regulation methods, see Hennes, LeRoy C., et al., Forest Control and Regulation, USDA Forest Service Research Note PSW-231, 10 p., illus., Pacific Southwest Forest and Range Experiment Station, Berkeley, Calif. 1971.

## Classifying Commercial Forest Lands for Cut Calculation and Control

The most important factor resulting in reduced allowable cuts under revised timber management plans is the reduction in land base available for full timber yields due to multiple use and environmental constraints which are being reflected primarily through classification of the land into categories.

The Forest Service has required in its recently revised manual that the commercial forest land be subclassified into categories called standard, special, marginal and unregulated. (See app. II for copies of FSM 2412.1 defining these.) For each of these the potential yield and programed allowable harvest is to be calculated. The basic calculation procedure is the same for each component but adjustments are made in the resulting cut for each, dependent upon multiple use and environmental considerations.

The standard component is generally the largest portion of the commercial forest land on a national forest. Little or no adjustment of the calculated cut on standard areas is made for multiple use reasons. On some forests an indirect adjustment occurs through the use of special silvicultural practices for environmental reasons. For example, a change to shelterwood in place of clearcutting has had a pronounced effect in reducing the calculated cut on some forests during the first decade. This occurs on the Rogue River and similar forests because the same number of acres are being regeneration cut under area regulation but at substantially less volume per acre.

On the Flathead National Forest the cut on standard areas was reduced by extending the conversion period for overmature timber to protect streams and watersheds from increased runoff due to too much removal of vegetation. This procedure has been seriously questioned by a team of watershed specialists retained by a local citizens group. Their final recommendations are reproduced in appendix III.

In several of the other currently proposed plans the potential yield includes similar reductions. However, as pointed out earlier, all of the plans now being prepared and/or reviewed show that potential yield equals the programed allowable harvest on standard areas.

The special component is called special because of the special silvicultural, harvesting, and treatments required for multiple use reasons. Light partial cuts, longer rotations, reduced or no thinnings, no cutting on streamsides, and similar practices reduce the yields projected for these areas. These are landscape management, recreation, streamside, and similar areas and are generally delineated specifically on multiple use maps. The potential yield on new plans being proposed usually show the calculated cut for special areas without the above constraints while the programed allowable harvest is after the adjustments downward resulting from these environmental constraints. On the eight currently proposed plans listed earlier, the programed allowable cut average 71 percent of the potential yield on special areas which in turn make up 17 percent of the total potential yield from all areas on these forests. The differences between potential yield and programed allowable cut canont be captured by investment of any kind, according to the proposed plans. In my opinion, this procedure is not in accordance with the manual which specifies that potential yield is after consideration of other resource uses and the environment.

The marginal component includes critical soils, steep slopes, or low volumes per acre on which harvesting with conventional methods is limited or impossible. These areas are usually delineated on multiple use maps. The harvest methods, yields, and methods of calculating the cut for these areas are usually the same as for standard areas in arriving at the potential yield. These are then reduced to reflect what can be accomplished as programed allowable cut. In the earlier list of proposed plans the potential yield from marginal areas is 156.0 million fbm (11 percent of total potential) but only 34.7 million fbm of it is in the proposed programed allowable cut. The extra 121.3 million fbm is apparently available only if special harvesting methods are used by the forest industry to harvest on these areas. This 121.3 million fbm is 9 percent of the current allowable cut for these forests. The proposed new programed allowable cut for these same eight forests is 9 percent lower than the current allowable cut (see table on p. 9). Therefore, it appears that, if special logging methods can be devised and used, the new allowable cuts will just equal what the current allowable cuts are. Two conclusions can be drawn about these eight example forests: (1) Federal investment is not required to capture this extra yield from marginal areas, and (2) if it is captured it will only bring supply back to its prior level.



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Unregulated harvests are those from such as experimental forests, recreation sites, and tracts isolated from markets. These areas are a minor portion of most national forests in Western United States.

### Factors Affecting the Allowable Cut Calculation

The period of foremost concern to PAPTE is the coming decade from 1973 to 1983. The allowable cuts during this period are controlled by certain elements or factors used in the calculation. These same factors are controlling in varying degrees regardless of the specific calculation procedure used. These factors need to be examined to determine which ones are subject to change and how such change could be brought about.

Before taking up controlling factors, one factor that does not control in any real nor specific manner needs to be identified and discussed. This is sustained yield. Sustained yield as defined by law was quoted earlier in this report. The Forest Service has not made further definition in its regulations and manuals. The potential yield is not defined as equal to sustained yield, but is defined as the "maximum harvest * * * to achieve the optimum perpetual sustained yield harvesting level * * *." Management plan reports currently being drafted loosely refer to sustained yield but do not define it nor quantify it. One of these plans states that the proposed allowable cut is "within the sustained-yield limits of the forest" thereby implying that some unspecified amount of yield limits the current allowable cut.

Careful examination of Forest Service words and thoughts leads to the conclusion that the key elements of the sustained-yield definition in the law are "the achievement * * * in perpetuity of a high level * * * output * * * without impairment of the productivity of the land." It is an unspecified yield goal to be achieved at some distant future time by maintaining the basic productivity of the land. The requirement that the yield be regular on an annual or periodic basis has not been translated into specific guidelines. However, FSM 2415.4 states that harvesting rates "will reflect balanced programs * * * necessary to achieve high level, sustained yield of sawtimber on a regulated forest." The significant term here is regulated forest. This has often been interpreted to mean one with an even distribution of age classes. When this interpretation is used, the only procedure that will achieve this is strict area regulation. Until recently, most western forests were not on area regulation. And even flow of volume is impossible, or at best difficult, under area regulation unless the forest is already fully regulated into equal areas of age classes.

If sustained yield requires strict adherence to equal annual or periodic flows, then the concept has been violated in the past as evidenced by fluctuations in the annual harvests and as evidenced by approved and proposed management plans which project fluctuating cuts in the future.

One can conclude from this analysis of the situation that the only element in sustained yield which is not voided or overridden by other policies and procedures used in calculating the cut is the requirement that anything done must not impair the productivity of the land. Stated positively, sustained yield requires the maintenance of the basic productivity of the land for all uses. This can and should be construed to apply to each acre being treated or harvested. In other words, it can be concluded that the Forest Service sustained-yield requirement can be met with careful harvesting that will not damage the soil and site but without even annual flow.

Currently, the Forest Service calculates the sustained-yield output of a national forest by computing the average annual volume yield in thinnings and final harvest from a regulated forest during one rotation, assuming all areas are managed; i.e., have been converted from natural or wild stands. Under this procedure the average annual yield over one rotation is independent of the age-class distribution. This fact can be demonstrated using data from any one of the eight example forest plans cited earlier. These proposed plans present the annual sustained yield as being attainable during the second rotation and beyond, regardless of whether the cutting schedule during the first rotation is aimed at area regulation; i.e., even age-class distribution, after the first rotation. This leads to the conclusion that the regeneration cutting of equal annual areas during the conversion period is not necessary to the achievement of sustained yield during the second rotation. Cutting of equal areas would achieve even flow during the second rotation but does not give even flow during the first or conversion period.

Therefore, sustained yield would seem to permit a rather wide latitude in selecting the rate at which careful harvesting can be scheduled in mature stands during the first rotation or conversion period. The sustained-yield concept as defined by law and by regulation need not be a seriously limiting factor in allowable cut calculations.

This does not, of course, deal with the fact that rapid cutting in early decades of the conversion period probably will require less rapid cutting later. Later reductions can be offset partly by management practices on existing young stands now.

Now let's turn our attention to factors that do control the first decade allowable cut under recent and current actual applications of Forest Service procedures, given the areas available. These can be classed into four groups.

A. Existing physical conditions about which little or nothing can be done.

1. Area of commercial forest land (excluding nonstocked areas).
2. Volume per acre of mature merchantable sawtimber.
3. Growth and mortality on mature merchantable sawtimber.
4. Stocking conditions in older but immature age classes.

B. Factors established by policy or judgment and generally which are not changed by investments or management inputs.

1. Silvicultural system.
2. Conversion rate of existing overmature.
3. Rotation (except regeneration period).
4. Degree of even flow desired (volume regulation).
5. Degree of age-class regulation desired and when (area regulation).

C. Factors which can be changed by Forest Service investments or expenditures for intensive cultural practices on the timber resource.

1. Regeneration period.
2. Rate of roading for accessibility to harvest and manage.
3. Rate of growth in younger age classes.
4. Backlog area of nonstocked which can be made productive by restocking.

D. Factors that can be changed by timber purchasers, industry, or Forest Service research through improved logging and utilization methods.

1. Volume per acre recoverable and usable in mature merchantable stands.
2. Area thinnable and salvageable on steep slopes and critical soils in marginal areas.

These factors are not mutually exclusive nor independent of each other. If, for example, strict area regulation is being used to calculate cut, then rotation becomes very important. In turn, this gives the regeneration period (a part of rotation) and area of nonstocked (a part of area base) great importance as factors that the Forest Service can change with increased funds. At the same time under area regulation the rate of growth on young stands cannot have any influence on the first decade cut and generally rate of roading will not affect this cut.

Given the current methods of calculating and controlling the allowable cut as revealed in a review of the plans now being proposed, these four kinds of factors have varying amounts of influence on the potential yield and programed allowable cuts. The most influential and controllable factors are those which can be affected by changes in policy or judgment or assumptions about the future without any added investment nor intensification of management. Some examples for each of the five factors will serve to illustrate the possible effects. Regarding silvicultural systems on the Umpqua National Forest, the new plan proposes to change from about 90 percent clearcutting on regeneration areas to 47 percent. Using the Forest Service's area regulation method in that plan, a continuation of 90 percent clearcutting instead of 47 percent would have increased the first-decade final harvest cut by 22 percent. Later decades would not be influenced. The two neighboring forests, with admittedly some differences in forest type and conditions, chose to have 5 percent clearcutting (Rogue River) and 85 percent (Siskiyou) rather than 47 percent.

Regarding conversion periods for old growth, the decision on length is generally being made on some basis other than the decadence or other condition of the old-growth stands. On the examples of Umpqua, Rogue River, Siskiyou, and Wallowa-Whitman, area regulation was used and the conversion period is simply how long these acres of old growth will last when cut at a rate determined by the total area of all stands divided by rotation. Similarly, on other forests, the conversion period is simply how long old growth lasts under the rate of harvest established by other factors.

Regarding rotation (except regeneration time) the basis for the decision is unclear but seems to be primarily based on culmination of mean annual increment but with some consideration of crop tree size at that age. In the Umpqua proposed plan 100 years was chosen as culmination of mean annual increment of volume in International ⅛-inch fbm units. If cubic feet of all trees had been used the rotation would have been 70 years, the crop trees would have been somewhat smaller, and the programed final harvest cut resulting from the Forest Service calculations would have been 43 percent more from the standard area of that forest. Combined with a continuation of 90 percent clearcut this would have amounted to about 75 percent more allowable cut in the first decade. There is every indication that such indicated increases were unacceptable to the Forest Service for reasons other than rational consideration of silviculture and of long-range future tree size and volume utilization objectives.

Regarding even flow, all the forests calculated by area regulation projected varying degrees of uneven flow over the next 100 years or so. The Umpqua scheduled a maximum of 17 percent increase in the second decade and a maximum decline of 11 percent in the ninth decade, among other lesser variations. But hidden within these fluctuations in total volume, are greater changes in cut composition. For example, the commercial thinning harvest is scheduled to decline 40 percent or by 22 million fbm per year in the third decade. These thinnings are small trees and entirely different from the final harvest and overwood which will still be large old growth at that time. This kind of uneven flow can have considerable local industry impacts. So, although total harvest might be even flow, scheduled changes in the components of the cut could have serious impacts.

Regarding age-class (area) regulation, the objective of equal uniform areas in each age class will be achieved after one rotation, but the harvest volume during the first rotation will vary. Citing the Umpqua proposal again, it would seem that the long-range objective of age-class distribution could have been given less priority so that other short-range objectives of volume harvest could be achieved, such as maintenance of the current actual cut level or slowly declining flow over the next several decades.

In reviewing the eight proposed plans it was found that all five of the above policy subjects were inadequately supported by facts and reasons or not supported at all. Often the basis was mostly technical, like culmination of mean annual increment, with little or no explanation of the policy aspects, like the selection of desired tree size or expected degree of utilization 100 years from now. The choice of silvicultural system was partly technical or scientific but also policy was involved. For example, statements were made that clearcutting was scientifically or ecologically sound on a particular forest and type but that objections to appearance were considered in choosing silvicultural systems. In most cases those decisions with policy implications but with wide technical latitude for alternatives were not reviewed by administrative officers. Thus, opportunities for significant variations in final allowable cut within technical and environment possibility were overlooked or were rejected by technical staff level foresters in the process of timber management planning.

The next most influential controllable factors in determining the first decade programed allowable cut are those in group D above; i.e., those affected by actions of timber purchasers and/or the industry. In the eight example plans, 9 percent more harvest could be added by use of special or more economical logging methods.

Lastly, the allowable cut in the first decade is influenced least by the level of investment or management intensity under current procedure as being applied in actual calculations. This situation is due to the use of area regulation and/or the use of timber RAM and to the relaxing of former rather rigid even flow objectives in calculating the cut. It is important to restate that the Forest Service manual instructions do provide for reflecting the effects of intensive management under C above. Yet, in actual application the plans now under review do not provide for any significant increases for these reasons.

### Sample Estimates of Possible Increases in Allowable Cuts

Revised calculations have been made for four national forests for which data were available to Mason, Bruce, and Girard. Both Timber RAM and hand computation using Forest Service methods were used but the controlling factors were varied and errors were corrected in Forest Service data and assumptions where deemed appropriate. The details of these cannot be covered adequately in this report. However, an example of the details is shown for the Umpqua National Forest in appendix IV. The results in terms of programed allowable cut were as follows:

| National forest | Millions of board feet, Scribner | | |
|---|---|---|---|
| | Total annual harvest forest service | | Revised by Mason, Bruce, and Girard |
| | Current | Proposed | |
| Flathead | 181.6 | 159.8 | 190 |
| Rogue River | 176.4 | 180.0 | 280 |
| Umpqua | 357.0 | 346.0 | 510 |
| Wallowa-Whitman | 167.7 | 186.0 | 234 |
| Total | 882.7 | 871.8 | 1,214 |

These revised cuts range from about 20 to 56 percent higher than the tentative Forest Service proposals and average 39 percent higher. The revised cut calculations include consideration for special and marginal areas and for environmental factors on all areas. Some more intensive management was applied but only to standard areas. The estimated improved yields were determined from Forest Service data on growth rates. To the extent that these extra cultural practices are not funded the above revisions would be potential yields. Even flow was not used but reasonable changes were allowed from decade to decade, similar to those permitted in Forest Service calculations. Rotation was shortened on only one forest, the Umpqua, from 100 to 80 years.

These forests are not fully representative of all the western national forests yet they do indicate what can be expected. Based on these it appears that those forests with similar situations could have similar increases, that these would average at least 30 percent above current allowable cuts, and that only part of the indicated increases require extra funding.[8]

## CONCLUSIONS

1. Sustained yield as defined in the law permits wide latitude in the rate at which the existing mature and overmature timber can be scheduled for harvesting. Hence, statutory requirements need not be a limiting factor on the national forest allowable cuts during the coming few decades. The contractual and other constraints on harvesting practices, the provision of K–V funds for restocking newly cutover areas, and the other practices which provide for protecting and maintaining the productivity of the forest land for timber and the other resources are fully adequate provisions to assure sustained yield of both timber and the noncommercial products and uses of the forests. A strict requirement of even flow of timber volume harvested annually or periodically is not necessary to achieve sustained yield.

2. The current allowable cut calculations being made are not providing a sound procedural basis for justification of increased expenditures for timber culture which will permit significant increases in allowable cut during the coming decade if increased funds were made available now. This is occurring in spite of the fact that the new Forest Service manual instructions provide for such justification procedure.

3. The current actual calculations of allowable cut are such that the resulting first decade cut is heavily influenced by arbitrary technical decisions and judgments that involve serious policy implications and conflicts. Most of these decisions are inadequately supported by facts, lack of documentation, and are not coordinated with other Forest Service and other Federal policies and objectives. Such factors as rate of conversion of overmature stands, rotation in relation to size and kind of future crop trees, degree of even flow, and desired future age-class distribution are being decided by staff foresters and technicians at low levels in the Forest Service organization.

4. The current and proposed allowable cuts are not directly nor specifically related to current or proposed levels of timber management and cultural programs. Consequently, one cannot properly determine the expected effects of increased funding for intensive management programs. For example, projections are often made (sometimes implicitly) about far more or far less timber growth than the current level of management justifies.

5. If the trends shown in examples of currently proposed revisions in allowable cuts continues, the total potential yield and programed allowable cut on western national forests will decline from the recent actual harvest levels by an estimated 16 percent during the coming years as most of these forests are being revised during that time. In terms of the harvest of the common kinds of timber by conventional methods, the total allowable cut will decline substantially more than 16 percent as the new revised cuts are announced.

6. Given the current availability of commercial

[8] The amount of extra funding could not be estimated because the Forest Service proposed plans did not clearly explain the current level of annual accomplishments and funding.

forest land, the current multiple use constraints, and current funding for cultural practices, the level of both potential yield and programed allowable cut are generally underestimated. This is due to the use of long rotations, conservative growth estimates, area methods of regulation, evenflow, and to omission of opportunities for more intensive practices based on increased funding. However, part of this conservatism is also stemming from a basic underlying notion within the Forest Service that a reduction in the allowable cut is needed to bring about an improvement in the environment and an enhancement of other uses. Past evidence shows that damage has been done to the environment and that conflicts have occurred with other uses during past allowable cut harvesting. However, almost all of these occurrences have been on specific harvest operations on specific areas and have not been due to the total level of the allowable cut. It is not the level of the cut but the manner in which each individual harvest is made that is critical. Therefore, given more careful harvesting (and roadbuilding), allowable cuts can be increased substantially while protecting the environment and other uses.

7. Based on sample forest calculations it appears that the allowable cuts on western national forests could be increased by 30 percent or more during the next decade and for at least one decade beyond. Only part of this increase requires a program of reforestation of nonstocked areas, prompt regeneration and control of stocking on young stands. This estimate of possible increase takes into account environmental constraints and special harvesting requirements where necessary. It also is made within the sustained-yield policy and with even-flow considerations similar to those used in current allowable cut calculations by the Forest Service.

8. If the even-flow policy as now applied by the Forest Service were relaxed even further, greater increases in allowable cut are possible than those indicated in No. 7 above. The upper limitations on such increases are of two kinds: environmental considerations and future levels of output during the first rotation. Neither one of these limits have been fully explored by the Forest Service.

## RECOMMENDATIONS

1. The period of time over which the existing mature and overmature stands of timber are converted to new stands of young trees on each national forest is directly controlling over the timber supply during the next few decades. The length of these periods are now decided without adequate consideration of the national timber supply problems and opportunities. It is recommended that the conversion period for this mature timber on the standard areas for each national forest be decided at the Chief's office level of the Forest Service where proper consideration can be given to current and long run national timber supply objectives.

2. The rotations (number of years) to be used to grow new timber crops on standard, special, and marginal areas on each national forest should be based on a combination of criteria including:

(*a*) The length of time necessary to get maximum yields in cubic foot volume of logs and trees estimated to be of the size necessary and suitable for utilization at selected future periods, but

(*b*) Only long enough to achieve a specified minimum projected annual earning rate, such as 5 percent, on the total growing stock required on a fully regulated forest managed on that rotation. Fully regulated means a regular age-class distribution of equal areas in each age class.

3. It is recommended that, given the conversion period and rotation as determined above, the forests and regions should develop a schedule of yields by decades for at least 1½ rotations as is now required, plus:

(*a*) A graphic description of the condition of the forest (by land categories) expected at the end of every 20 years, showing age classes and other pertinent information,

(*b*) A list of specific stand treatments, other cultural measures, and road construction planned during the next 5 years based on current funding from all sources. The harvest schedule should be based on this level,

(*c*) A list of the additional treatment opportunities and a schedule of when the extra yield will occur. Top priority should be given to those which will yield harvests in the future periods when above schedule of yields is low. Rates of return expected on each additional treatment program should be calculated and presented.

4. It is recommended that the programed allowable harvest (sales) during the conversion period

(as determined under recommendation 3 above) should be reexamined annually by the Chief of Forest Service and that significant changes may be made, up or down, on any national forest based on:

(*a*) Consultation between the Chief of the Forest Service and the heads of other Federal agencies responsible for housing, banking, monetary controls, etc.

(*b*) Consideration of local economic situations regarding available processing facilities and labor, other timber sources, and local economic conditions.

(*c*) Determination of changes in funding and staffing required for any changes in the volume of sales, acres to reforest after harvest, etc. Requirement should be to obtain from K–V or appropriations sufficient funds to bring all extra harvested acres to full stocking within 10 years of regeneration cutting.

5. It is recommended that a program be instituted with the goal of having all or most of the national forest harvesting done by contracts let to qualified harvesters under sealed bids with expected production of logs to be sold at public oral auction prior to the harvesting. Log sales should be by species and quality groups for delivery over long periods of time such as a year or longer, possibly with price escalation. This program should be started first on a trial basis on:

(*a*) Harvests which require special new logging systems such as skylines or helicopters,

(*b*) Harvests on special or marginal areas where partial cuts or special care is required,

(*c*) On all regular harvests of some forests where national forest timber is less than half the local supply, where there are numerous conversion plants processing all kinds of logs, and where third-party scaling is standard practice.

(More details of this recommendation are presented in a separate report to PAPTE entitled "Timber Sales Policies and Procedures on National Forests in Relation to Short Run Timber Supply.")

# APPENDIX I

**TABLE 1.—Summary of Timber Sale Accomplishment and**

| National forest | Sawtimber: As of Jan. 1, 1970: Area nonreserved commercial forest land thousand acres | As of Jan. 1, 1970: Deferred commercial forest land thousand acres | Allowable cut sawtimber as of Jan. 1, 1971 | Allowable cut backlog or overcut | Financed goals: Cut: Plan | Cut: Actual | Cut: Percent | Sell: Plan | Sell: Actual | Sell: Percent | Volume offered not sold | Uncut volume: Under contract | Uncut volume: Ratio to allowable cut | Average price: Appraised per thousand board feet | Average price: High bid per thousand board feet | Average specified road cost per unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | | | | |
| REGION 1[1] | | | | | | | | | | | | | | | | |
| Beaverhead | 992 | 46 | 65.4 | 138.3 | 29.4 | 17.7 | 60.2 | 44.6 | 1.3 | 2.9 | | 76.9 | 1.18 | | | |
| Bitterroot | 749 | 156 | 53.2 | 31.7 | 69.0 | 46.2 | 67.0 | 56.9 | 30.1 | 52.9 | | 70.0 | 1.32 | 6.57 | 8.41 | 14.44 |
| Clearwater | 1,296 | | 211.8 | 461.4 | 192.5 | 128.3 | 66.6 | 203.1 | 108.0 | 53.2 | | 557.9 | 2.63 | 5.28 | 6.07 | 7.24 |
| Coeur d'Alene | 695 | | 103.0 | 17.2 | 118.1 | 95.6 | 80.9 | 119.2 | 99.7 | 83.6 | 5.5 | 248.5 | 2.41 | 9.28 | 14.28 | 7.35 |
| Colville | 837 | 4 | 92.5 | 99.9 | 107.9 | 70.5 | 65.3 | 104.1 | 63.6 | 61.1 | | 193.2 | 2.09 | 2.32 | 7.53 | 9.92 |
| Custer | 260 | 139 | 10.4 | 123.3 | 5.7 | 1.2 | 21.1 | 6.3 | 7.5 | 119.0 | | 8.7 | .84 | 3.78 | 3.78 | 2.11 |
| Deerlodge | 846 | | 49.0 | 231.3 | 40.1 | 39.2 | 97.8 | 41.0 | 15.5 | 37.8 | | 90.8 | 1.85 | 5.30 | 9.68 | 4.56 |
| Flathead | 1,113 | 70 | 181.6 | 1.5 | 166.8 | 149.1 | 89.4 | 209.1 | 153.8 | 73.6 | | 375.7 | 2.07 | 3.87 | 17.07 | 6.74 |
| Gallatin | 558 | 101 | 48.0 | 138.5 | 34.3 | 23.6 | 68.8 | 21.1 | 12.5 | 59.2 | 5.7 | 80.8 | 1.68 | 7.90 | 7.94 | 5.17 |
| Helena | 636 | 54 | 32.7 | 141.0 | 24.5 | 14.5 | 59.2 | 21.8 | 16.0 | 73.4 | | 77.0 | 2.35 | 3.51 | 5.13 | 5.75 |
| Kaniksu | 1,330 | 32 | 153.1 | 183.4 | 199.9 | 136.9 | 68.5 | 177.0 | 170.9 | 96.6 | 6.6 | 367.8 | 2.40 | 10.19 | 15.45 | 4.71 |
| Kootenai | 1,672 | | 234.2 | 95.8 | 236.4 | 205.7 | 87.0 | 222.2 | 217.0 | 97.7 | | 578.0 | 2.47 | 4.20 | 11.62 | 7.67 |
| Lewis & Clark | 943 | 144 | 40.4 | 238.1 | 20.6 | 16.1 | 78.2 | 15.3 | 11.8 | 77.1 | 1.5 | 57.3 | 1.42 | 14.68 | 14.68 | |
| Lolo | 1,703 | 87 | 191.7 | 226.4 | 206.8 | 144.5 | 69.9 | 172.3 | 111.1 | 64.5 | .2 | 413.4 | 2.16 | 4.25 | 15.09 | 6.21 |
| Nezperce | 1,180 | | 105.3 | 6.8 | 118.6 | 103.1 | 86.9 | 130.5 | 92.4 | 70.8 | 11.0 | 339.3 | 3.22 | 4.22 | 4.29 | 9.22 |
| St. Joe | 781 | 23 | 99.0 | 74.3 | 149.4 | 110.9 | 74.2 | 105.5 | 74.4 | 70.5 | 8.3 | 209.0 | 2.11 | 9.44 | 10.73 | 8.36 |
| Subtotal | 15,591 | 856 | 1,671.3 | 2,046.7 | 1,720.0 | 1,303.1 | 75.8 | 1,650.0 | 1,185.6 | 71.9 | 38.8 | 3,744.3 | 2.24 | 5.94 | 11.87 | 7.22 |
| REGION 2[3] | | | | | | | | | | | | | | | | |
| Arapaho | 517 | 66 | 28.5 | 101.5 | 22.0 | 11.1 | 50.5 | 17.0 | 10.1 | 59.4 | | 36.5 | 1.28 | 2.00 | 2.10 | |
| Bighorn | 595 | 6 | 19.5 | 56.7 | 26.0 | 17.5 | 67.3 | 16.0 | 28.1 | 175.6 | 3.9 | 50.6 | 2.59 | 2.43 | 2.77 | 2.09 |
| Black Hills | 1,112 | | 67.0 | 170.5 | 64.0 | 55.9 | 87.3 | 41.0 | 42.3 | 103.2 | 2.2 | 211.8 | 3.16 | 5.00 | 5.66 | 8.09 |
| Grand Mesa-Uncompahgre | 774 | | 40.0 | 293.5 | 20.0 | 8.9 | 44.5 | 5.0 | 4.6 | 92.0 | | 83.5 | 2.09 | 3.53 | 3.53 | 8.34 |
| Gunnison | 976 | 5 | 46.2 | 307.4 | 17.0 | 3.6 | 21.2 | 3.0 | 8.9 | 296.7 | | 35.9 | .78 | 2.00 | 2.01 | .67 |
| Medicine Bow | 741 | | 59.1 | 310.7 | 50.0 | 31.8 | 63.6 | 26.0 | 15.2 | 58.5 | 3.0 | 189.2 | 3.20 | 2.00 | 2.27 | 2.53 |
| Nebraska | 57 | | | | | | | | | | | | | | | |
| Pike | 743 | 61 | 10.0 | 60.0 | 8.0 | 2.1 | 26.3 | 3.0 | 1.0 | 33.3 | .8 | 18.1 | 1.81 | | | |
| Rio Grande | 893 | 125 | 60.6 | 358.7 | 32.0 | 26.0 | 81.3 | 33.0 | 13.3 | 40.3 | | 87.3 | 1.44 | 2.00 | 2.00 | 5.11 |
| Rooseveldt | 498 | | 28.3 | 165.9 | 8.8 | 6.2 | 70.5 | 5.3 | 5.7 | 107.5 | | 13.7 | .48 | 2.00 | 2.05 | |
| Routt | 834 | 20 | 50.7 | 202.2 | 42.0 | 30.6 | 72.9 | 37.0 | 31.6 | 85.4 | .1 | 72.5 | 1.43 | 2.00 | 2.00 | 6.55 |
| San Isabel | 316 | 263 | 10.0 | 46.8 | 8.0 | 2.8 | 35.0 | 3.5 | .7 | 20.0 | | 10.4 | 1.04 | | | |
| San Juan | 1,172 | 82 | 127.0 | 472.4 | 100.0 | 77.2 | 77.2 | 90.0 | 64.7 | 71.9 | 9.3 | 216.1 | 1.70 | 2.97 | 3.09 | 7.45 |
| Shoshone | 605 | 21 | 9.5 | 47.5 | 16.2 | 11.6 | 71.6 | 3.2 | 3.7 | 115.6 | | 13.9 | 1.46 | 6.57 | 10.15 | |
| White River | 981 | 80 | 38.8 | 253.6 | 16.0 | 8.0 | 50.0 | 7.0 | 3.7 | 52.9 | | 48.2 | 1.24 | 4.24 | 4.65 | |
| Subtotal | 10,814 | 729 | 595.2 | 2,847.4 | 430.0 | 293.3 | 68.2 | 290.0 | 233.6 | 80.6 | 19.3 | 1,087.7 | 1.83 | 3.05 | 3.33 | 5.55 |
| REGION 3[3] | | | | | | | | | | | | | | | | |
| Apache | 768 | 10 | 68.7 | −14.6 | 76.1 | 59.1 | 77.7 | 57.4 | 41.4 | 72.1 | .5 | 175.1 | 2.55 | 10.37 | 15.29 | 12.21 |
| Carson | 679 | 24 | 48.8 | 170.8 | 49.7 | 26.6 | 53.5 | 58.1 | 39.9 | 68.7 | 2.5 | 102.5 | 2.10 | 7.17 | 7.54 | 5.83 |
| Cibola | 447 | | 17.0 | 104.6 | 14.5 | 1.0 | 6.9 | 21.1 | 10.2 | 48.3 | 10.5 | 12.9 | .76 | 10.61 | 10.61 | 3.17 |
| Coconino | 553 | | 65.2 | −5.7 | 64.9 | 64.5 | 99.4 | 69.7 | 47.4 | 68.0 | 3.5 | 168.8 | 2.59 | 20.00 | 20.00 | 4.35 |
| Coronado | 13 | | 5.0 | 38.2 | 4.9 | 3.7 | 75.5 | 5.5 | | | | | | | | |
| Gila | 462 | 25 | 23.6 | 13.3 | 22.7 | 18.2 | 80.2 | 21.5 | 25.4 | 118.1 | 2.2 | 46.8 | 1.98 | 14.80 | 14.80 | .04 |
| Kaibab | 619 | | 54.7 | 71.2 | 60.8 | 39.1 | 64.3 | 50.3 | 33.6 | 66.8 | 5.6 | 97.5 | 1.78 | 8.54 | 8.54 | 4.60 |
| Lincoln | 315 | | 11.4 | 14.0 | 27.9 | 6.5 | 23.3 | 9.0 | 12.7 | 141.1 | 1.7 | 180.8 | 15.86 | 4.41 | 8.55 | |
| Prescott | 108 | | 3.1 | 12.3 | 3.1 | | | 1.6 | 1.2 | 75.0 | | 5.6 | 1.81 | 5.45 | 5.45 | |
| Santa Fe | 760 | | 46.1 | 79.4 | 51.4 | 61.5 | 119.6 | 48.8 | 43.6 | 89.3 | 8.8 | 78.4 | 1.70 | 6.72 | 8.79 | 2.04 |
| Sitgreaves | 420 | | 56.2 | −50.3 | 53.4 | 59.1 | 110.7 | 50.6 | 60.5 | 119.6 | 3.2 | 104.1 | 1.85 | 19.16 | 19.77 | 5.51 |
| Tonto | 143 | | 9.4 | −3.1 | 4.7 | 4.7 | 100.0 | .2 | .3 | 150.0 | | 13.9 | 1.48 | | | |
| Subtotal | 5,287 | 59 | 409.2 | 430.1 | 434.1 | 344.0 | 79.2 | 393.8 | 316.2 | 80.3 | 38.5 | 986.4 | 2.41 | 12.54 | 13.80 | 4.91 |

See footnotes at end of table.

## Allowable Cut on the National Forest, Fiscal Year 1971

| Convertible products | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Financed goals | | | | | | | Uncut volume | | Average price | | |
| | | Cut | | | Sell | | | | | | | | |
| Allowable cut convertible products as of Jan. 1, 1971 | Allowable cut backlog or overcut | Plan | Actual | Percent | Plan | Actual | Percent | Volume offered not sold | Under contract | Ratio to allowable cut | Appraised per cord | High bid per cord | Average specified road cost per unit |
| *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | | | | |
| 31.3 | | 3.0 | 1.3 | 43.3 | 2.2 | 1.5 | 68.2 | | | | | | |
| | | 18.0 | 2.1 | 11.7 | | 2.0 | | | | | | | |
| | | 11.4 | 8.8 | 77.2 | 21.0 | 7.5 | 35.7 | | | | 8.60 | 9.11 | |
| | | | .2 | | | .1 | | | | | | | |
| | | 11.0 | 1.7 | 15.5 | 11.0 | .8 | 7.3 | | | | | | |
| | | 1.4 | .5 | 35.7 | 1.2 | .6 | 50.0 | | | | | | |
| 135.0 | | 2.0 | 2.1 | 105.0 | 3.2 | 5.4 | 168.8 | | | | .83 | .83 | |
| 84.0 | | 1.0 | 2.6 | 260.0 | 1.0 | 2.1 | 210.0 | | | | | | |
| 23.5 | | 12.8 | 1.2 | 9.4 | 1.8 | 1.4 | 77.8 | | | | | | |
| 38.7 | | 3.4 | 3.5 | 102.9 | 4.2 | 5.2 | 123.8 | | | | | | |
| | | 50.0 | 3.3 | 6.6 | 38.0 | 5.7 | 15.0 | | | | | | |
| | | 7.8 | .6 | 7.7 | 6.4 | 4.9 | 76.6 | | | | | | |
| | | 3.4 | 1.3 | 38.2 | 4.2 | 1.9 | 45.2 | | | | | | |
| 56.0 | | 2.0 | 1.7 | 85.0 | 2.0 | 1.9 | 95.0 | | | | .25 | .25 | |
| | | .6 | 3.2 | 533.3 | .6 | .8 | 133.3 | | | | | | |
| | | 6.6 | 4.7 | 71.2 | 4.0 | 2.0 | 50.0 | | | | | | |
| 368.5 | | 134.4 | 38.8 | 28.9 | 100.8 | 43.8 | 43.5 | | | | 2.82 | 2.95 | |
| 63.0 | 595.4 | 2.0 | 2.4 | 120.0 | | 1.6 | | | 0.4 | 0.01 | | | |
| 67.0 | 588.6 | 2.8 | 2.3 | 82.1 | 2.8 | 1.7 | 60.7 | | 1.1 | .02 | 1.54 | 1.54 | |
| 170.0 | 876.8 | 58.4 | 54.6 | 93.5 | 56.0 | 41.0 | 73.2 | 8.0 | 146.6 | .86 | .59 | .87 | .10 |
| 69.0 | 612.2 | 2.6 | .4 | 15.4 | | .5 | | | .3 | | | | |
| 20.0 | 175.5 | .2 | .6 | 300.0 | .2 | .2 | 100.0 | | .1 | .01 | | | |
| 120.0 | 1,168.7 | 16.0 | 2.8 | 17.5 | 3.0 | 3.5 | 116.7 | 6.0 | 16.3 | .14 | | | |
| 13.0 | 66.2 | 2.6 | 3.7 | 142.3 | .2 | 3.6 | 1,800.0 | | 2.0 | .15 | | | |
| 26.0 | 73.8 | .2 | .4 | 200.0 | | .4 | | | | | | | |
| 46.0 | 382.2 | 2.4 | 3.5 | 145.8 | 2.8 | 3.0 | 107.1 | | .5 | .01 | | | |
| 95.0 | 861.1 | 8.0 | 12.0 | 150.0 | 14.0 | 7.4 | 52.9 | | 3.4 | .04 | | | |
| 8.0 | 134.0 | 1.0 | .7 | 70.0 | | .5 | | | .3 | .04 | | | |
| 51.0 | 409.3 | | .3 | | | .7 | | | | | | | |
| 7.0 | 160.4 | 1.2 | .8 | 66.7 | | .7 | | | .2 | .03 | | | |
| 19.0 | 1,121.4 | 2.6 | 2.0 | 76.9 | 1.0 | 2.9 | 290.0 | | 15.1 | .79 | | | |
| 774.0 | 7,225.6 | 100.0 | 86.5 | 86.5 | 80.0 | 67.7 | 84.6 | 14.0 | 186.3 | .24 | .60 | .88 | .10 |
| 70.1 | 480.0 | 45.4 | 31.1 | 68.5 | 1.5 | 4.7 | 313.3 | | 1,554.0 | 22.17 | 0.98 | 0.98 | |
| 105.8 | 687.3 | 7.7 | 2.1 | 27.3 | 7.7 | 2.4 | 31.2 | | | | | | |
| 6.0 | 447.7 | 4.8 | 4.2 | 87.5 | 4.8 | 4.4 | 91.7 | | .7 | .12 | | | |
| 48.0 | 342.6 | 22.4 | 8.7 | 38.8 | 16.0 | 11.6 | 72.5 | 5.0 | 1,209.9 | 25.21 | 2.25 | 2.25 | |
| | | 2.5 | 2.3 | 92.0 | 2.5 | 2.2 | 88.0 | | | | | | |
| 10.0 | 336.0 | 1.8 | 1.7 | 94.4 | 1.8 | 1.7 | 94.4 | | | | | | |
| 27.9 | 162.8 | 27.4 | 18.5 | 67.5 | 3.4 | .6 | 17.6 | | 700.1 | 25.09 | | | |
| 1.0 | 3.1 | 5.6 | 4.0 | 71.4 | 5.6 | 4.0 | 71.4 | | | | | | |
| 17.3 | 119.0 | 1.0 | .9 | 90.0 | 1.0 | 1.0 | 100.0 | .1 | | | | | |
| | | 4.6 | 1.6 | 34.8 | 4.6 | 1.5 | 32.6 | | | | | | |
| 38.9 | 119.9 | 11.6 | 6.3 | 54.3 | 1.5 | .4 | 26.7 | | 847.1 | 21.78 | | | |
| 20.2 | 83.9 | 16.9 | 18.3 | 108.3 | 2.0 | 2.4 | 120.0 | | 506.9 | 25.09 | | | |
| 345.2 | 2,782.3 | 151.7 | 99.7 | 65.7 | 52.4 | 36.9 | 70.4 | 5.1 | 4,818.7 | 13.96 | 1.88 | 1.88 | |

| National forest | Sawtimber: As of Jan. 1, 1970: Area nonreserved commercial forest land thousand acres | As of Jan. 1, 1970: Deferred commercial forest land thousand acres | Allowable cut sawtimber as of Jan. 1, 1971 | Allowable cut backlog or overcut | Financed goals: Cut: Plan | Cut: Actual | Cut: Percent | Sell: Plan | Sell: Actual | Sell: Percent | Volume offered not sold | Uncut volume: Under contract | Uncut volume: Ratio to allowable cut | Average price: Appraised per thousand board feet | Average price: High bid per thousand board feet | Average specified road cost per unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | | | | |
| REGION 4 [3] | | | | | | | | | | | | | | | | |
| Ashley | 558 | 12 | 30.2 | 124.2 | 14.5 | 10.0 | 69.0 | 18.7 | 19.6 | 104.8 | | 48.3 | 1.60 | 2.70 | 3.12 | 0.06 |
| Boise | 1,546 | | 175.8 | 195.0 | 146.5 | 101.7 | 69.4 | 176.4 | 176.3 | 99.9 | | 491.5 | 2.80 | 6.61 | 7.09 | 4.48 |
| Bridger | 314 | | 39.4 | 111.5 | 29.4 | 23.2 | 78.9 | 24.8 | 6.3 | 25.4 | | 43.0 | 1.09 | 4.74 | 4.74 | |
| Cache | 237 | | 16.1 | 56.1 | 3.9 | 1.7 | 43.6 | 8.5 | 6.7 | 78.8 | | 16.6 | 1.03 | 4.35 | 4.44 | 4.37 |
| Caribou | 337 | | 18.8 | 70.2 | 1.0 | .3 | 30.0 | 2.5 | 2.3 | 92.0 | | 3.2 | .17 | 13.89 | 13.89 | |
| Challis | 781 | 293 | 78.4 | 362.9 | 9.6 | 4.1 | 42.7 | 17.2 | 14.8 | 86.0 | | 23.3 | .30 | 4.82 | 8.45 | .32 |
| Dixie | 603 | | 29.2 | 19.6 | 29.5 | 23.6 | 80.0 | 22.4 | 26.4 | 117.9 | | 100.3 | 3.43 | 3.75 | 3.75 | 0.46 |
| Fishlake | 352 | | 19.8 | 94.0 | .9 | .6 | 66.6 | 6.6 | 5.6 | 84.8 | 1.2 | .9 | .05 | 14.64 | 14.64 | 1.33 |
| Humbolt | 29 | | 1.6 | 3.1 | | | | | | | | | | | | |
| Manti-LaSal | 348 | | 17.1 | 22.0 | 17.3 | 4.8 | 27.7 | 13.2 | 9.2 | 70.0 | | 27.3 | 1.60 | 5.58 | 7.73 | |
| Payette | 1,010 | | 95.2 | 8.7 | 99.9 | 85.6 | 85.7 | 93.7 | 38.5 | 41.1 | 6.2 | 196.7 | 2.07 | 9.14 | 9.41 | 6.47 |
| Salmon | 1,058 | 71 | 40.4 | 22.7 | 35.4 | 31.3 | 88.4 | 44.2 | 43.9 | 99.3 | 2.0 | 86.0 | 2.13 | 5.42 | 5.50 | 3.16 |
| Sawtooth | 333 | 161 | 20.5 | 16.6 | 14.7 | 9.9 | 67.3 | 11.4 | 9.0 | 78.9 | 9.8 | 30.0 | 1.46 | 5.72 | 5.72 | 8.23 |
| Targhee | 861 | 95 | 62.8 | 86.1 | 76.7 | 53.3 | 69.5 | 41.6 | 65.5 | 157.5 | .4 | 497.0 | 7.91 | 3.75 | 4.11 | 3.14 |
| Teton | 174 | | 53.4 | 270.6 | 33.0 | 10.3 | 31.2 | 16.8 | 23.2 | 138.1 | | 55.6 | 1.04 | 6.81 | 6.82 | 3.77 |
| Toiyabe | 149 | | 14.5 | 8.0 | 9.5 | 8.0 | 84.2 | 8.8 | 8.5 | 96.6 | | 17.9 | 1.23 | 19.69 | 28.33 | |
| Uinta | 294 | | 5.4 | 12.9 | 2.1 | 2.1 | 100.0 | 2.1 | 2.9 | 183.1 | | 7.1 | 1.31 | 7.58 | 7.69 | |
| Wasatch | 345 | 10 | 21.6 | 77.7 | 12.2 | 5.0 | 41.0 | 11.1 | 12.7 | 114.4 | | 25.6 | 1.19 | 2.48 | 4.37 | |
| Subtotal | 9,369 | 642 | 740.2 | 1,561.9 | 536.1 | 375.5 | 70.0 | 520.0 | 471.4 | 90.7 | 19.6 | 1,670.3 | 2.26 | 6.19 | 6.83 | 3.48 |
| REGION 5 [3] | | | | | | | | | | | | | | | | |
| Angeles | 44 | | 1.2 | | 0.2 | | | 0.2 | | | | | | | | |
| Cleveland | 9 | | | | 0.2 | | | | | | | | | | | |
| Eldorado | 411 | | 130.3 | 100.2 | 155.0 | 114.3 | 73.7 | 121.0 | 128.6 | 106.3 | | 259.6 | 1.99 | 12.07 | 16.29 | 6.82 |
| Inyo | 159 | | 15.3 | 3.5 | 18.0 | 25.2 | 140.0 | 100.0 | 8.2 | 82.0 | | 15.0 | .98 | 18.34 | 28.48 | 0.47 |
| Klamath | 1,116 | 14 | 240.3 | 100.7 | 282.0 | 199.0 | 70.6 | 250.0 | 248.6 | 99.4 | 1.2 | 534.8 | 2.23 | 6.64 | 23.91 | 12.93 |
| Lassen | 747 | | 166.6 | 103.8 | 212.7 | 128.9 | 60.6 | 196.7 | 187.2 | 95.2 | | 353.0 | 2.12 | 15.33 | 37.49 | 5.62 |
| Los Padres | 72 | | 2.0 | | 0.3 | | | | | | | | | | | |
| Mendocino | 361 | | 90.5 | 46.9 | 81.3 | 80.4 | 98.9 | 77.7 | 28.1 | 36.2 | | 147.6 | 1.63 | 2.97 | 3.35 | 17.49 |
| Modoc | 573 | | 61.6 | 62.4 | 78.9 | 55.1 | 69.8 | 63.9 | 64.8 | 101.4 | | 173.3 | 2.81 | 11.44 | 28.84 | 15.15 |
| Plumas | 769 | | 220.3 | 231.0 | 238.0 | 198.2 | 83.3 | 198.0 | 211.3 | 106.7 | | 511.3 | 2.32 | 13.47 | 19.28 | 7.23 |
| San Bernardino | 114 | | 7.1 | | 10.5 | 6.1 | 58.1 | 2.5 | 6.0 | 240.0 | | 1.4 | .20 | .95 | .95 | 0.01 |
| Sequoia | 416 | | 110.0 | 260.7 | 174.6 | 137.3 | 78.6 | 83.4 | 77.6 | 93.0 | 7.5 | 344.3 | 3.13 | 5.82 | 7.46 | 3.67 |
| Shasta Trinity | 1,125 | 112 | 283.7 | 55.8 | 362.2 | 237.0 | 65.4 | 240.2 | 236.5 | 98.5 | 5.6 | 545.1 | 1.92 | 14.54 | 28.69 | 11.42 |
| Sierra | 548 | | 152.2 | 185.7 | 170.3 | 130.1 | 76.4 | 169.7 | 138.2 | 81.4 | | 314.6 | 2.07 | 5.19 | 5.55 | 3.88 |
| Six Rivers | 752 | 31 | 179.6 | 30.3 | 226.0 | 180.9 | 80.0 | 204.0 | 189.2 | 92.7 | 1.8 | 458.1 | 2.55 | 18.11 | 47.60 | 8.96 |
| Stanislaus | 411 | | 139.4 | 26.0 | 164.8 | 140.7 | 85.4 | 130.8 | 131.6 | 100.6 | | 182.9 | 1.31 | 16.85 | 18.20 | 6.52 |
| Tahoa | 552 | | 148.6 | 201.8 | 156.0 | 132.9 | 85.2 | 150.0 | 101.3 | 67.5 | | 415.5 | 2.80 | 11.02 | 17.01 | 8.35 |
| Subtotal | 8,179 | 157 | 1,948.7 | 1,349.8 | 2,331.0 | 1,766.1 | 75.8 | 1,898.1 | 1,757.2 | 92.6 | 16.1 | 4,256.5 | 2.18 | 12.13 | 24.38 | 8.59 |
| REGION 6 [1] | | | | | | | | | | | | | | | | |
| Deschutes | 1,368 | | 138.0 | 10.6 | 185.0 | 138.5 | 74.9 | 191.3 | 159.5 | 83.4 | | 459.5 | 3.33 | 21.87 | 22.12 | 2.37 |
| Fremont | 930 | | 143.0 | −9.4 | 204.1 | 101.0 | 49.5 | 160.2 | 135.3 | 84.5 | 2.0 | 417.1 | 2.92 | 10.59 | 13.30 | 10.45 |
| Gifford Pinchot | 1,086 | | 416.4 | −136.0 | 597.6 | 392.9 | 65.7 | 438.3 | 449.2 | 102.5 | 11.1 | 1,141.8 | 2.74 | 22.85 | 35.24 | 9.35 |
| Malheur | 1,182 | | 171.0 | −6.0 | 262.3 | 187.5 | 71.5 | 200.7 | 218.4 | 108.8 | 9.2 | 551.6 | 3.23 | 7.30 | 8.25 | 6.69 |
| Mt. Baker | 407 | | 164.3 | 120.8 | 169.6 | 124.3 | 73.3 | 111.8 | 117.1 | 104.7 | 29.6 | 313.3 | 1.91 | 12.83 | 20.60 | 8.22 |
| Mt. Hood | 1,033 | 3 | 330.0 | 123.4 | 451.2 | 303.3 | 67.2 | 410.2 | 421.2 | 102.7 | 4.2 | 963.0 | 2.92 | 17.14 | 28.40 | 10.29 |
| Ochoco | 670 | | 131.0 | −71.3 | 162.4 | 133.3 | 82.1 | 163.1 | 160.2 | 98.2 | | 289.0 | 2.21 | 8.34 | 9.51 | 5.35 |
| Okanogan | 765 | | 88.1 | 54.0 | 109.1 | 52.8 | 48.4 | 95.4 | 87.4 | 91.6 | | 316.2 | 3.59 | 4.66 | 10.69 | 3.08 |
| Olympic | 535 | | 371.4 | 340.3 | 417.3 | 249.5 | 59.8 | 365.0 | 287.8 | 78.8 | 10.8 | 772.1 | 2.08 | 19.23 | 22.49 | 3.45 |
| Rogue River | 546 | 29 | 176.4 | 47.2 | 251.9 | 149.6 | 59.4 | 195.4 | 197.9 | 101.3 | .5 | 429.3 | 2.43 | 25.45 | 33.65 | 3.70 |
| Siskiyou | 746 | | 190.9 | 93.4 | 244.8 | 199.6 | 81.5 | 224.0 | 248.0 | 110.7 | | 530.0 | 2.78 | 19.64 | 31.68 | 17.10 |
| Siuslaw | 589 | | 348.0 | 361.1 | 447.1 | 269.2 | 60.2 | 374.1 | 360.2 | 96.3 | .1 | 89.8 | 2.56 | 34.99 | 38.92 | 7.51 |
| Snoqualmie | 614 | 83 | 214.3 | 67.0 | 276.3 | 184.6 | 66.8 | 218.9 | 137.9 | 63.0 | 6.9 | 567.7 | 2.65 | 11.31 | 19.01 | 10.69 |
| Umatilla | 941 | | 135.1 | 45.5 | 254.0 | 122.5 | 48.2 | 195.9 | 214.5 | 10 .5 | 1.9 | 419.7 | 3.11 | 4.95 | 5.52 | 8.61 |
| Umpqua | 874 | | 357.0 | 46.5 | 469.7 | 347.0 | 73.9 | 383.8 | 442.3 | 115.2 | .2 | 947.6 | 2.65 | 22.71 | 27.80 | 8.82 |
| Wallowa-Whitman | 1,177 | 9 | 167.7 | −14.2 | 236.7 | 158.8 | 67.1 | 221.4 | 229.1 | 103.5 | 3.5 | 378.1 | 2.25 | 5.12 | 5.18 | 9.28 |
| Wenatchee | 776 | 55 | 125.2 | 128.7 | 191.4 | 83.5 | 43.6 | 133.7 | 83.1 | 62.2 | 14.1 | 415.0 | 3.31 | 3.96 | 4.24 | 3.11 |
| Willamette | 1,324 | | 622.6 | 186.2 | 779.8 | 654.8 | 84.0 | 692.7 | 718.0 | 103.7 | | 1,842.3 | 2.96 | 27.32 | 29.12 | 7.75 |
| Winema | 812 | 17 | 99.6 | −87.8 | 180.9 | 137.7 | 76.1 | 120.2 | 103.0 | 85.7 | 15.2 | 474.3 | 4.76 | 14.68 | 19.52 | 3.82 |
| Subtotal | 1,6375 | 196 | 4,390.0 | 1,300.0 | 5,891.2 | 3,990.4 | 67.7 | 4,896.1 | 4770.1 | 97.4 | 109.3 | 12,118.4 | 2.76 | 19.08 | 24.28 | 8.01 |

See footnotes at end of table.

**Allowable Cut on the National Forest, Fiscal Year 1971**—Continued

| Allowable cut convertible products as of Jan. 1, 1971 | Allowable cut backlog or overcut | Convertible products: Financed goals: Cut: Plan | Cut: Actual | Cut: Percent | Sell: Plan | Sell: Actual | Sell: Percent | Volume offered not sold | Uncut volume: Under contract | Uncut volume: Ratio to allowable cut | Average price: Appraised per cord | Average price: High bid per cord | Average specified road cost per unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | | | | |
| | | 2.3 | 1.6 | 69.6 | 2.3 | 2.0 | 87.0 | | | | | | |
| | | .6 | .4 | 66.7 | .6 | .4 | 66.7 | | | | | | |
| | | 1.2 | .8 | 66.7 | 1.2 | .4 | 33.3 | | | | | | |
| | | .3 | .2 | 66.7 | .3 | .1 | 33.3 | | | | | | |
| | | .7 | 2.3 | 328.6 | .7 | 1.1 | 157.1 | | | | | | |
| | | .4 | .4 | 100.0 | .4 | .4 | 100.0 | | | | | | |
| | | 1.0 | 1.6 | 160.0 | .8 | 5.8 | 725.0 | | | | .58 | .58 | 1.11 |
| | | .6 | .3 | 50.0 | .6 | .5 | 83.3 | | | | | | |
| | | | | | .1 | .1 | 100.0 | | | | | | |
| | | .5 | .2 | 40.0 | .3 | .1 | 33.3 | | | | | | |
| | | .2 | .2 | 100.0 | .2 | .2 | 100.0 | | | | | | |
| | | .8 | .7 | 87.5 | .8 | .8 | 100.0 | | | | | | |
| 5.6 | | 4.5 | 3.2 | 71.1 | 4.6 | 2.6 | 56.5 | | | | | | |
| | | 7.3 | 5.6 | 76.7 | 7.3 | 6.1 | 83.6 | 0.1 | | | | | |
| | | 2.6 | .5 | 19.2 | 5.0 | 1.1 | 22.0 | | | | | | |
| | | 1.0 | .6 | 60.0 | 1.0 | .8 | 80.0 | | | | | | |
| | | 1.1 | .1 | 9.1 | 1.1 | .1 | 9.1 | | | | | | |
| | | 2.7 | 1.7 | 63.0 | 2.7 | 2.8 | 103.7 | | | | | | |
| 5.6 | | 27.8 | 20.4 | 73.4 | 30.0 | 25.4 | 84.7 | 0.1 | | | .58 | .58 | 1.11 |
| | | 1.6 | 1.7 | 106.3 | 1.8 | 1.2 | 66.7 | | | | | | |
| | | 1.6 | 1.0 | 62.5 | 1.6 | 1.9 | 118.8 | | .9 | | | | |
| | | 10.0 | 1.5 | 15.0 | 10.0 | .8 | 8.0 | | | | | | |
| | | 4.0 | .8 | 20.0 | 4.0 | .9 | 22.5 | | .1 | | | | |
| | | | 13.8 | | | 1.5 | | | | | | | |
| | | .6 | 3.9 | 650.0 | .6 | 1.9 | 316.7 | | | | | | |
| | | 1.4 | .4 | 28.6 | 1.4 | .7 | 50.0 | | .3 | | | | |
| | | 5.4 | | | 3.4 | .3 | 8.8 | | .3 | | | | |
| | | .2 | .1 | 50.0 | .2 | .1 | 50.0 | | | | | | |
| | | 6.0 | 5.3 | 88.3 | 6.0 | 2.9 | 48.3 | | .6 | | | | |
| | | 19.0 | 8.6 | 45.3 | 19.0 | 8.8 | 46.3 | | 4.6 | | | | |
| | | 6.8 | 1.1 | 16.2 | 1.2 | .8 | 66.7 | | | | | | |
| | | 1.6 | 24.3 | 1,518.8 | 1.6 | 2.1 | 131.3 | | | | | | |
| | | 7.4 | 3.0 | 40.5 | 8.6 | 1.9 | 22.1 | | .3 | | | | |
| | | | 47.3 | | | 2.7 | | | | | | | |
| | | .4 | 5.8 | 1,450.0 | .4 | 1.3 | 325.0 | | | | | | |
| | | 4.0 | 6.7 | 167.5 | 4.0 | 5.9 | 147.5 | | | | | | |
| | | 70.0 | 125.3 | 179.0 | 63.8 | 35.7 | 56.0 | | 7.1 | | | | |
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| 42.0 | | | | | | | | | | | | | |

| National forest | Sawtimber: As of Jan. 1, 1970: Area nonreserved commercial forest land thousand acres | Deferred commercial forest land thousand acres | Allowable cut sawtimber as of Jan. 1, 1971 | Allowable cut backlog or overcut | Financed goals: Cut: Plan | Cut: Actual | Cut: Percent | Sell: Plan | Sell: Actual | Sell: Percent | Volume offered not sold | Uncut volume: Under contract | Ratio to allow able cut | Average price: Appraised per thousand board feet | High bid per thousand board feet | Average specified road cost per unit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | (millions of board feet) | | | | |
| REGION 8 [2] | | | | | | | | | | | | | | | | |
| Alabama | 626 | | 43.7 | 31.1 | 32.2 | 32.2 | 100.0 | 34.4 | 27.9 | 81.1 | 0.7 | 53.3 | 1.22 | 29.23 | 39.45 | 8.20 |
| Cherokee | 599 | | 31.1 | 52.0 | 23.0 | 22.9 | 99.6 | 28.0 | 29.9 | 106.8 | 1.0 | 69.0 | 2.22 | 11.59 | 19.89 | 2.11 |
| Daniel Boone | 530 | | 31.9 | 6.6 | 42.0 | 23.0 | 54.8 | 31.9 | 19.9 | 62.4 | .9 | 49.1 | 1.54 | 15.63 | 20.03 | .06 |
| Florida | 1,035 | | 15.3 | 14.7 | 17.4 | 12.5 | 71.8 | 17.7 | 9.3 | 52.5 | | 14.5 | .95 | 48.62 | 59.06 | |
| George Washington | 799 | | 19.8 | 21.3 | 18.7 | 14.4 | 77.0 | 15.7 | 11.7 | 74.5 | .4 | 16.2 | .82 | 16.96 | 19.95 | 1.95 |
| Georgia | 807 | | 49.4 | 12.4 | 40.9 | 50.7 | 124.0 | 50.0 | 45.8 | 91.6 | | 75.4 | 1.53 | 24.43 | 38.76 | .70 |
| Jefferson | 499 | | 15.0 | 30.6 | 11.3 | 9.7 | 85.8 | 9.9 | 4.5 | 45.5 | 1.3 | 12.9 | .86 | 11.27 | 18.06 | |
| Kisatchie | 552 | | 51.1 | 118.9 | 52.8 | 47.0 | 89.0 | 66.0 | 70.3 | 106.5 | | 101.8 | 1.99 | 37.37 | 60.46 | 6.47 |
| Mississippi | 1,119 | | 95.2 | −8.0 | 98.2 | 97.7 | 99.5 | 110.5 | 109.1 | 98.7 | .1 | 171.8 | 1.80 | 36.45 | 49.85 | 5.45 |
| N. Carolina | 1,035 | | 45.4 | 97.7 | 69.3 | 39.5 | 57.0 | 49.5 | 34.9 | 70.5 | 1.2 | 159.2 | 3.51 | 17.91 | 26.68 | 2.14 |
| Ouachita | 1,515 | | 86.9 | 3.8 | 78.0 | 61.0 | 78.2 | 87.0 | 83.6 | 96.1 | 8.4 | 114.7 | 1.32 | 35.09 | 42.09 | 5.73 |
| Ozark-St. Francis | 1,097 | | 34.7 | 120.0 | 20.9 | 23.8 | 113.9 | 21.5 | 19.6 | 91.2 | .9 | 31.1 | .90 | 29.14 | 34.57 | .95 |
| S. Carolina | 551 | | 57.1 | 4.2 | 45.0 | 53.1 | 118.0 | 50.0 | 47.7 | 95.4 | | 82.4 | 1.44 | 33.65 | 41.02 | 6.21 |
| Texas | 625 | | 82.4 | −36.3 | 79.1 | 65.7 | 83.1 | 76.9 | 60.4 | 78.5 | .1 | 80.7 | .98 | 42.44 | 54.90 | 7.28 |
| Subtotal | 11,389 | | 659.0 | 469.0 | 628.8 | 553.2 | 88.0 | 649.0 | 574.6 | 88.5 | 15.0 | 1032.1 | 1.57 | 32.01 | 43.65 | 4.79 |
| REGION 9 [2] | | | | | | | | | | | | | | | | |
| Allegheny | 488 | | 26.7 | 6.8 | 26.0 | 24.6 | 94.6 | 22.5 | 21.9 | 97.3 | .5 | 39.1 | 1.46 | 39.66 | 45.02 | 10.18 |
| Chequamegon | 747 | | 5.3 | 14.8 | 2.8 | 2.2 | 78.6 | 3.2 | 2.6 | 81.3 | .3 | 10.0 | 1.89 | 19.26 | 21.55 | .01 |
| Chippewa | 570 | | 8.5 | 75.3 | 10.0 | 7.2 | 72.0 | 11.5 | 6.9 | 60.0 | .6 | 9.7 | 1.14 | 31.96 | 34.11 | |
| Clark | 740 | | 32.5 | 57.0 | 26.0 | 25.8 | 99.2 | 27.4 | 18.6 | 67.9 | 4.7 | 36.7 | 1.13 | 12.88 | 14.05 | |
| Green Mountain | 226 | | 18.0 | 90.7 | 16.3 | 12.3 | 75.5 | 11.2 | 8.5 | 75.9 | 1.8 | 28.3 | 1.57 | 42.26 | 42.82 | 3.16 |
| Hiawatha | 736 | | 6.8 | 16.1 | 4.2 | 2.6 | 61.9 | 5.6 | 3.9 | 69.6 | 1.8 | 10.0 | 1.47 | 23.46 | 27.04 | |
| Huron-Manistee | 850 | | 8.2 | 52.9 | 5.0 | 2.2 | 44.0 | 2.4 | 3.3 | 137.5 | .4 | 17.0 | 2.07 | 11.97 | 16.94 | |
| Mark Twain | 582 | | 21.0 | 78.8 | 20.0 | 21.6 | 108.0 | 19.3 | 20.2 | 104.7 | .5 | 41.7 | 1.99 | 14.31 | 17.65 | |
| Monongahela | 785 | | 56.0 | 189.6 | 43.3 | 30.4 | 70.2 | 43.0 | 24.3 | 56.5 | 2.7 | 53.9 | .96 | 15.75 | 19.10 | 1.50 |
| Nicolet | 571 | | 6.3 | 13.1 | 6.4 | 3.0 | 46.9 | 5.2 | 6.0 | 115.4 | | 20.9 | 3.32 | 31.31 | 40.44 | .05 |
| Ottawa | 837 | | 11.2 | 11.6 | 8.6 | 2.9 | 33.7 | 7.7 | 5.8 | 75.3 | 1.0 | 19.6 | 1.75 | 30.96 | 41.98 | .22 |
| Shawnee | 215 | | 9.1 | 4.3 | 7.9 | 7.3 | 92.4 | 7.2 | 5.6 | 77.8 | 1.5 | 23.6 | 2.59 | 16.51 | 20.14 | |
| Superior | 1,557 | | 12.1 | 50.9 | 14.0 | 7.1 | 50.7 | 29.0 | 6.1 | 21.0 | .2 | 37.9 | 3.13 | 12.53 | 14.78 | |
| Wayne-Hoosier | 266 | | 6.1 | −2.0 | 5.4 | 4.4 | 81.5 | 6.2 | 4.9 | 79.0 | .5 | 7.4 | 1.21 | 23.61 | 27.59 | |
| White Mountain | 606 | | 15.0 | 56.5 | 10.3 | 7.4 | 71.8 | 10.9 | 10.4 | 95.4 | | 18.7 | 1.25 | 29.14 | 40.85 | .24 |
| Subtotal | 9,776 | | 242.8 | 716.4 | 206.2 | 161.0 | 78.1 | 212.3 | 149.0 | 70.2 | 16.5 | 374.5 | 1.54 | 24.23 | 28.65 | 2.18 |
| REGION 10 [1] | | | | | | | | | | | | | | | | |
| Chugach | 749 | 74 | 67.5 | 133.1 | 10.0 | 1.9 | 19.0 | 55.0 | 11.8 | 21.5 | | 546.5 | 8.10 | 8.82 | 10.63 | |
| North Tongass | 2,483 | | 527.6 | 806.8 | 300.0 | 228.9 | 76.3 | 445.0 | 77.5 | 17.4 | | 13,684.9 | 25.94 | 4.80 | 9.68 | 1.76 |
| South Tongass | 1,912 | | 292.7 | 142.9 | 300.0 | 355.3 | 118.4 | 500.0 | 126.0 | 25.2 | 10.8 | 6,537.1 | 22.33 | 7.59 | 10.50 | 1.92 |
| Subtotal | 5,144 | 74 | 887.8 | 1,082.8 | 610.0 | 586.1 | 96.1 | 1,000.0 | 215.3 | 21.5 | 10.8 | 20,768.5 | 23.39 | 6.65 | 10.21 | 1.76 |
| SUMMARY R 1–10 | | | | | | | | | | | | | | | | |
| Region 1 | 15,591 | 856 | 1,671.3 | 2,046.7 | 1,720.0 | 1,303.1 | 75.8 | 1,650.0 | 1,185.6 | 71.9 | 38.8 | 3,744.3 | 2.24 | 5.94 | 11.87 | 7.22 |
| Region 2 | 10,814 | 729 | 595.2 | 2,847.4 | 430.0 | 293.3 | 68.2 | 290.0 | 233.6 | 80.6 | 19.3 | 1,087.7 | 1.83 | 3.05 | 3.33 | 5.55 |
| Region 3 | 5,287 | 59 | 409.2 | 430.1 | 434.1 | 344.0 | 79.2 | 393.8 | 316.2 | 80.3 | 38.5 | 986.4 | 2.41 | 12.54 | 13.80 | 4.91 |
| Region 4 | 9,369 | 642 | 740.2 | 1,561.9 | 536.1 | 375.5 | 70.0 | 520.0 | 471.4 | 90.7 | 19.6 | 1,670.3 | 2.26 | 6.19 | 6.83 | 3.48 |
| Region 5 | 8,179 | 157 | 1,948.7 | 1,349.0 | 2,331.0 | 1,766.1 | 75.8 | 1,898.1 | 1,757.2 | 92.6 | 16.1 | 4,256.5 | 2.18 | 12.13 | 24.38 | 8.59 |
| Region 6 | 16,375 | 196 | 4,390.0 | 1,300.0 | 5,891.2 | 3,990.4 | 67.7 | 4,896.1 | 4,770.1 | 97.4 | 109.3 | 12,118.4 | 2.76 | 19.08 | 24.28 | 8.01 |
| Region 8 | 11,389 | | 659.0 | 469.0 | 628.8 | 553.2 | 88.0 | 649.0 | 574.6 | 88.5 | 15.0 | 1,032.1 | 1.57 | 32.01 | 43.65 | 4.79 |
| Region 9 | 9,776 | | 242.8 | 716.4 | 206.2 | 161.0 | 78.1 | 212.3 | 149.0 | 70.2 | 16.5 | 374.5 | 1.54 | 24.23 | 28.65 | 2.18 |
| Region 10 | 5,144 | 74 | 887.8 | 1,082.8 | 610.0 | 586.1 | 96.1 | 1,000.0 | 215.3 | 21.5 | 10.8 | 20,768.5 | 23.39 | 6.65 | 10.21 | 1.76 |
| Grand totals | 91,924 | 2,713 | 11,544.2 | 11,804.1 | 12,787.4 | 9,372.7 | 73.3 | 11,509.3 | 9,673.0 | 84.0 | 283.9 | 46,038.7 | 3.99 | 15.62 | 22.06 | 7.24 |

[1] Volumes for harvest and sell sawtimber include convertible products shown on convertible products portion of report.

[2] Percentage accomplishment does not include volume offered and not sold.

| | | Convertible products | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Financed goals | | | | | | | | | | | |
| | | Cut | | | Sell | | | | Uncut volume | | Average price | | |
| Allowable cut convertible products as of Jan. 1, 1971 | Allowable cut backlog or overcut | Plan | Actual | Percent | Plan | Actual | Percent | Volume offered not sold | Under contract | Ratio to allowable cut | Appraised per cord | High bid per cord | Average specified road cost per unit |
| *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | *(thousands of cords)* | | | | |
| 43.4 | 36.7 | 26.0 | 35.6 | 136.9 | 41.2 | 64.6 | 156.8 | 3.4 | 64.2 | 1.48 | 4.64 | 6.22 | 0.25 |
| 47.8 | 206.0 | 44.0 | 27.0 | 61.4 | 44.0 | 34.2 | 77.7 | 6.0 | 93.0 | 1.95 | 1.24 | 1.51 | |
| 12.3 | 81.7 | 18.9 | 5.2 | 27.5 | 30.0 | 21.4 | 71.3 | 2.4 | 27.3 | 2.22 | 1.45 | 1.49 | .03 |
| 112.6 | 89.5 | 157.2 | 124.8 | 79.4 | 152.6 | 170.0 | 111.4 | 18.0 | 248.4 | 2.21 | 8.37 | 10.42 | .09 |
| 113.9 | 228.3 | 62.6 | 49.1 | 78.4 | 88.6 | 50.2 | 56.7 | 2.0 | 59.1 | .52 | 1.01 | 1.39 | |
| 8.1 | −31.2 | 18.2 | 32.0 | 175.8 | 24.0 | 29.2 | 121.7 | | 34.7 | 4.28 | 3.96 | 4.89 | |
| 60.0 | 118.7 | 38.4 | 48.0 | 125.0 | 34.6 | 14.8 | 42.8 | 6.4 | 26.8 | .45 | 1.83 | 2.87 | |
| 64.5 | 83.2 | 64.6 | 80.4 | 124.5 | 99.3 | 108.0 | 108.8 | | 158.7 | 2.46 | 3.35 | 4.92 | .60 |
| 87.6 | 63.4 | 103.6 | 110.8 | 106.9 | 109.0 | 112.0 | 102.8 | 7.8 | 149.3 | 1.70 | 3.33 | 3.95 | .79 |
| 225.2 | 231.2 | 73.4 | 48.0 | 65.4 | 45.0 | 44.6 | 99.1 | 2.7 | 191.1 | .85 | 2.08 | 2.21 | .58 |
| 77.4 | 5.0 | 124.0 | 91.4 | 73.7 | 140.0 | 149.0 | 106.4 | 18.9 | 216.3 | 2.79 | 2.27 | 2.59 | .24 |
| 23.5 | −14.6 | 18.2 | 29.4 | 161.5 | 27.0 | 22.6 | 83.7 | 2.7 | 27.9 | 1.19 | 3.48 | 4.10 | |
| 73.8 | −35.8 | 110.0 | 127.4 | 115.8 | 142.0 | 148.0 | 104.2 | | 303.9 | 4.12 | 4.22 | 5.90 | 1.42 |
| 43.1 | 117.3 | 43.2 | 32.8 | 75.9 | 49.0 | 64.6 | 131.8 | .7 | 43.9 | 1.02 | 3.43 | 4.03 | |
| 993.2 | 1,179.4 | 902.3 | 841.9 | 93.3 | 1,026.3 | 1,033.2 | 100.7 | 71.0 | 1,644.6 | 1.60 | 3.84 | 4.91 | .52 |
| 136.8 | 215.3 | 33.4 | 28.1 | 84.1 | 33.0 | 40.7 | 123.3 | 5.1 | 91.0 | .67 | .87 | 1.03 | |
| 120.3 | 204.2 | 84.4 | 79.0 | 93.6 | 99.8 | 96.0 | 96.2 | .1 | 296.6 | 2.47 | 1.79 | 2.54 | .04 |
| 141.7 | 527.5 | 90.0 | 80.5 | 89.4 | 87.4 | 100.0 | 114.4 | 6.0 | 337.5 | 2.38 | 1.69 | 2.45 | |
| 59.8 | 67.4 | 12.0 | 12.6 | 105.0 | 13.2 | 18.2 | 137.9 | 2.4 | 28.6 | .48 | 3.44 | 3.48 | |
| 12.0 | 91.2 | 7.4 | 3.1 | 41.9 | 5.6 | 6.2 | 110.7 | 5.5 | 17.2 | 1.43 | 1.22 | 1.42 | |
| 96.5 | 189.7 | 65.6 | 40.5 | 61.7 | 177.4 | 89.2 | 50.3 | 100.3 | 210.2 | 2.18 | 2.51 | 3.66 | |
| 124.7 | 284.7 | 132.2 | 131.6 | 99.5 | 118.8 | 104.7 | 88.1 | 17.3 | 377.0 | 3.02 | 1.98 | 2.60 | |
| 51.5 | 48.8 | 4.0 | 2.7 | 67.5 | 3.4 | 2.2 | 64.7 | | | | | | |
| 50.0 | 192.2 | 25.4 | 18.8 | 74.0 | 20.8 | 12.5 | 60.1 | | 48.7 | .97 | 1.96 | 2.31 | |
| 88.4 | 63.4 | 81.2 | 74.0 | 91.1 | 91.2 | 91.5 | 100.3 | 2.6 | 304.6 | 3.45 | 2.03 | 3.43 | .05 |
| 136.3 | 127.4 | 92.8 | 64.3 | 69.3 | 81.0 | 67.7 | 83.6 | 15.1 | 357.2 | 2.62 | 2.21 | 2.98 | .05 |
| 22.7 | 38.7 | 3.8 | 4.1 | 107.9 | 3.6 | 2.8 | 77.8 | .5 | 25.7 | 1.13 | .50 | .50 | |
| 595.8 | 5,324.0 | 150.0 | 164.7 | 109.8 | 102.2 | 40.4 | 39.5 | 29.1 | 1,176.8 | 1.98 | 2.70 | 2.99 | |
| 15.7 | 24.9 | 7.2 | 7.1 | 98.6 | 7.6 | 7.1 | 93.4 | .5 | 8.3 | .53 | .50 | .97 | |
| 78.0 | 321.2 | 56.0 | 52.3 | 93.4 | 58.4 | 48.5 | 83.0 | | 76.3 | .98 | 1.28 | 2.50 | .18 |
| 1,730.2 | 7,720.6 | 845.4 | 763.4 | 90.3 | 903.4 | 727.7 | 80.6 | 184.5 | 3,355.7 | 1.94 | 1.93 | 2.79 | .03 |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| 368.5 | | 134.4 | 38.8 | 28.9 | 100.8 | 43.8 | 43.5 | | | | 2.82 | 2.95 | |
| 774.0 | 7,225.6 | 100.0 | 86.5 | 86.5 | 80.0 | 67.7 | 84.6 | 14.0 | 186.3 | .24 | .60 | .88 | .10 |
| 345.2 | 2,782.3 | 151.7 | 99.7 | 65.7 | 52.4 | 36.9 | 70.4 | 5.1 | 4,818.7 | 13.96 | 1.88 | 1.88 | |
| 5.6 | | 27.8 | 20.4 | 73.4 | 30.0 | 25.4 | 84.7 | .1 | | | .58 | .58 | 1.11 |
| | | 70.0 | 125.3 | 179.0 | 63.8 | 35.7 | 56.0 | | 7.1 | | | | |
| 42.0 | | | | | | | | | | | | | |
| 993.2 | 1,179.4 | 902.3 | 841.9 | 93.3 | 1,026.3 | 1,033.2 | 100.7 | 71.0 | 1,644.6 | 1.66 | 3.84 | 4.91 | .52 |
| 730.2 | 7,720.6 | 845.4 | 763.4 | 90.3 | 903.4 | 727.7 | 80.6 | 184.5 | 3,355.7 | 1.94 | 1.93 | 2.78 | .03 |
| | | | | | | | | | | | | | |
| 258.7 | 18,907.9 | 2,231.6 | 1,976.0 | 88.5 | 2,256.7 | 1,970.4 | 87.3 | 274.7 | 10,012.4 | 2.35 | 2.99 | 3.94 | .32 |

[3] Volumes for harvest and sell sawtimber do not include convertible products.

[4] Reflects only actual harvest during management plan period. Does not include uncut volumes under contract.

**TABLE 2.—Status of National Forest Timber Management Planning in Western Regions, September 1972**

| Region and forest | Allowable cut of sawtimber Jan. 1, 1972 | Date of current approved plan[1] | Scheduled date of next plan revision: Based on new inventory | Scheduled date of next plan revision: Based on old inventory |
|---|---|---|---|---|
| Region 1: | | | | |
| Beaverhead | 93.5 | July 1, 1970 | | July 1, 1973 |
| Bitterroot | 66.3 | July 1, 1965 | | Do. |
| Clearwater | 211.8 | July 1, 1966 | | Do. |
| Coeur d'Alene | 103.0 | July 1, 1964 | July 1, 1973 | |
| Colville | 92.5 | July 1, 1965 | | Do. |
| Custer | 10.4 | July 1, 1967 | | Do. |
| Deerlodge | 67.0 | July 1, 1968 | | Do. |
| Flathead | 194.6 | July 1, 1969 | | Do. |
| Gallatin | 52.0 | July 1, 1966 | | Do. |
| Helena | 40.5 | July 1, 1969 | | Do. |
| Kaniksu | 153.1 | 1959, 1961, and 1963. | | Do. |
| Kootenai | 234.2 | July 1, 1967 | | Do. |
| Lewis and Clark | 40.4 | 1961 and 1967 | July 1, 1973 | |
| Lolo | 191.7 | 1959 and 1961 | | Do. |
| Nezperce | 105.3 | July 1, 1963 | | Do. |
| St. Joe | 99.0 | July 1, 1962 | | Do. |
| Total | 1,755.3 | | | |
| Region 2: | | | | |
| Arapaho | 28.5 | June 30, 1972 | July 1, 1973 | |
| Bighorn | 19.5 | do | do | |
| Black Hills | 67.0 | Sep. 18, 1963 | do | Do. |
| GM-Unc | 40.0 | July 6, 1972 | July 1, 1973 | |
| Gunnison | 46.2 | July 13, 1972 | | Do. |
| Medicine Bow | 59.1 | June 30, 1972 | July 1, 1973 | |
| Nebraska | | | | |
| Pike | 10.0 | July 13, 1972 | | Do. |
| Rio Grande | 60.6 | June 30, 1972 | July 1, 1973 | |
| Roosevelt | 28.3 | do | | Do. |
| Routt | 50.7 | July 3, 1972 | July 1, 1973 | |
| San Isabel | 10.0 | June 30, 1972 | | Do. |
| San Juan | 127.0 | do | July 1, 1973 | |
| Shoshone | 9.5 | Oct. 30, 1970 | July 1, 1973 | |
| White River | 38.8 | June 30, 1972 | | Do. |
| Total | 595.2 | | | |
| Region 3: | | | | |
| Apache | 68.7 | 1963, 1948, 1954, and 1963. | June 30, 1973 | |
| Carson | 48.8 | 1963, 1965, and 1966. | do | |
| Cibola | 17.0 | Dec. 22, 1971 | do | |
| Coconino | 65.2 | Feb. 4, 1965 | Dec. 31, 1972 | |
| Coronado | 5.0 | 1962 | June 30, 1973 | |
| Gila | 23.4 | Sept. 14, 1972 | | May 15, 1967 |
| Kaibab | 65.0 | 1962 and 1972 | June 30, 1973 | |
| Lincoln | 20.5 | Apr. 14, 1972 | | May 15, 1967 |
| Prescott | 3.1 | Dec. 8, 1965 | June 30, 1973 | |
| Santa Fe | 46.1 | 1958, 1960, and 1962. | Dec. 31, 1973 | |
| Sitgreaves | 56.2 | Mar. 9, 1967 | June 30, 1973 | |
| Tonto | 9.4 | 1963 and 1965 | Dec. 31, 1973 | |
| Total | 426.6 | | | |
| Region 4: | | | | |
| Ashley | 30.2 | Oct. 27, 1965 | | 1972 |
| Boise | 175.8 | May 21, 1967 | 1977 | |
| Bridger | 39.4 | Apr. 7, 1965 | 1973 | |
| Cache | 16.1 | Apr. 19, 1967 | | 1973 |
| Caribou | 18.8 | Apr. 13, 1967 | | Do. |
| Challis | 78.4 | May 26, 1966 | | Do. |
| Dixie | 29.2 | Dec. 22, 1965 | 1973 | |
| Fishlake | 19.8 | May 9, 1966 | | 1973 |
| Humboldt | | June 21, 1972 | 1980 | |
| Region 4—Con. | | | | |
| Manti-LaSal | 17.1 | 1–3, 10, 1966 | | 1973 |
| Payette | 95.2 | June 11, 1971 | 1974 | |
| Salmon | 40.4 | Feb. 19, 1970 | 1975 | |
| Sawtooth | 20.5 | May 18, 1966 | | 1973 |
| Targhee | 62.8 | Mar. 15, 1965 | 1973 | |
| Teton | 53.4 | Oct. 24, 1962 | | 1973 |
| Toiyabe | 16.3 | Apr. 3, 1970 | 1978 | |
| Uinta | 5.4 | May 23, 1966 | 1974 | |
| Wasatch | 21.6 | Nov. 6, 1965 | | 1973 |
| Total | 740.4 | | | |
| Region 5: | | | | |
| Angeles | 1.2 | Oct. 17, 1961 | July 1, 1974 | |
| Cleveland | 0 | do | do | |
| Eldorado | 130.3 | June 13, 1960 | do | |
| Inyo | 15.3 | Mar. 29, 1967 | July 1, 1975 | |
| Klamath | 240.3 | Dec. 22, 1960 | July 1, 1973 | |
| Lassen | 166.6 | Aug. 10, 1961 | do | |
| Los Padres | 2.0 | Oct. 17, 1961 | July 1, 1974 | |
| Mendocino | 90.5 | June 13, 1960 | July 1, 1973 | |
| Modoc | 61.6 | July 14, 1959 | do | |
| Plumas | 220.3 | Aug. 15, 1960 | do | |
| San Bernadino | 7.1 | Oct. 17 1961 | July 1, 1974 | |
| Sequoia | 110.0 | Oct. 18, 1961 | do | |
| Shasta-Trinity | 283.7 | 1959 and 1960 | July 1, 1973 | |
| Sierra | 152.2 | Nov. 1, 1960 | July 1, 1974 | |
| Six Rivers | 206.4 | Nov. 22, 1971 | July 1, 1981 | |
| Stanislaus | 139.4 | Aug. 6, 1959 | July 1, 1973 | |
| Tahoe | 148.6 | July 9, 1959 | do | |
| Total | 1,975.5 | | | |
| Region 6: | | | | |
| Deschutes | 138.0 | June 14, 1963 | 1974 | |
| Fremont | 143.0 | May 6, 1965 | 1975 | |
| Gifford Pinchot | 416.4 | 1962 | 1973 | |
| Malheur | 171.0 | Jan. 18, 1962 | do | |
| Mount Baker | 164.3 | 1962 | do | |
| Mount Hood | 330.0 | Jan. 14, 1963 | 1974 | |
| Ochoco | 131.0 | June 25, 1963 | do | |
| Okanogan | 88.1 | Oct. 28, 1969 | 1978 | |
| Olympic | 371.4 | 1957, 1968, and 1970. | 1976 | |
| Rogue River | 176.4 | Sept. 21, 1962 | 1973 | |
| Siskiyou | 190.9 | June 1, 1962 | do | |
| Siuslaw | 348.0 | Nov. 10, 1966 | 1976 | |
| Snoqualmie | 214.3 | Mar. 3, 1969 | 1974 | |
| Umatilla | 135.1 | Jan. 11, 1963 | 1973 | |
| Umpqua | 357.0 | Dec. 5, 1961 | do | |
| Wallowa-Whitman. | 167.7 | Aug. 22, 1962 | do | |
| Wenatchee | 125.2 | Dec. 16, 1963 | 1974 | |
| Willamette | 622.6 | May 17, 1965 | do | |
| Winema | 99.6 | May 6, 1965 | 1975 | |
| Total | 4,390.0 | | | |
| Region 10: | | | | |
| North Tongass | 530.0 | Not available | Not available | Not available |
| South Tongass | 294.0 | do | do | Do. |
| Chugach | 68.0 | do | do | Do. |
| Total | 892.0 | | | |
| Total, Western Regions. | 10,755.0 | | | |

[1] Where more than 1 date is given, dates are for working circles.

## Excerpts from Forest Service Manual

TITLE 2400—TIMBER MANAGEMENT[1]

The logic for determining major classification of productive forest land is shown in exhibit 2.

*2412.11—Area classification definitions.*—The gross area of national forest ownership includes land and water areas. These terms are defined as follows:

1. *Land area.*—The area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river flood plains (omitting tidal flats below mean high tide); streams, sloughs, estuaries, and canals less than 120 feet in width; and lakes, reservoirs, and ponds less than 1 acre in area.

2. *Water.*—Streams, sloughs, estuaries, and canals more than 120 feet in width; and lakes, reservoirs, and ponds more than 1 acre in area.

*2412.12—Land classification.*—Land is further classified into forest and nonforest.

1. *Forest land.*—Land at least 10 percent occupied; stocked by forest trees of any size, or formerly having had such tree cover, and not currently developed for nonforest use.

2. *Nonforest land.*—Land that has never supported forests and lands formerly forested where use for timber utilization is precluded by development for other uses.

*2412.13—Forest land classification.*—Forest land is further classified as productive or unproductive.

1. *Productive forest land.*—Forest land which is producing or capable of producing crops of industrial wood. This includes areas suitable for management to grow crops of industrial wood generally of a site quality capable of producing in excess of 20 cu ft per acre of annual growth. This includes both accessible and inaccessible areas. Permanently inoperable or nonstockable areas are excluded because they are not suitable for silvicultural management. Conversely, nonstocked areas which are stockable and otherwise meet this definition are included.

2. *Unproductive forest land.*—All forest land not included in the productive forest land classification.

*2412.14 Productive forest land classification.*—Productive forest land is divided into several further classifications including reserved, deferred, and commercial forest.

1. *Productive reserved forest land.*—Productive forest lands withdrawn from timber utilization by statute, administrative regulation (Federal Code of Regulations), or by designation in land-use plans approved by the regional forester.

2. *Deferred forest land.*—Productive forest land that has been administratively identified for study as possible additions to the Wilderness System or other withdrawal from timber utilization under authority granted in the Federal Code of Regulations.

3. *Commercial forest land.*—Forest land which is producing or capable of producing crops of industrial wood and has not been reserved or deferred. This includes areas suitable for management to grow crops of industrial wood generally of a site quality capable of producing in excess of 20 cu ft per acre of annual growth. This includes both accessible and inaccessible areas. Permanently inoperable or nonstockable areas are excluded because they are not suitable for silvicultural management. Conversely, nonstocked areas which are stockable and otherwise meet this definition are included.

*2412.15—Commercial forest land classification.*—All commercial forest land in the National Forest System is further subdivided into one of the components of standard, special, marginal, or unregulated.

1. *Standard.*—The component of the regulated (FSM 2415.3) commercial forest land area on which crops of industrial wood can be grown and harvested with adequate protection of the forest resources under the usual provisions of the timber sale contract.

This area includes stands of immature trees or areas not yet accessible, but which will be in the future under the normal course of events. This area is capable of producing timber crops that have a reasonable probability of demand under the accessibility and economic conditions projected for a 10-year-plan period, even though portions of the area may not be developed during this period. Economic conditions projected for the plan period should generally assume continuation of average forest product prices experienced during the past 3 years.

[1] USDA Forest Service Manual Amendment No. 68, May 1972.

## *EXHIBIT 1

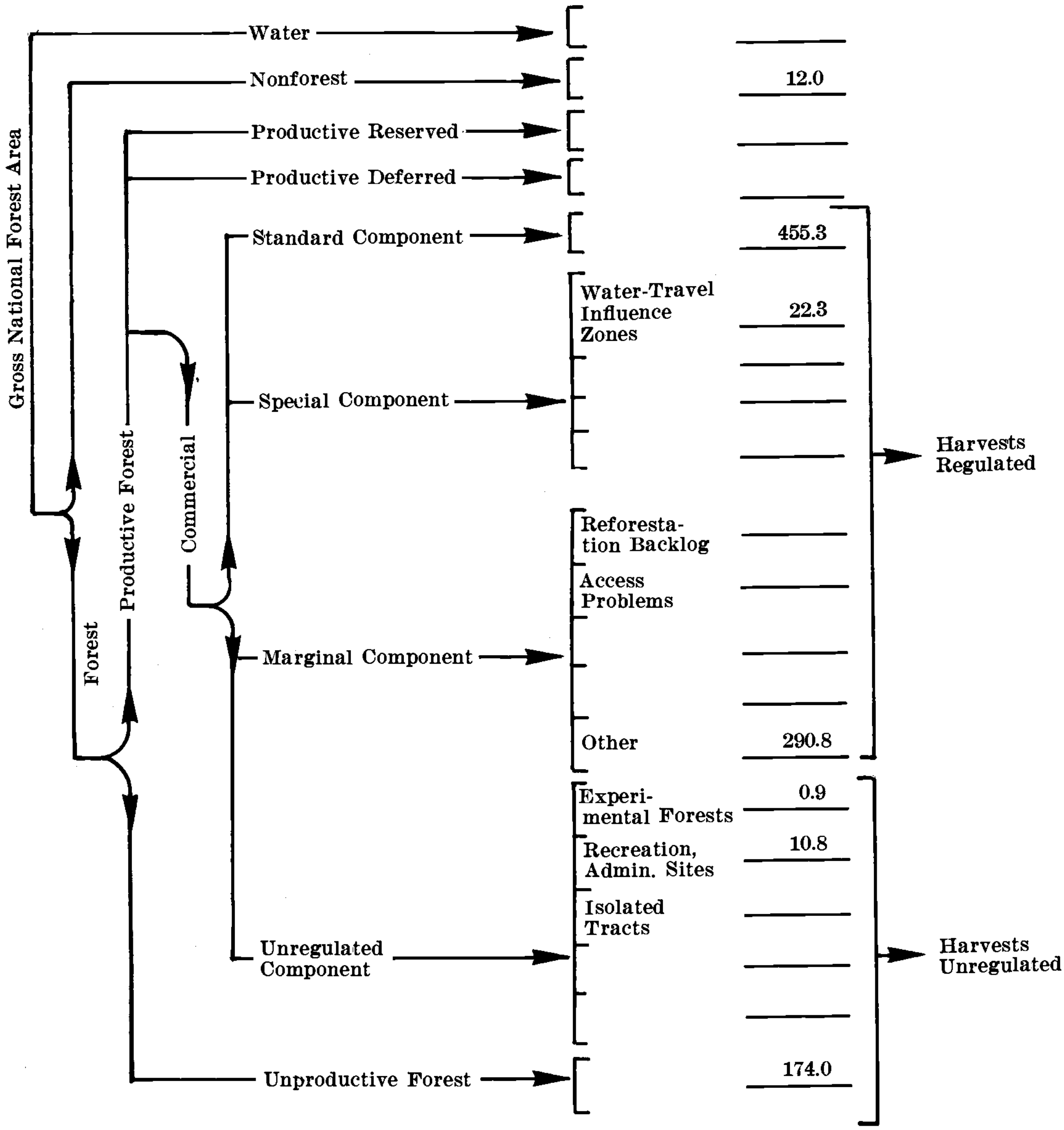
### Standard Land Use Classification For Timber Management

22 | Sasquatch National Forest
Code | Name

Effective Period, FY *1970* through *1980*

| Sub Unit
Code | Name

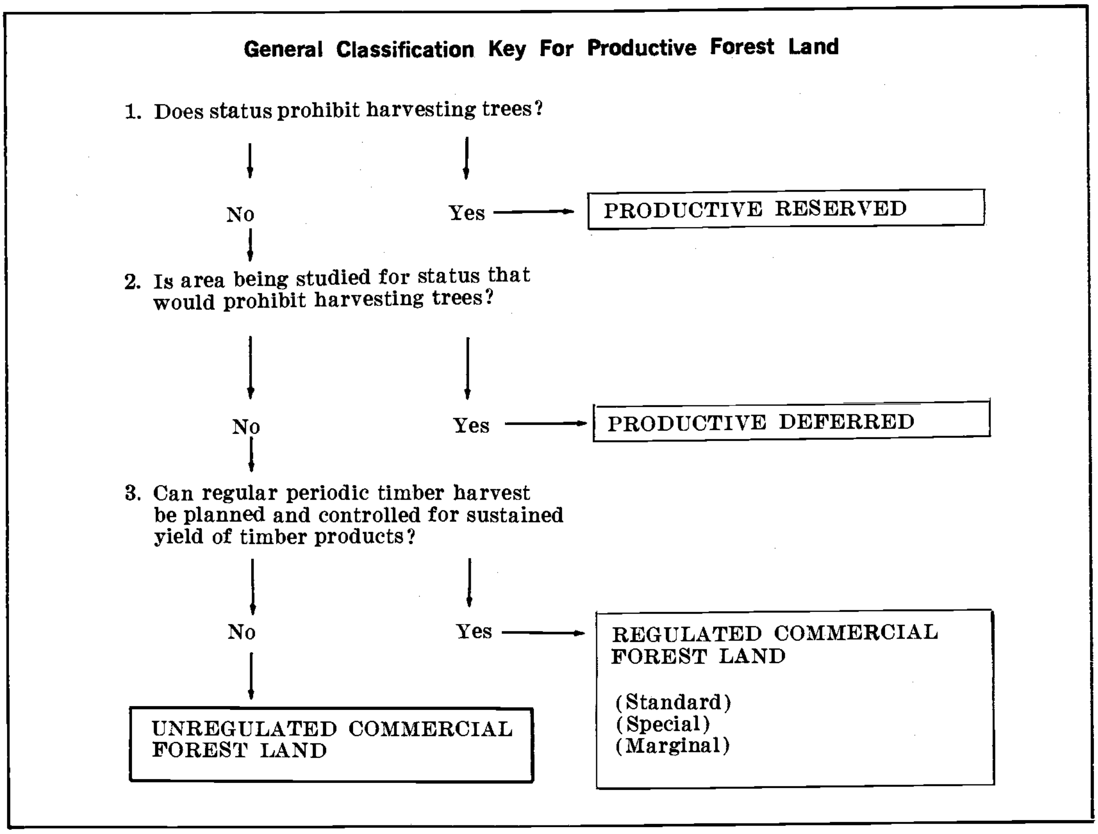
M Acres




TOTAL GROSS NATIONAL FOREST AREA 966.1

*The logic for determining major classification of productive forest land is shown in exhibit 2.

## EXHIBIT 2




2. *Special.*—The component of the regulated commercial forest land area that is recognized in the multiple-use plan as needing specially designed treatment of the timber resource to achieve landscape or other key resource objectives. Areas where timber management activities are informally delayed pending multiple use planning studies and management decisions, travel and water influence zones, peripheral portions of developed sites, and classified recreation areas, such as Whiskeytown-Shasta Trinity National Recreation Area where timber harvest is a secondary or minor management objective should be included in this classification. Areas identified as special will be included in this component whether or not there is a reduction in yield or no harvest at all expected in the 10-year-plan period.

3. *Marginal.*—This component of the regulated commercial forest land includes area not qualifying as standard or special components primarily because of excessive development cost, low-product values, or resources protection constraints. Included may be drainages requiring unusual logging techniques, such as helicopters, areas where harvesting is blocked until Government-constructed roads are in place, or species types not presently in demand. Also included is the backlog of nonstocked areas that would otherwise be classed as standard, but are in need of reforestation that cannot be accomplished with Knutson-Vanderberg Act funds.

4. *Unregulated.*—This is commercial forest land that will not be organized for timber production under sustained yield principles. It includes:

Experimental forests; recreation and administrative sites; existing and planned recreation development sites (FSM 2330.5); special interest areas (FSM 2360); and those administrative sites where timber harvest is permissible but not a goal of management, such as ranger stations, guard stations, nurseries, etc.

Isolated tracts of commercial forest land so completely remote from manufacturing centers that organizing and scheduling sustained periodic harvest is impractical.



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2412.2—Block.—Block may be used to designate major administrative division of a national forest. This use usually will be limited to designation of areas to which part of an operating schedule or control record is assigned. Frequently, the areas will be coextensive with ranger districts. The term may also be used to identify small areas which are regulated with, but are detached from, a main working circle area.

2412.3—Compartment.—A compartment is defined as an organization unit or small subdivision of forest area for purposes of orientation, administration, and silvicultural operations, and defined by permanent boundaries, either of natural features or artificially marked, which are not necessarily coincident with stand boundaries.

Where compartments are used, it is desirable that the inventory data permit rough estimates of quantities involved in the major planned cultural operations in each. An approximation of the compartment volumes available for cutting during the next decade is desirable. Estimates based on stand and condition class averages are usually sufficient. Refinements, as needed, are provided for in the action plan.

Compartments are essential to intensive management. Their use simplifies the total job of converting wild to well-managed forests. Since the compartment is a primary operating and record unit, boundary changes are undesirable. Regional instructions regarding compartmentation should include normal and maximum size.

2412.4—Stand.—A stand is an aggregation of trees or other growth occupying a specific area and sufficiently uniform in composition (species), age arrangement, and condition as to be distinguishable from the forest or other growth on adjoining areas.

Usually where compartments are numbered, stands will be designated on maps and records by the compartment number followed by a decimal number.

Where conditions are such that it can be done at reasonable cost, stands may be mapped (or existing maps updated), as part of inventory. Data shall be recorded in a form which will permit summary by groups of like stands. Where complicated stand and condition classes preclude useful mapping as part of inventory, provision should be made for mapping progressively over the cutting periods, as a compartment or sale area examination requirement. This provision may also be made where the sampling pattern is sufficiently intensive to give stand area estimates that are accurate enough for long-range planning.

2415.41—Potential yield.—The potential yield for the next 10 years is the maximum harvest that could be planned to achieve the optimum perpetual sustained-yield harvesting level attainable with intensive forestry on regulated areas considering the productivity of the land, conventional logging technology, standard cultural treatments, and interrelationship with other resource uses and the environment. As used here, conventional logging technology and standard cultural treatments include all applicable developed and proven systems for intensive management of the area whether or not they are currently economical or in general use in the area. Excluded are the effects of intensive activities that, at this time, remain speculative or with unquantified benefit over large portions of the country such as genetics, fertilization, and irrigation.

Forests products other than sawtimber are usually available and may or may not have reasonable probability of demand. The volume of such wood that is available should also be computed and stated on the potential-yield statement (FSM 2415.45, exhibit 1) under the heading of "Products".

The potential yield is a 10-year area and volume figure. Where the activity or area is regulated, volume should be estimated. Where harvest volume is regulated, the area to be harvested or treated should be estimated.

Control records (area and/or volume) must be kept separately for each of the components of the potential yield so that the harvest will come from the area or activity for which it was planned. Potential yield, therefore, is expressed in components which are not interchangeable in controlling the regulated harvest.

Regional foresters may establish additional subheadings or elements within each component. In order to have effective management controls, it is essential that each noninterchangeable component and element of the potential yield be readily identifiable by field personnel either by mapped area or by the unique nature of the management activity itself.

The total potential yield for the 10-year-plan period is the full potential in area and volume that should be harvested under the policy stated in

FSM 2410.3. It is subdivided into any combination of the three regulated components (standard, special, marginal), for the long-range control.

1. Standard—The regulated harvest that: (1) can and should be produced through intensive management on standard acres of the forest; and (2) has a reasonable probability of demand and/or funding under the accessibility and economic conditions projected for the plan period; and (3) can be harvested with adequate protection of the forest resources under usual provisions of the timber sale contract including usual utilization.

2. Special—The regulated harvest on special areas that can and should receive special attention because of landscape, environmental, soil, or other key-use considerations. The potential yield for this component is the harvest that can be carried out without violating the direction given in subregional, multiple-use guides or multiple-use plans.

3. Marginal—The regulated harvest from marginal areas that is silviculturally desirable to meet management objectives, but requires special funding or has a low probability of being acceptable to prospective purchasers during the plan period.

In addition marginal potential yield opportunities often occur on standard areas. These opportunities may include: (1) poletimber thinning yields, (2) earned yield increases on standard areas resulting from activities on marginal areas, such as reforestation of nonstocked backlog acres not covered by K–V funds, and (3) earned yield increases on standard areas from activities, such as timber stand improvement that cannot be accomplished under the Knutson-Vandenberg (K–V) Act.

2415.42—Programed allowable harvest.—The programed allowable harvest is that part of the potential yield that is scheduled for a specific year. It is based on current demand, funding, silvicultural practices, and multiple-use considerations. Annually, a programed allowable harvest statement will be prepared and submitted to the Chief reflecting the expected level of financing and showing the scheduled mix of yield components. The programed allowable harvest statement may consist of both regulated and unregulated acres or volume, or both as appropriate.

The programed allowable harvest will be the cutting plan and commitment shown in reports, such as the timber business report, program attainment report, and the timber sale accomplishment report.

Where components of the programed allowable harvest are less than the potential yield, it will be a continuing objective to remove the barriers and work the programed allowable harvest up to the full potential yield.

Neither overharvesting nor underharvesting of any component of the regulated harvest will be carried forward to a subsequent 10-year-plan period.

2415.43—Potential yield and programed allowable harvest calculations.

1. Potential yield calculations.—These calculations should employ a form of tabular scheduling through time by stand condition, size, or age reflecting a high level of intensive management. A tabular format similar to an area-volume check or Timber RAM report is appropriate. Calculations should summarize periodic timber outputs for at least 1½ rotations to insure compliance with the policy stated in FSM 2410.3. The use of allowable cut formulas should be avoided except as rough checks on tabular methods.

Where multiple-use coordinating requirements dictate a change from normal silvicultural systems, the reduction in yield, if any, must be determined. One acceptable method is to lengthen the rotation (FSM 2415.23). Computerized yield simulations, models, and linear programing techniques, when available, provide an effective means of evaluating the effect of multiple-use prescription alternatives.

When necessary for control, analysis may be by recognized working group and the potential yield and programed allowable harvest established on that basis (FSM 2412.5).

Calculations for the standard and special components of the regulated harvest will ordinarily require more exacting accuracy standards while the relatively lower probability of accomplishing marginal regulated harvest objectives will permit less exact calculations.

Recognized silvicultural treatments (FSM 2471) should appear as noninterchangeable practices in the potential yield calculations. Opportunities for intermediate cutting and regeneration cutting including: (1) group, patch, and strip cutting, (2) shelterwood, and (3) selection cutting, when of significant area, should be recognized as noninterchangeable practices in the calculations. Similarly, when significant areas offer opportunities for removal of overstories from advanced regeneration, poles or immature sawtimber, these practices should be handled as noninterchangeable and the released understory stands by reentered in the calculations at their appropriate age. Where necessary to guide management on a forest, major silvicultural treatment classes may have subheadings, such as seed tree under shelterwood or sanitation salvage under intermediate harvests.

Where opportunities exist for increasing potential yield through additional funding for reforesting the backlog of nonstocked areas or timber stand improvement on stands not qualifying under the K–V act, the preferred method for computing possible yield increases associated with such activities is to calculate potential yields as if the: (1) activity would not be accomplished and (2) activity would be accomplished. The resulting difference is an indication of the potential yield adjustment earned through actual accomplishment of the activity. When such activities are planned, the potential productivity increases per acre treated will be a stated yield increase factor per acre accomplished. For reforestation of the backlog of nonstocked burns, cut over areas not covered by K–V funds or rehabilitation of nonmerchantable stagnated stands, the increase will be continuing and accumulative for each year remaining in a rotation. For release or precommercial thinning the increase will be for one time only and a like area of TSI accomplishment would be required each year to maintain the added yield through a rotation.

Where marginal yield opportunities require funds in addition to those generated by the commercial timber sale activities, the factor for potential yield increases per acre treated in this portion of the marginal potential yield statement will be footnoted at the bottom of the statement (exhibit 1 at the end of FSM 2415.45). As a minimum, factors will be shown for: (1) reforestation of the nonstocked backlog acres, and (2) for timber stand improvement opportunities not covered under the K–V Act.

The purpose of maintaining separate controls on these two specific activities is to support program emphasis on them and to increase programed allowable harvest when earned by actually having made these investments in tree growing.

2. *Programed allowable harvest calculations.*— These calculations generally involve the aggregation of activities that can be scheduled for the ensuing fiscal year(s) from the opportunities indicated in the potential yield statement. The level of the programed allowable harvest is based on indicated financing for the ensuing fiscal year(s). It is developed from detailed action plans for sales, cultural work, and Government road construction.

Where marginal yields are indicated in the potential yield statement for reforesting nonstocked backlog acres, timber stand improvement, or for access road construction, the programed allowable harvest should include yield increases earned by multiplying acreage of such work accomplished in the previous fiscal year or years, times the appropriate factor as indicated on the potential yield statement.

As an aid to developing the potential yield and programed allowable harvest, regional foresters may specify intermediate work formats and program levels that can be condensed and summarized into the standard statement formats shown in exhibit 1 at the end of FSM 2415.45 and 2415.46, respectively.

2415.44—*Potential yield and programed allowable harvest approval.*—The area and volume of potential yield developed in the timber management plan will set the maximum rate of harvest during the period covered by the plan, unless the plan is revised prior to expiration.

The potential yield statement is shown as exhibit 1 at the end of FSM 2415.45. The potential yield for a national forest will be effective when approved by the regional forester. Interim adjustments may be approved annually by the regional forester to cover emergency situations or major changes in land use decisions. Regional foresters may elect to annually revise the potential yield statement to reflect increases in the standard area, such as when nonstocked backlog areas are reforested, marginal areas qualify as standard due to Government access road construction, or type conversion is accomplished. Approval of programed allowable harvest may be delegated to forest supervisors.

2415.45—*Form of potential yield statement.*— The summary format for showing the approved potential yield should be as shown in exhibit 1 which follows. When significant changes in the commercial forest land base occur or other major changes dictate, regional foresters may approve a new potential yield statement. In such cases the years remaining in the plan period will be shown in effective period and acres and volumes will be appropriate for the shorter period.

2415.46—Form of Programed Allowable Harvest Statement.—The summary format for showing the approved annual programed allowable harvest is shown in exhibit 1 which follows. This will facilitate updating the programed allowable harvest as progress is made in bringing components up to the full potential yield.

**EXHIBIT 1.—Potential Yield Statement, Potential Yield**

[Code: 22. Name: Sasquatch National Forest. Fiscal year: 1970 through 1980, effective period. Approved: (S) Fred Smith, Regional Forester. Date: April 16, 1969]

| | Thousand acres | Sawtimber | | Products | |
|---|---|---|---|---|---|
| | | Thousand cord units | Million board feet | Thousand cord units | Thousand cords |
| Standard—Total | 94.6 | 133.8 | 2059.3 | | |
| Group, patch, strip | 45.6 | 94.9 | 1460.3 | | |
| Shelterwood | | | | | |
| Selection | | | | | |
| Intermediate | 18.1 | 12.6 | 194.1 | | |
| OS removal | 30.9 | 26.3 | 404.9 | | |
| Special—Total | 1.7 | 0.3 | 5.0 | | |
| Marginal—Total | 142.4 | 51.1 | 850.0 | 78.0 | 101.4 |
| Reforested backlog [1] | | | | | |
| TSI backlog [2] | 40.6 | 1.1 | 17.1 | | |
| Access road | | | | | |
| Other | 101.8 | 50.0 | 832.9 | 78.0 | 101.4 |
| Total potential yield | 238.7 | 185.2 | 2914.3 | 78.0 | 101.4 |

[1] Increases due to this activity are earned at the rate of —— fbm per acre per year for each acre reforested since plan revision and will be harvested from standard areas.

[2] Increases due to this activity are earned at the rate of 420 fbm for each acre accomplished previous full fiscal year and will be harvested from standard areas.

**EXHIBIT 1.—Programed Allowable Harvest Statement, Annual Programed Allowable Harvest**

[Code: 22. Name: Sasquatch National Forest. Effective fiscal year 1972. Approved (S) *Charles Brown, Forest Supervisor.* Date: *Dec. 15, 1970*]

| | Thousand acres | Sawtimber | | Products | |
|---|---|---|---|---|---|
| | | Thousand cord units | Million board feet | Thousand cord units | Thousand cords |
| Standard—Total | | | | | |
| Group, patch, strip | 4.56 | | 146.0 | | |
| Shelterwood | | | | | |
| Selection | | | | | |
| Intermediate | 1.81 | | 19.4 | | |
| OS removal | 3.10 | | 40.5 | | |
| Special—Total | 0.17 | | 0.5 | | |
| Marginal—Total | | | | | |
| Reforest backlog [1] | | | | | |
| TSI backlog [2] | | | | | |
| Access road | | | | | |
| Other | | | | | |
| Unregulated—Total | | | | | |
| Total programed allowable harvest | 9.63 | | 206.4 | | |

[1] Increases due to this activity are earned at the rate of —— fbm per acre per year for each acre reforested since plan revision and will be harvested from standard areas.

[2] Increases due to this activity are earned at the rate of 420 fbm for each acre accomplished previous full fiscal year and will be harvested from standard areas.

## APPENDIX III

### RECOMMENDATIONS

*Allowable cut reassessment*

In view of the evaluations and suggestions indicated above the team suggests the forest reassess their allowable cut projections. As one specific suggestion on recalculation of the allowable cut using Timber RAM, it is suggested that the forest be stratified not only by stand condition (as in the present calculation), but also by land zone (standard, marginal, etc.) and any substrata of hydrologically or otherwise sensitive areas. Restrictions on conversion periods, management intensity, access, utilization, techonology, etc., could then be developed specifically for each of these strata. In terms of the RAM model, this would increase the number of land class entries from the present level of 9 to 40 or 50 but it would present a much more refined and realistic analysis of the actual situation on the Flathead.

In any RAM calculations, the harvest control constraints appear to have a dominant influence on the solution to any given problem or run. These constraints essentially reflect the forest policy toward "even flow" of timber production over time and consequently the forest's policy toward the local timber-based economy. These constraints deserve much more thorough discussion and justification. This should include a discussion of the alternatives of spreading any needed reduction in harvest over a longer period. Timber RAM was developed to determine optimum harvest schedules using a linear programing solution technique

[1] Copy of recommendations from a study of forest management practices on the Flathead National Forest, Mont., Dils report, October 1972.

which ordinarly makes it an optimizing model (i.e., choosing the best solution among many alternatives). However, Timber RAM was used on the Flathead primarily as a simulation technique because the input assumptions are so limiting and the solution so constrained. Different assumptions regarding timber management intensity, access, harvest control, etc., would result in a variety of physically possible and environmentally practical timber yield schedules from the Flathead National Forest. This would greatly assist in the problem of choosing which timber yield schedule is best. In making the choice, the forest must clearly articulate its timber production objectives and establish criteria for choosing among alternative schedules.

Since it will be over a decade before the interdisciplinary planning process is completed for all 35 planning units, the allowable cut calculations should be viewed with considerable flexibility. As new information and technologies become available adjustments will frequently need to be made. The forest should avoid getting locked in or committed to any one allowable cut forecast.

The distinction between programed sell and allowable cut must be clearly drawn and understood by industry, the community and the Forest Service. Alternative levels of both programed sell and allowable cut which could be realized with different levels of financing should be specified. If the present level of programed sell is considered to be too low in relation to local economy and national needs, the Forest Service should make it clear just what personnel and funds are required to achieve higher levels of cut consistent with environmental quality. The industry and the community can then share in the mutual responsibility for developing the needed manpower and resources (see U.S. Forest Service manual FSM 2410, dated May 1972).

*Planning methodology*

It is critical that the Flathead Forest develop some systematic procedures for coordinating unit planning efforts at the forest level. Unless such coordination is instituted, the total forest plan will simply be the sum of the numerous small plans. Since the forest is the designated planning and decision making unit, choices among alternative mixes of goods and services still must be made at the forest level with the tradeoffs and balances made among the smaller unit plans.

Unit planning tends to emphasize land capability as the major determinant of management. At the same time the forest as a whole must still provide a mix of goods and services that best meets the needs of the American people.

*Timber sale contracts and administration*

The team urges the consideration of some innovative timber sale contract and administration procedures on a trial basis on the Flathead National Forest.

It is apparent that until acceptable techniques and procedures are developed for harvesting timber on the marginal and special lands, and until decisions are made on the land areas currently being considered as wilderness candidates, wild river or other undeveloped areas, the annual timber harvest from the Flathead Forest will in fact, be considerably less than the allowable cut.

Further, as the forest proceeds in its quality management program and as it complies with the directives of the National Environmental Policy Act, greater effort must be devoted to timber sale preparation, administration and supervision for any given level of allowable cut. To offset the anticipated shortage of funds and personnel we suggest that the forest industries assume more responsibility for quality management and for timber sale administration and control.

As a starting point and on a trial basis, we recommend that the Flathead Forest and the local forest industry cooperate in designing salvage, sanitation, and/or commercial thinning cuts in which the forest industry assumes a major role in sale supervision. Industry would be expected to employ an environmental forester who would work very closely with the forest staff in assuring compliance with Forest Service determined environmental safeguards and standards on harvesting operations. Construction and maintenance of roads would be of paramount importance. Industry, through its environmental forester, would first police itself. Failure to comply with established standards or procedures would result in a substantial fine being imposed on the contractor. By placing any such fines in a fund that would be used for the mutual benefit of the timber industry, the stigma of a criminal act would be removed and the motivation to cooperate would be greatly enhanced. Repeated or gross failure should result in sale closure and forfeiture to the United States of any required bond. If entered into wholeheartedly by both, we believe such a procedure would reduce the environmental damage observed on some past sales. (See also recommendation on operator training below.) Adoption of a strict code of ethics would be a direct contribution to upgrading the images of the industry and of the profession.

If the forest industry can demonstrate its ability to police itself and make substantial progress toward quality management on our public lands, the time formerly devoted to sale administration by Forest Service personnel can be substantially reduced and thus diverted to other quality management activities. Demonstrated success on a trial basis could lead to a broadened program and consequently to an increase in programed sell. The team believes that such innovative steps could result in improvement in environmental quality (needed salvage and sanitation cuts could be accomplished more rapidly and economically). More rapid conversion to intensive forest management would be possible under such a program.

*Old-growth conversion*

The study team recommends that consideration for the general forest be given to a reduction in the time period proposed for the removal of the old-growth timber on the Flathead Forest (50 years). It is the consensus of the forestry profession that intensive management of old-growth timber is at best difficult. In the case of the Flathead, there is an estimated annual loss of 18 million fbm to decadence in these old-growth forests. There is greater opportunity for insect and disease infestation in mature and overmature stands. There is generally a much greater volume of available fuel which creates a higher fire hazard. Further, the old-growth forests present much greater management problems with respect to volume of difficulty to dispose of slash and debris. Often the old-growth forest contains large areas of down timber which makes travel and access difficult for wildlife and recreationists alike.

The more rapidly such areas are harvested (consistent with other multiple-use considerations) the earlier the Flathead Forest will be able to achieve intensive forest management and its stated longer range objective of a substantial increase in timber yield while enhancing the forest environment and nontimber uses.

The team recognizes that old-growth forests have other values than industrial use and that even in the general forest zone it will be desirable to retain some such stands for esthetic and for study purposes.

*Forest land classification (land capability per use per classification)*

It is recommended that decisions be reached as early as practical on the several proposed changes in forest land classifications under study or moratorium. Under such consideration are the Middle Fork 1970 moratorium lands, the Wild River candidate areas, and four roadless areas, with wilderness potential. Although these areas were not examined in depth by the team, the percentage of total area that could conceivably be classified as wilderness or undeveloped for other than wilderness type recreation seems disproportionately high for the Flathead. There is currently a large area of the forest in limbo. Many management decisions are dependent on the outcome of such classifications. These decisions will have a significant impact upon the planning of State and local government and the timber industry.

*Operator training*

It is recommended that the forest industry in concert with the Forest Service initiate a series of training sessions for their woods-working personnel and subcontractors. These sessions would consider environmental management objectives and methods. Representatives of conservation groups could be invited to participate in or observe such sessions.

It is evident that some of the past criticism leveled at the forest industry and the Forest Service regarding poor performance of harvesting operations is justified. Such practices as poor layout and design of cutting areas, logging up to stream channels, running logging equipment and dozers across streams, unnecessary soil movement and disturbances, both overload and overheight loading of log trucks and poor road maintenance are examples of practices that are correctable. Operators need to be apprised of the practices to which the public objects and of the penalties for failure to comply.

*Timber utilization*

Here is another opportunity for industry to exert a strong and positive influence on the management of the Flathead National Forest. Utilization of smaller logs allows forest managers to increase production on forest lands through thinnings, reduce the hazard of fire from larger harvest operations, to reduce the volume of slash, and to help relieve public concern over the esthetic problems associated with slash accumulation. The development of markets for small material and the diversification necessary for processing should be an industry responsibility. The Forest Service, on the other hand, must provide the Flathead National Forest with sufficient manpower to administer such a program. Closer utilization of the timber resource is currently a high priority program throughout the Forest Service. The Flathead National Forest provides an excellent laboratory for implementing such a program.

*Wildlife winter habitat cuttings*

The study team recommends that the Flathead Forest in cooperation with the Montana Department of Fish and Game initiate a program of identifying areas throughout the forest (excluding wilderness) where game animals are now wintering. Winter range is generally the primary factor controlling wildlife. Biologists indicate that game often are found wintering in low snowfall areas not normally considered to be big game wintering habitat. Such areas, locally referred to as microclimates, are often only a few hundred acres in size in the lee or snowshadow of a higher mountain. Biologists are reasonably certain that many more areas than those presently known exist and believe that the wildlife habitat (winter range) could be measurably improved by selective cutting or controlled burning which would open up the canopy and promote the growth of browse plants.

Identification of such areas by both on the ground and aerial surveillance could readily lead to timber harvests designed primarily to improve winter range and enhance wildlife management. At the same time, they would make an added contribution to the annual harvest.

*Road systems planning*

It is recommended that a master road plan be developed for the Flathead Forest as early as possible and that the Forest Service seek new and more appropriate methods for financing the construction and maintenance of forest roads.

A master road plan indicating the projected future development of the Forest and showing classes of roads present and projected would be an invaluable tool in planning. Such a plan should consider multiple-use needs such as recreation access, forest protection, and fish and wildlife considerations as well as timber harvest. The master plan should indicate the permanent multiple-use road system as well as temporary roads which might be used for timber extraction.

Increased attention should be directed to the location, construction, maintenance, and eventual abandonment of the temporary roads. The Forest should consider the need for logging techniques which require less dense roading, increased use of one-way haul roads which require less earth moving, the application (and enforcement) of better road maintenance practices, and specific abandonment and closure procedures. Temporary roads should be put to bed (surface scarification, drainage, and seeding) as soon as they are no longer in use for timber extraction. In the Flathead Forest, particularly in the back country, road location, and layout should be coordinated with the Montana Department of Fish and Game for wildlife management considerations.

The present system of financing roads on national forests does not appear to be appropriate to either quality management or multiple-use management. The majority of new road construction cost is carried by timber sale contracts (decreasing the price paid by the contractor for standing timber). This practice has tended to put undue pressure on both the Forest Service and the contractor to get maximum income from the harvest operation to offset roading costs. The result has frequently been to concentrate the timber harvest operations on relatively small areas of the forest. As the road system is developed, the harvest can be more readily spread over the forest.

It is urged that the Forest Service seek new funding procedures and establish new policies for the construction of the primary road systems. It seems more appropriate for the timber sale contract to carry only that portion of the temporary road system construction related specifically to timber harvest. Appropriated funds and/or income derived from all uses should provide the primary road system.

Both the Forest Service in general and the Flathead Forest have announced policy decisions to reduce clearcutting practices and increase partial cutting. To reach the level of timber harvest set, it is apparent that the cut will have to be spread over a larger area and that more road construction will be required in a shorter time period (not necessarily a greater volume of roading in total).

*Timber harvest on marginal and special lands*

It is recommended that the Flathead timber industry immediately and aggressively enter into a partnership with the Forest Service to develop appropriate harvesting technologies for the marginal and special lands. We believe the major initiative and responsibility for this effort should be assumed by industry. A variety of methods is available such as cable and balloon systems, but an investment of time and resources is needed to adapt them to the Flathead. Since the allowable cut is finally partitioned by land strata, industry cannot expect the forest to increase sales on standard lands to compensate for logging problems on the marginal lands. If industry wants the additional volumes, then they must learn to log on marginal lands.

*Personnel stability*

It is recommended that present personnel promotion and transfer policies of the Forest Service be reexamined to determine if ways can be found to reduce the personnel turnover rate at the forest level. The cornerstone of any quality management program is the soundness of informed judgments by specialists and managers on the ground. Sensitivity to and extended personal experience with the local ecological, social, and economic situation provides the best background for well-informed judgments. Hence, the greater the emphasis on quality management, the greater the inherent conflict with a personnel management program which fosters rapid turnover. Just as an example, if the level I intensive unit planning effort is expected to take a decade to accomplish, it is quite possible that up to three complete sets of personnel will rotate through the Flathead Forest before that level is reached. Continuity, competence, and consistency of the planning effort will be difficult to achieve under these conditions. In a new and innovative planning effort such as this, personnel should have the opportunity to live with their successes and to rectify their mistakes.

*Streamside management*

Many of the water quality and fisheries problems associated with logging and road construction could be avoided by implementing a rigid streamside management program. Keeping machinery out of the channel and off channel banks, leaving trees and other vegetation to provide shade for the stream and to act as barriers for downslope movement of slash, eliminating channel crossings, using bridges on perennial streams, and felling trees parallel to or away from the stream will prevent many problems. Wider buffer strips along streams with selective logging in these strips to reduce blowdown and logging debris reaching the stream are suggested. Similarly bridges should replace the use of culverts in areas where fish passage is necessary for spawners to reach spawning beds. As early as possible poorly placed culverts should be replaced and logging debris should be cleaned up on high value spawning streams. Road placement, engineering, and maintenance are highly significant factors in fisheries management. Alternative means of timber harvest should be considered where road problems cannot be overcome.

Enforcement of existing regulations has been lax in the past. Here is yet another instance in which industry, too, can through cooperation significantly aid the Forest Service in doing a better job of resource management.

*Wildlife management considerations*

As additional timber harvesting operations are planned it is recommended that special attention be given to wildlife management problems. Size and location of cutting areas and access road use are of particular concern.

Relatively small and adequately dispersed cutting areas, including clearcutting, are not considered detrimental to wildlife. Timber harvest operations on Sullivan Creek on the west side of the south fork of the Flathead River provides an example of poor planning as far as wildlife management is concerned. Approximately 5 miles of this drainage is unroaded. The rest is roaded and has been logged as are all contiguous drainages in a circle of 330°. Observation in this area in 1971 indicated that a herd of elk, some goats, mule deer, and both black and grizzly bear were holed up in this relatively small area away from the activities of man and vehicles.

If and when further timber sales are prepared for the Sullivan Creek area, it is recommended that roads present or planned in both the north and south forks of Lost Creek be closed at least 2 or 3 miles below their present ending point. In addition, it is recommended that travel in Bunker Creek be restricted to the lower end. Addition Creek, Bruce Creek, Soldier Creek, Connor Creek, and Slide Creek should all be closed to motorized travel. The same guidelines would apply to a practical degree, when a new area is logged or when activities are continued in an area that has formerly been logged.

Management of these surrounding areas as de facto wilderness during periods of logging would enhance wildlife and multiple-use management.

*Research needs*

Inevitably, studies such as this generate more questions than can be readily answered. Although the team did not consider research needs in detail, a number of obvious problems were apparent. It is suggested that the forest, in cooperation with the Intermountain Forest and Range Experiment Station, the State universities in Montana, the State's natural resources agencies and Montana forest industries concentrate research efforts on some of the practical problems of forest management exemplified on the Flathead Forest. Some examples are:

1. Quantitative identification of streamflow increases, sediment production and channel damage associated with environmentally controlled logging operations and timber harvesting technology.
2. Development and/or adaptation of an acceptable timber harvesting technology capable of profitably logging marginal and sensitive forests.
3. Assessment of the total costs and benefits of environmental quality management including, if applicable, income foregone (e.g., what does quality road construction and maintenance cost?).
4. Development of quality standards for environmental management (e.g., water quality, sediment, erosion, aesthetics tolerances).
5. Assessment of conditions under which no stumpage value or even a negative stumpage price (i.e., payment could be made to a timber operator for harvesting a problem area) might be justified to achieve an improvement in environmental quality.

## APPENDIX IV

# Copy of Mason, Bruce and Girard Report on a Review of the Proposed Umpqua National Forest Management Plan

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GENTLEMEN: You have asked me to review and comment to you on the Umpqua National Forest's proposed 10-year timber management plan and the draft environmental impact statement for that plan. Following is a summary of my findings and a supporting discussion of specific subjects.

SUMMARY OF FINDINGS AND CONCLUSIONS

After careful review and detailed calculations of my own, it is my opinion that the proposed plan and the draft environmental statement are an inadequate basis for the support of the important decisions and proposed actions in this plan. More specifically, I have found that:

1. The Forest Service calculations of the proposed allowable cut were not made properly in some respects and were based on several critical factors, such as rotation, which were not adequately supported by facts and reasons.

2. The plan document did not clearly follow the manual instructions which require a clear statement of potential yield and programed allowable cut, whose difference is the amount of first-decade increase in harvest which could be made if full funding and staffing for intensive management and intensive utilization were available.

3. The plan document did not explain what specific program actions, other than timber harvesting, were required to achieve the plan objectives and what the effect would be if these actions were not financed.

4. The draft environmental statement does not (nor does the plan) examine alternatives in sufficient detail to permit other agencies or the public to make any meaningful evaluation of the soundness of the chosen action program. It fails completely to present the relationship between what has been the program on the Umpqua forest and what it will be under the proposed program.

5. Using the Forest Service's own timber resource allocation model (RAM) I have determined that the programed allowable harvest for the first decade should be at least 462 million fbm per year and that the potential yield for the first decade under full-intensive

multiple-use management could be at least 538 million fbm per year.

### Review of the Proposed Plan

*Forest Service Procedure in Brief*

In their proposed plan the Forest Service has calculated and presented: (1) A full-yield allowable cut without adjustments, and (2) a programed allowable cut which includes adjustments for the special and marginal areas. The so-called full-yield cut was calculated using all 874,569 acres of the commercial forest land except 12,000 acres of nonstocked area which were not expected to be restocked within the 10-year-plan period. Included in these commercial forest lands were 59,384 acres of lodgepole pine type which were placed in the marginal land category. They assigned a full-yield cut of 2.91 million fbm per year to the lodgepole pine type but excluded it from the programed allowable cut. In my later analysis I have accepted this procedure.

For all the CFL acres, excluding the lodgepole pine-type, the Forest Service calculated separate harvests classed as regeneration, overwood removal, commercial thinning, and mortality salvage.

The regeneration cut was calculated on a strict area regulation basis. The total CFL area, excluding lodgepole pine type and nonstocked, is 803,185 acres. They selected a rotation of 100 years and consequently their proposed regeneration cut is based on harvesting 8,032 acres per year. Of these acres, 47 percent are to be clearcut and 53 percent are to be shelterwood cut. The shelterwood cut is to remove 60 percent of the total merchantable volume followed 10 years later by an overwood removal of the remaining volume.

The overwood removal cut was calculated based on the removal of existing overwood during the first three decades and starting in decade two the newly created overwood from the regeneration shelterwood cuts will be removed from 8,032 acres per year. The existing overwood cut was limited by their estimates of the accessibility and operability of the acres with overwood.

Commercial thinnings were calculated on the basis of the availability of thinnable age classes and their accessibility and operability.

Mortality salvage calculations consisted of determining an estimated amount of existing and new mortality that would occur on the uncut, overmature age classes and was also dependent upon estimated accessibility and operability.

After the full yields were determined in this manner, these were allocated to the standard area and to the special areas which apparently had been delineated on the map and the acreage determined. For the standard areas the programed allowable cut was proposed as being equal to the full-yield or potential yield cut. For the special areas adjustments were made to reduce the cut on some portions of these special areas due to longer rotations, retaining newly created overwood for longer periods, by making no thinnings, and by projecting no yield or only mortality salvage for some areas.

The results of their calculations are summarized on page 6 of the proposed plan and later in this report.

*The New Inventory and Land Classification*

Before critically reviewing the Forest Service calculations and plan, I reviewed the information from the new inventory on which this plan is based.

A field inventory was made using sample plots during the summers of 1968 and 1969. The Forest Service states arbitrarily that the summarized data in the 61-page inventory report reflects conditions as of January 1, 1970.

That inventory classed the unreserved or available lands into commercial, noncommercial, and nonforest. The commercial class was based on its site capability to grow at least 20 cu ft. of wood per acre per year.

Average site was determined to be site index 105. This compares to the average of 114 which was determined in the previous inventory 10 years earlier. The new plan gives no explanation for this difference. In fact, the total area of commercial forest land was lower in the new inventory, 874,569 acres versus 934,324 acres, and a principal reason given was for acreage moved to noncommercial class due to low site. This should have had the effect of raising the average site on the remaining area. I should point out, though, that the estimated yields of future new stands in the plan was based on broad site class IV whose average is site index 110. Nevertheless, site determination is critical in cut calculations which are keyed to future productivity; i.e., sustained yield and even flow. For example, the yield tables on which the Forest Service based its future yield estimates indicate about 25 percent more yield from site index 114 than from 105. (See pp. 26 and 27 of USDA bulletin 201.)

An important factor in this proposed plan is the land classification for multiple-use management purposes. The commercial forest area on the Umpqua was classed into the following categories:

| | Acres | Percent |
|---|---|---|
| Standard | 607,036 | 75.6 |
| Special | 194,349 | 24.2 |
| Marginal, lodgepole | (59,384) | |
| Marginal, nonstocked | (12,000) | |
| Unregulated | 1,800 | .2 |
| Total excluding marginal | 803,185 | 100.0 |
| Total | (874,569) | |

The special classification was apparently made by mapping the areas of landscape management and streamside management zones. In other words, the inventory plots were not used to make this classification.

The nonstocked area of 12,000 acres is based on a reforestation status report (maps) which determined that these would not be stocked during the plan period, nor apparently thereafter until funds are available to do so. This is not clearly explained in the plan (see p. 16).

The unregulated area was apparently estimated from maps showing occupancy zones.

The lodgepole area was taken from the inventory plot classifications.

The standard area was the remainder after these other mapped or estimated areas were subtracted from the total commercial forest land as estimated from plots.

Certain assumptions are implied by the procedure used to get these areas and the manner in which they were used. These are:

(*a*) The lodgepole pine type does not occur on any of the special and unregulated areas, which were determined from maps.

(*b*) The age-class distribution is the same on both the standard and special areas.

(*c*) The site capability is the same on the standard and special areas.

(*d*) None of the nonstocked area is within the special areas.

Apparently the Forest Service judged that these implicit assumptions were necessary due to inadequate data.

Further classification of the individual plots which fell in any of the standard, special, and unregulated areas was made to determine:

(*a*) Age class by 10-year intervals as of inventory date;

(*b*) Areas with harvestable overstory;

(*c*) Areas needing regeneration cutting;

(*d*) Areas qualifying for commercial thinning based on merchantable excess trees;

(*e*) Portion of total area on operable slopes for thinning and salvage and accessible to roads.

In the time I had available it was not possible to review the soundness and accuracy of the land classification and inventory based on maps and plots. For that reason I cannot vouch for the accuracy and soundness of the data but have accepted these as reported in the proposed plan and the supporting statistics.

Obviously, more and better information would always help. However, additional information costs money and much of what is now gathered is not used—such data as area condition class, stand size class, detailed forest types, cubic foot volumes, detailed growth and mortality by species and forest type, and volume by species and tree diameter class are not used in any manner in this plan nor in the supporting calculations, even though these were collected and reported in a 61-page document.

In my opinion the types of data available to the Forest Service are entirely sufficient to support a properly determined plan. However, I have serious questions about the Forest Service's application of the inventory data and other related information in preparing their proposed plan. These questions are raised in the following sections.

*Comments on Specific Procedures Used by the Forest Service*

(*a*) *Age-class distribution.*—In my opinion the Forest Service did not use a proper age-class distribution. The area regulation procedure requires that the volume per acre assigned to each age class should be the average volume when cut, or in other words, the average volume of the stand at its age at the midpoint of the decade in which it is cut. The midpoint of the first decade in this plan will be 1978. Since the age-class determination for the Umpqua forest was made at the time of inventory during the 1968 and 1969 field seasons, at least 8 years needs to be added to these inventory age classes; or 8 years of growth needs to be added to the average 1968–69 inventory volume of stands to be cut in the first decade in order to determine the average volume per acre at harvest. Using Forest Service growth estimates and their calculation procedure, this correction would give 3.3 million fbm more of regeneration harvest per year in the first decade (about 1 percent) and similarly more in future decades. In overwood removal this correction would increase their result by 1.7 million fbm per year.

In this same regard the Forest Service failed to add any growth on the excess trees to be commercially thinned from 50- to 150-year-old stands in the first and subsequent decades. They used the 1968–69 volume of these trees as the volume per acre in excess trees in 1978, or 10,656 fbm per acre (without salvable dead, see p. 24 of plan). Growth for 8 years should have been added. The 172 fbm per acre per year for the total forest, which they used on old growth and overwood, is 0.58 percent of the total inventory volume per acre. If growth on these excess trees was calculated at 0.58 percent per year for 8 years, it would amount to about 5 percent and give a volume in excess trees in 1978 of 11,225 fbm per acre. Extending this by acres harvested would give 2.2 million fbm per year extra thinnings in the first decade. Such growth was also omitted in decade two and beyond.

In my opinion, regardless of the allowable cut calculation procedure, the age classes should be adjusted by adding the years and adding the growth since inventory before the inventory data is used. The fact that the age was determined originally to the nearest 10 years does not alter this requirement for a sound procedure.

(*b*) *Growth rate.*—The total annual growth on all the commercial forest area was estimated from the inventory as 172 fbm per acre per year. (See p. 25 of the inventory statistics.) The Forest Service applied this inventory estimate of net growth per acre per year to the regeneration acres and overwood acres on standard and special areas—even though that estimate was based on inventory data from all of the commercial forest area including old growth, young growth, nonstocked, and lodgepole pine type.

No growth was applied to the excess trees on areas to be commercially thinned, as was noted earlier.

In my opinion, this was an incorrect procedure and more representative growth data could have been determined from the plot data after it had been sorted into the timber and land classes as scheduled for harvest. For illustration, one can note that the net growth on the Douglas-fir type was 193 fbm per acre per year. This type made up 85 percent of the total growth on all commercial forest lands; yet, 75 percent of the Douglas-fir type was in stands over 100 years of age. If the nonstocked acres of Douglas-fir type were excluded, the inventory growth estimate would be 205 fbm per acre per year. Surely the regeneration acres with their high volumes per acre are growing faster than the 172 fbm average of the total forest land. The use of 200 fbm instead of 172 in Forest Service calculations would result in about 5 million fbm regeneration cut per year in the first decade.

(*c*) *Rotation.*—The rotation has a significant influence on the regeneration harvest under the area regulation method used to calculate the proposed cut. Therefore, the selection of rotation should be a well supported and documented decision. This is not the case in the proposed plan. Rotation is discussed on page 30 of the plan. It appears that 100 years was chosen based primarily on the culmination of the mean annual growth of international ⅛-inch log rule volume. This implies that trees 7 inches and larger will be utilized in the more distant future and that lumber or some similar solid wood product will be the desired product. No justification is given for these assumptions about the future.

If, for example, cubic feet of all trees had been used, the culmination would have been at 65 years and a rotation of, say 70 years, might have been selected. This would have resulted in 43 percent more regeneration cutting in the first decade or 87 million fbm per year more harvest from the standard area in the first decade. Obviously, this is an important decision requiring fuller consideration and more public discussion. Foresters can determine how much of what kind of wood might be grown but public representatives (concerned with future as well as present needs) must decide what should be grown.

Another factor which was omitted from consideration when deciding on rotation was the cost of growing timber. The major share of the cost of growing timber is the interest cost on the value of the growing stock which must be held. The culmination of mean annual growth results in no return on the investment required to hold the extra growing stock needed when growing 100-year-old timber versus 95-year-old timber. In other words, public investment is made at no return to the public.

In my opinion, economic considerations were seriously lacking in this and many other parts of the plan and planning process.

(*d*) *Overwood removal.*—Overwood is the volume in those mature trees which are now standing and growing on areas where young reproduction is also growing. It is either already there or this condition will be created by shelterwood cutting of 60 percent of the stand, followed by regeneration of a new stand under the remaining trees.

The newly created overwood will be harvested starting in the second decade, at a rate determined by the area regulation method of calculation. As such it is influenced by the same factors.

Existing overwood is, by definition, now growing on the same area with stands of young growth immature timber. Thus, its rate of removal is a judgment decision. The Forest Service scheduled its removal in the first decade, limited only by accessibility and operability. Therefore, more rapid roading would permit more rapid harvest of this timber during the first decade.

(*e*) *Silvicultural system.*—The plan proposed that "53 percent of the regeneration cut volume" should be harvested by shelterwood cutting, and the remaining 47 percent from clearcutting (see p. 14). This statement is not entirely consistent with the calculations which are based on 53 percent of the area to be cut by shelterwood—which results in 40 percent of the volume coming from shelterwood in the first decade and 53 percent in subsequent decades.

The reasons cited for shelterwood cutting is past failures to obtain either natural or artificial regeneration on severe sites common to southwestern Oregon after clearcutting. Progress of timber management reports for the Umpqua forest indicate that about 9 percent of the regeneration cutting has been by shelterwood (prep. seed cut) during the past 5 years. In earlier periods one can assume that even smaller portions of the harvest cut was by shelterwood. However, a June 20, 1972, notice to the public by the supervisor of the Umpqua states that, "The 1971 reforestation status report shows that 91 percent of the area harvest cut through fiscal year 1960 is satisfactorily stocked." Unless reforestation success has declined rapidly on areas harvested since 1960 (which were about 90 percent clearcut) it would not appear that the statistics would support the need for a change to 53 percent shelterwood cutting due to regeneration failures.

But if, indeed, failures are occurring, and if future ones can possibly be corrected by shelterwood, the plan does not indicate how 53 percent was determined. Two neighboring forests, with admittedly some differences in forest types and conditions, have recently proposed to harvest 95 percent by shelterwood (Rogue River) and 15 percent (Siskiyou).

The portion to be shelterwood cut has a significant effect on the calculated first decade harvest in this plan. For example, a change to 25 percent shelterwood would increase the regeneration harvest in Forest Service calculations by 14 percent or 38 million fbm per year. Such an important factor needs to be more fully explored and the final decision better supported by facts and stated purposes than is the case in this plan.

(*f*) *Allocation of the harvests to land categories.*—After the various kinds of harvest were calculated for the combined acreage of the standard, special and unregulated areas, the cuts were allocated to these on the basis of their percent of the total area. This assumes that each age class, type, and other conditions such as operability and accessibility occurs proportionately throughout these land categories. Sufficient plot and map data was available to determine a more representative and truer distribution of these forest conditions. This "broad brush" treatment could have a significant effect on the harvest level as well as the resulting environmental condition of the forest after the plan is put into effect.

*General Comments on the Plan*

(*a*) *Potential yield and programed allowable cut.*—In May 1972, the Forest Service manual was revised. Among other things, provision was made that two harvest levels should be determined and presented in new management plans. These were to be called potential yield and programed allowable cut. The purpose of the potential yield statement was to establish an objective for the first decade such that, if full funding and staffing for intensive management and intensive utilization were available, the programed allowable cut could be raised to this potential yield and thereby reflect accomplishments beyond those planned and financed under the programed allowable cut.

The proposed Umpqua plan does not follow this manual procedure, possibly because it was drafted and approved by the supervisor in November 1971, which was prior to the May 1972, manual revision. The draft environmental statement does present a potential yield but it is simply the so-called "full yield" from the plan and does not embody the basic concepts given in the manual instructions.

The May 1972 manual states that:

> The potential yield for the next 10 years is the maximum harvest that could be planned to achieve the optimum perpetual sustained-yield harvesting level attainable with intensive forestry on regulated areas considering the productivity of the land, conventional logging technology, standard cultural treatments, and inter-relationship with other resource uses and the environment. As used here, conventional logging technology and standard cultural treatments include all applicable developed and proven systems for intensive management of the area, whether or not they are currently economical or in general use in the area.

In my opinion the potential yields (full yield) on pages 6 and 7 of the plan and on page 5 of the impact statement do not fit the definition nor the intent of the manual. First of all, the full yield on page 6 of the plan is described as "yields that could be cut if there were no overriding multiple-use values," while the manual says that potential yield will be the yield after consideration of "interrelationships with other resource uses and the environment." The reductions from potential yield to programed allowable cut made on the special areas of the Umpqua were all made for multiple-use and environmental reasons. Apparently, then, there is no amount of effort that would permit increasing the programed allowable cut to the potential yield on these special areas. However, the manual states that:

> Where components of the programmed allowable harvest are less than the potential yield, it will be a continuing objective to remove the barriers and work the programmed allowable harvest up to the full potential yield.

Secondly, the plan does not indicate that all standard cultural treatments and conventional logging technology were scheduled to be applied to all the regulated areas during the first 10 years in calculating the potential yield. Therefore, additional effort must be possible that would increase the proposed potential yield. For example, the plan states on page 14 that accelerated roading would permit increases in mortality salvage, commercial thinning, and overwood removal yet the plan's potential yield (full yield) does not include these possible extra volumes.

Third, the plan does not clearly set forth the potential yields for marginal areas and volumes as specified in 2415.43 of the manual. This section requires, as a minimum, that the potential yield be stated (under marginal) for reforestation of the nonstocked backlog acres and for timber stand improvement opportunities not covered under the K–V Act. Separate from the potential yield statement on page 6 of the plan, the Forest Service notes on page 16 that the cut from the standard area could be increased 1.4 million fbm per year for each 3,000 acres of the 12,000-acre nonstocked backlog which is satisfactorily reforested. This would be a total of 5.6 million fbm per year. This should have appeared in the potential yield of the plan and the impact statement. As for TSI, the plan is unclear as to whether it is definitely to be carried out on all available acres or whether that is a goal which is not financed as yet. (See p. 17.) I question this because only 4,300 acres were precommercially thinned during 1961–71 while 24,000 acres are the goal for 1972–81; only 7,658 acres were released from brush and grass while 30,000 acres are the goal for this plan period. These goals for this plan period do not say whether the work is entirely, partly, or not to be financed by K-V funds.

(*b*) *Method of calculating and controlling the planned cut.*—The Chief of the Forest Service has gone on record saying that, with increased funding and manpower to carry out more intensive timber management programs of known effectiveness, the national forest yields can be increased substantially. (With accelerated practices the sale offerings might be increased 39 percent by 1978.)

The Umpqua Forest is a major single contributor to the total national forest harvests, well over 3 percent of about 11 billion fbm total. Its fair share of a 39-percent increase, based on the current allowable cut of 357 million fbm, would be 139 million fbm or a total of 496 million fbm. The proposed programed allowable cut is 343 million or 4 percent less than current, and the only extra available for increase is 2.9 million for lodgepole pine and 5.4 million for reforesting nonstocked areas. Therefore, the potential for this forest is 351 million fbm, or 2 percent less than current, by 1978 based on what the forest thinks is attainable with intensive forestry. Where will the Forest



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Service get 39 percent more harvest by 1978 if appropriations and manpower were given to them for an accelerated management program?

Under the area regulation method of calculation used on this plan the only input factor which could bring such an increase in calculated harvest would be shortening the rotation. Since this only influences the regeneration cut on standard area, rotation would have to be shortened to about 65 years in order to increase the harvest by 139 million fbm. What accelerated management could reduce rotation from 100 years to 65 years?

In my opinion, the method of calculation used on the Umpqua Forest is not appropriate for making sound management plans that includes examination of the effects of alternative levels of intensive cultural practices.

This plan calculates the cut based on area but specifies that the measure and control of performance will be on volume (p. 3). If, as is very possible, the volumes per acre used in the calculation differ from those actually experienced in cutting during the plan period, then performance will not really be in accordance with the plan. For example, the average volume per acre harvested from clearcut sales on the Umpqua Forest during the past 5 years has been 53,000 fbm while the plan for the next 10 years is based on 42,500 fbm per acre from clearcuts. Overstory removals during the last 5 years have averaged 13,300 fbm per acre while the plan is based on 9,800 fbm. Volumes on areas yet to be cut may, in fact, be different than areas recently cut. However, if future age-class distribution is to be regular as desired by the Forest Service, better control is needed than that provided under volume regulation. This also leads me to the opinion that strict area regulation was not a good and proper basis for this plan.

### Comments on the Draft Environmental Statement

1. The Forest Service manual requires that the schedule of harvest volumes should "summarize periodic timber outputs for at least 1½ rotations." The plan does not do this but covers only one rotation (100 years). An important requirement in considering environmental impacts is what are the longrun effects. The draft statement presents only the allowable cut volume planned for a 10-year period (p. 5 and does not specify what is expected beyond that).

2. Many people are concerned that timber crops may be scheduled for all national forest areas. The draft statement (p. 5) fails to mention and describe the 100,772 acres of noncommercial and nonforest which are an important part of the Umpqua.

3. The discussion of environmental effects includes economics. The documentation of the relationship of the total and per unit volume of timber harvest to the local economic and social health and well-being is good. However, it does not relate the proposed timber harvest level to past level of allowable cut and actual cut from the Umpqua nor to the needs of the Nation for timber products. I have already commented on the relationship of the proposed cut to the current allowable cut, a reduction of 4 percent. Using Forest Service figures, this would mean a loss of 56 jobs in timber industry and 112 jobs in related industries.

The average actual cut from the Umpqua during the past 5 years has been 425 million fbm per year. The proposed allowable cut is 19 percent lower than this and will mean the loss of 328 jobs in timber industry and 656 jobs in related industry, for a total of 984 jobs lost.

No mention was made of the effect of the proposed reduction from the present level on the Nation's lumber and plywood needs.

4. On page 6 the draft statement includes balloons and helicopters as generally available logging systems on the Umpqua. On the very next page it defers logging on certain areas until these systems are available.

5. Roads are cited as needing careful construction to limit resource damage. On page 8 where shelterwood cutting is endorsed for its lesser impact no mention is made as to whether shelterwood cutting will require more road construction to harvest a given volume during the first decade.

6. On page 13, alternative 2 is described without explaining specifically how 280 million fbm cut was calculated. Stocking control and increased road access and prompt reforestation are the only management practices which are apparently to be omitted in comparison to the selected alternative 3. Since none of these had any influence on the calculated harvest in the first 10 years in the selected alternative as shown in the plan, I fail to see how this alternative could show a reduced yield unless some different method of calculation was used on this alternative.

7. A close examination of the plan calculations leading to the selected alternative indicates that

numerous other alternatives are possible which would have varying effects on the environment. Since the effects as documented in the draft statement for the alternative proposed are so generalized and qualitative, it is entirely possible that an alternative of much higher yields now and later could be proposed that would also pass the environmental test.

The draft statement really only presents two alternatives, Nos. 2 and 3. No. 1 is obviously against the law and No. 4 is rejected primarily because Forest Service rules do not permit taking credit now for practices not yet proven. The only alternative that was examined in detail was No. 3, the selected one. In my opinion, numerous other alternatives are possible, even if they only document higher potential yields which could be attained by more management effort while still protecting and enhancing the other uses and the environment.

## Some Proposed Alternatives Using the Forest Service Timber Resource Allocation Method (RAM)

Most of the timber management planning on western national forests is now being done using Timber RAM. This is a computerized model which permits the user to calculate alternative schedules of timber harvest and select an optimum one which best suits his objective, such as maximum volume over some period of time. This computer model keeps separate the various types of harvest and classes of land and permits the use of constraints such as even flow, accessibility, and age at which harvested. After solving for optimum alternative harvest schedule, it calculates the volume and acreage of harvest by type and source, the growth, the inventory, and the costs and returns by decades for as long as 400 years in the future.

I have used this computer program to examine a wide range of alternatives other than the harvest proposed by the Forest Service. The complete details can be made available to the Forest Service and to anyone you wish to see them. In this report I will briefly describe the results.

### *Simulation of Forest Service Proposal on RAM*

As a first step in my review I used the Forest Service's estimate of acreage by age class, volume per acre yields, accessibility and operability, and all other pertinent data found in their plan to prepare input for Timber RAM for the 803,185 acres which excludes lodgepole and nonstocked. When run in the computer, my result essentially simulated their results which they labeled "full yield."

### *Alternative 2 With RAM*

Next, I made certain revisions in order to calculate what I will call alternative 2. The following changes were made:

1. The age classes (timber classes) were separated into standard and special based on the implicit assumption in the plan that the standard and special areas had the same proportions in each age class as in total; i.e., 75.6 percent in standard and 24.2 percent in special.

2. The special area was further subdivided, on the same assumption, into the various landscape management and streamside management zones. Yields and rotations for these zone areas were revised to match those used by the Forest Service in making adjustments for multiple use (see pp. 15 and 30 of the plan). The no-yield areas were omitted.

3. All of the age-class acreages were revised to effectively update the age from the 1968–69 inventory date to 1978, the midpoint of the first plan period. This was necessary because Timber RAM requires it. To be on the conservative side I added 7 years instead of 8. This was done by moving 70 percent of the area of each age class to the next higher age class, because Timber RAM is programed to handle ages 10, 20, 30, etc., rather than 17, 27, 37, etc.

4. The 12,000 acres of nonstocked which was said to be difficult to restock was included, but I specified to the computer than it could not be restocked until at least the second decade.

After these changes were made I ran alternative 2 for standard area and alternative 2 for special. However, befor doing so I had to specify what should be optimized. I specified, based on analysis of earlier runs and in keeping with Forest Service objectives, that the total volume harvest of all kinds in the first decade should be maximized but that the total for subsequent decades should not fall by any more than 2½ percent for the next 10 decades. I determined that the recent 7 year average actual harvest on the Umpqua has been about 420 million fbm per year. Since the standard area is 75.6 percent of the new commercial forest land area, I assumed that 320 million was from standard and 100 million from special.

However, I reduced the special to 70 million in proportion to the Forest Service yield reductions. I used 320 and 70 million as the estimated current level of harvest which is a required RAM input. I then specified that the first decade cut could not drop more than 2½ percent below these levels. This seems reasonable in relation to the Forest Service objectives of community stability. I also specified that the age classes in the second rotation should be reasonably well proportioned.

The yields per acre, accessibility and operability were the same as used by the Forest Service.

The results of my alternative 2 for the standard and special areas are shown graphically in figures 1 and 2 for comparison with the Forest Service proposal. On the standard area the RAM alternative 2 harvest is basically at the same level as the Forest Service proposal, except that alternative 2 more smoothly declines. The decline then leveling and increase in inventory under alternative 2 is promising. Because growth is increasing in decades 14 through 19, the harvest then could be increased somewhat to maintain a stable inventory if this alternative were chosen.

For the special areas the Forest Service did not calculate the adjusted yields beyond the first 10-year period. Alternative 2 for the special areas results in a fairly reasonable balance between growth and harvest. An increase in inventory results from growth exceeding harvest for five decades which in turn is due to modified harvesting, salvage only on some areas, and long rotations. Examination of these results lead me to accept alternative 2 as a reasonable schedule for these lands and to recommend a first decade cut of 82 million fbm instead of the Forest Service 67 million fbm. The complete computer output shows a complete schedule of which areas should be harvested and the type of harvest.

Table B in the appendix shows the RAM alternative 2 total harvests by type for the standard, special, and lodgepole areas combined. The total for the 10-year-plan period is 465 million fbm per year in comparison with the Forest Service proposal of 343 million.

*Alternative 3R*

On page 30 of the proposed plan the Forest Service reports that it is possible to obtain, through intensive management, growth rates of 8 rings per inch instead of the 11 rings per inch on which their proposal is based. They report the yields of thinning and final harvests for that intensity of management for the newly regenerated stands of timber.

Alternative 3R is one in which these yields are substituted in the timber RAM program for the standard area only for newly regenerated stands and for existing thinnable stands 10–40 years old. All other input was kept the same, including the accessibility or present rate of roading. (That is the reason for the R designation on this alternative.) Figure 3 presents the harvest, growth, and inventory for alternative 3R. Comparison with alternative 2 in figure 1 shows the higher growth and greater inventory, which, in turn, supports higher level harvests particularly in later decades and during the second rotation. However, this promise of higher yields also permits somewhat greater harvest now on the standard area—380 million fbm instead of 346 million fbm per year. The complete schedule for the first rotation is given in appendix table C.

I will digress here to point out that the timber RAM calculations include costs and returns. In order to compare the economic advantages of alternatives, I entered the following unit costs and returns:

| | Standard area | Special area |
|---|---|---|
| Gross stumpage income per thousand board feet: | | |
| Final harvest and overstory removal | $50.00 | $40.00 |
| Commercial thinnings | 30.00 | 25.00 |
| Mortality salvage | 10.00 | 10.00 |
| Twenty-five percent payments to local counties per thousand board feet: | | |
| Final harvest and overstory removal | 12.50 | 10.00 |
| Commercial thinnings | 7.50 | 6.25 |
| Mortality salvage | 2.50 | 2.50 |
| Costs per acre: | | |
| Reforestation cost for nonstocked land | 100.00 | 100.00 |
| Reforestation after regeneration cut | 20.00 | 20.00 |
| Sales costs per thousand board feet: | | |
| Final harvest and overstory removal | 1.50 | 2.00 |
| Commercial thinnings | 2.50 | 3.00 |
| Mortality salvage | 3.00 | 3.00 |

These same costs and revenues were used for all alternatives. Using these the computer calculated the present net worth at 3, 5, and 8 percent of the gross stumpage, returns to counties, the costs and the gross stumpage less costs.

Now back to comparisons. The present net worth of the extra stumpage income less the costs and the payments to counties of alternative 3R versus alternative 2 on the standard area at 5 percent interest is $19,624,000. This is an average of about $980,000 per year extra income to the U.S. Treasury or an extra $1.60 per acre per year for intensive cultural work to achieve the extra growth needed to support this level of harvest. This is over and above the K–V which would be collected to reforest and carry out TSI on new young stands.

The extra income to the counties would have a net worth of $7,026,540 at 5 percent interest, or an average of $351,000 per year.

The extra 34 million fbm of annual harvest would provide 136 more forest industry jobs and 272 related jobs.

In total with alternative 2 on the special lands the first decade harvest could be 462 million fbm in comparison to the recent average actual harvest of 420 million fbm and with the Forest Service proposal of 346 million fbm.

*Alternative 3*

The road system is not scheduled to be complete until the third decade under the Forest Service proposal and in alternatives 2 and 3R above. The proposed plan refers to the limits on salvage and thinnings due to lack of a complete road system. Alternative 3 was run with the same input data as 3R, but with all stands scheduled to be fully accessible by road by the end of the first decade. The limits on operability for thinning and salvage was retained.

Figure 4 shows the harvest, growth, and inventory for 20 decades under this alternative. The extra yields are about 10 million fbm per year more than under alternative 3R. However, this was the result of considerable increases in salvage and thinning and some reductions in final harvest because the computer was limited by the 2½-percent minimum decrease by decades. (Note in figs. 1, 2, 3, and 4 that the rate of decrease is at the 2½-percent maximum limit.) If this limit were relaxed, the thinning and salvage increases would not be made at the expense of the final harvest in the first decade and more than 10 million fbm per year extra yield would result. Such an alternative can easily be computed and more rapid roading could be surely justified.

*Alternative 4*

In all the alternatives, the yields, inventory, and rates of growth for all existing standing timber, 50 years old and older and for unthinnable stands 10–40 years old have been the same as those used by the Forest Service in their proposed plan. The inventory for 10- to 40-year-old thinnable stands was also the same, but yields and growth rates different from Forest Service were used in alternatives 3 and 3R. The inventories per acre are shown graphically in figure 5.

Figures 6 and 7 show the yields and inventory used for the various alternatives. Alternative 2 is essentially the same as used by the Forest Service. Alternatives 3 and 3R are based on eight rings per inch as described on page 30 of the Forest Service plan.

I made a review of the growth rates, inventories, and yields being used by other agencies. On O. & C. lands of similar site in the same area the BLM has estimated more rapid growth under intensive management and used shorter rotation than 100. On standard area only alternative 4 was run using approximately the same growth rate as used by the BLM on the south Umpqua management unit which is site index 115. I used a rotation of 80 years and 47 percent clearcut and 53 percent shelterwood with a first cut of 60 percent and the balance removed 10 years later. Thinnings were at 40, 50, 60, and 70 years of age. I assumed full accessibility at the end of the first decade. All other limits and data were the same as the Forest Service used.

The results of this alternative of intensive management in terms of harvest, growth, and inventory are shown in figure 8. The harvest level is higher than all other alternatives for the standard area. Even though the rotation is 80 rather than 100 years the long-range sustained yield is the same as alternatives 3 and 3R. The harvest from the standard area in the first decade is 418 million fbm per year compared to 380 million in alternative 3, 346 million in alternative 2, and 276 million under the Forest Service proposal. The inventory under alternative 4 stabilizes after about a 60-year period of reduction to sustained yield levels. Growth rises rapidly during this same period to the level of the harvest and the two hold together from then on.

Alternative 4 requires more intensive management of the currently 10- to 40-year-old thinnable stands and all of the newly regenerated stands. Yields from the other existing stands are essentially the same as under other alternatives. The other main differences are full accessibility and more rapid liquidation of overmature timber. The effect is to more than double the growth in 60 years.

In terms of extra present net worth of the net stumpage income to the Treasury after payments to counties and sales and reforestation costs, alternative 4 is better than alternative 2 by $35,830,000. In terms of average net annual returns to Treasury this alternative 4 will bring in an extra $1,790,000 annnually based on the assumed stumpage rates and costs.

During the first decade there will be 123,956 acres 50 years of age and under in alternative 4. With a 10-year extra income of $17,900,000 this is $144.40 per acre available for a single treatment. During the second decade there are 211,617 acres in age classes 50 years and under and the extra income provides $84.60 per acre for another treatment. These available extra incomes are over and above any K–V funds collected on sales and I have also allowed $20 per acre for reforesting after harvest.

In my opinion, any forester would welcome the opportunity to intensify the management on these standard acres, given the opportunity to use the extra net income for stocking control and growth enhancement on the new stands.

This alternative 4, at the same time will provide an extra average annual payment to the counties of about $650,000 per year over alternative 2 or about a 20-percent increase.

*Summary of Alternatives*

Following is a tabular summary of the results of the Forest Service and my alternatives for the plan period, 1972–81:

| | Millions of board feet per year | | | |
|---|---|---|---|---|
| | Standard | Special | Lodgepole pine | Total |
| Forest service proposal: | | | | |
| Full yield | 276. 0 | 88. 4 | 2. 9 | 367. 3 |
| Programed cut | 276. 0 | 67. 3 | . 0 | 343. 3 |
| Alternative: | | | | |
| No. 2 | 377. 3 | 84. 8 | 2. 9 | 465. 0 |
| No. 3R | 410. 6 | 84. 8 | 2. 9 | 498. 3 |
| No. 3 | 422. 7 | 84. 8 | 2. 9 | 510. 4 |
| No. 4 | 450. 1 | 84. 8 | 2. 9 | 537. 8 |

A comparison of the long-range yields can also be made for the alternatives.

| | Average total harvest per year millions of board feet | | |
|---|---|---|---|
| | Conversion period, 1st rotation | Post conversion, 2d rotation | Sustained yield |
| Forest service proposal, full yield | 405. 2 | 318. 7 | 318. 7 |
| Alternative: | | | |
| No. 2 | 401. 6 | 322. 4 | 334. 0 |
| No. 3R | 431. 4 | 469. 7 | 476. 1 |
| No. 3 | 442. 0 | 469. 5 | 476. 1 |
| No. 4 | 501. 6 | 477. 6 | 477. 3 |

Additional details by type of harvest for each of the above five alternatives for decades 1 through 10 are provided in appendix tables A through E, which will be mailed to you separately.

Conclusions and Recommendations

In my opinion, you should request that the Forest Service reexamine its proposed plan for the purpose of developing several specific alternatives. These alternatives should start from a revised inventory base and should provide a description of what intensive management program will be in effect at the present level of financing and the expected yield and what additional intensive management practices are possible and the extra yields they would provide. In this manner they could conform to their own manual instructions, particularly in regard to the differences between programed allowable cut and potential yield.

Much of the preparation I have done for using the Timber RAM program can be easily made available to them in order to shorten the time and effort needed to evaluate several alternatives of their own. In fact, I have been told by the regional office staff that they intended to run the Umpqua data on Timber RAM when time permitted after other higher priority forests have been run.

If I can provide any further information to you or to the Forest Service to explain or support my findings, please let me know.

Sincerely,

Carl A. Newport.

FIGURE 1.—Harvest, Growth, and Inventory for 200 Years for Standard Area Alternative 2 (616,299 acres)
COMPARED TO FOREST SERVICE PROPOSED HARVEST

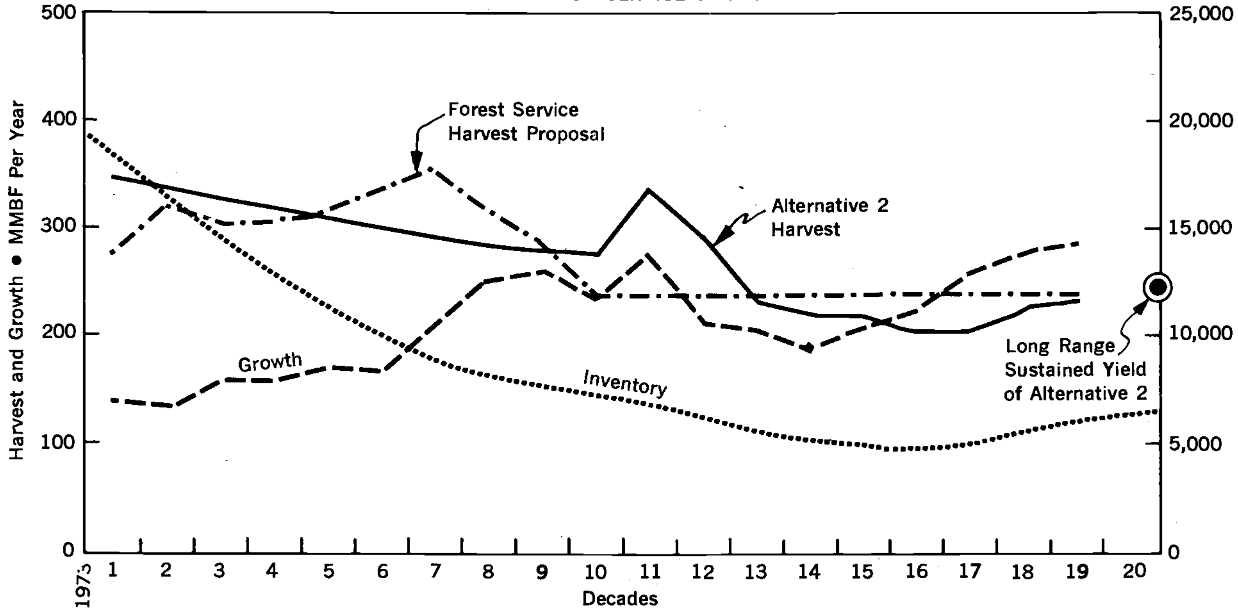



FIGURE 2.—Harvest, Growth, and Inventory for 200 Years for Special Area Alternative 2
(194,349 acres, including 14,396 acres of no yield)

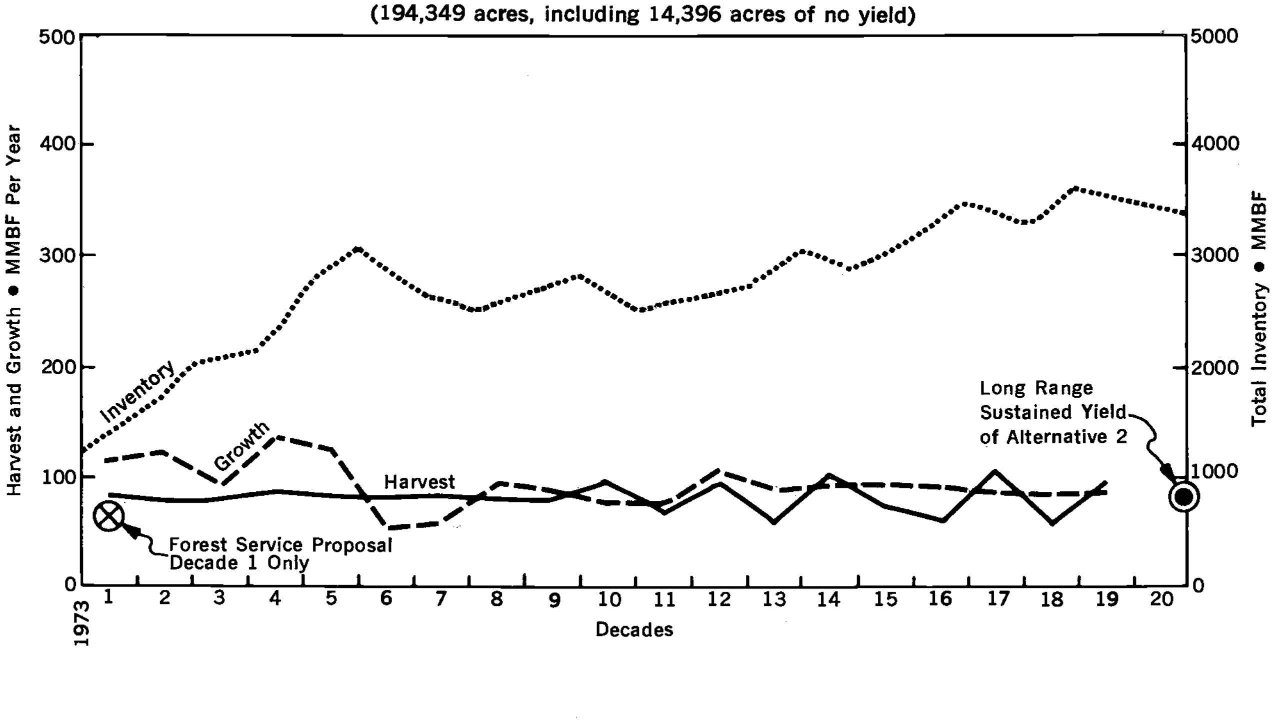


FIGURE 4.—Harvest, Growth, and Inventory for 200 Years for Standard Area Alternative 3 (616,299 acres)

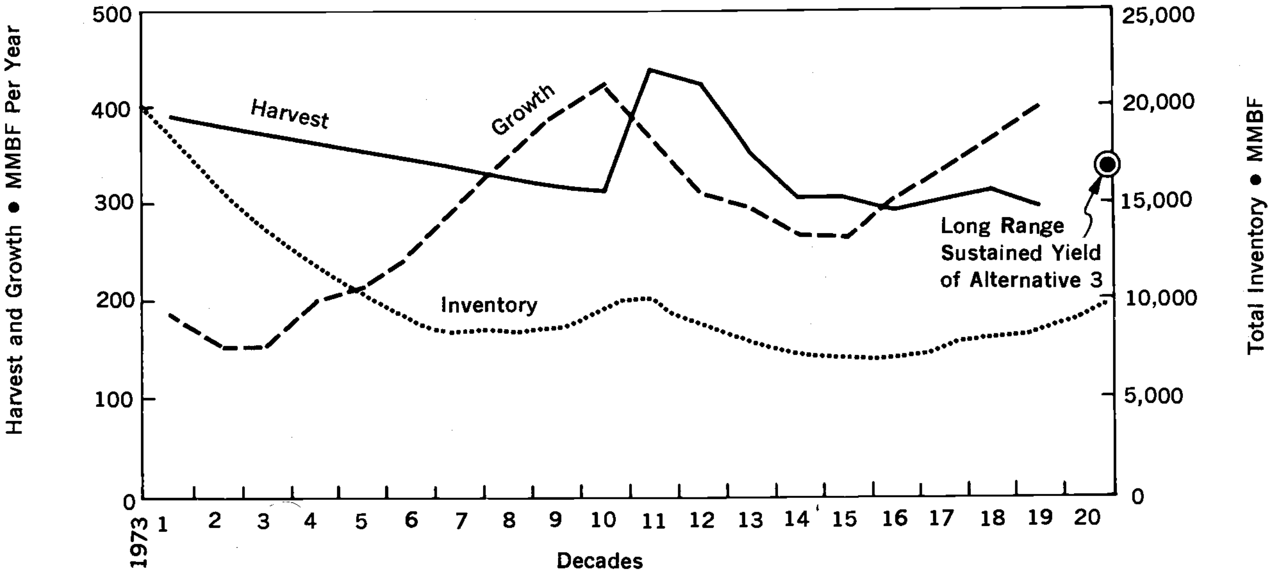



FIGURE 5.—Standing Timber Inventory for Standard Area Alternatives 2, 3R, 3, & 4
(Just before harvest or thinning)

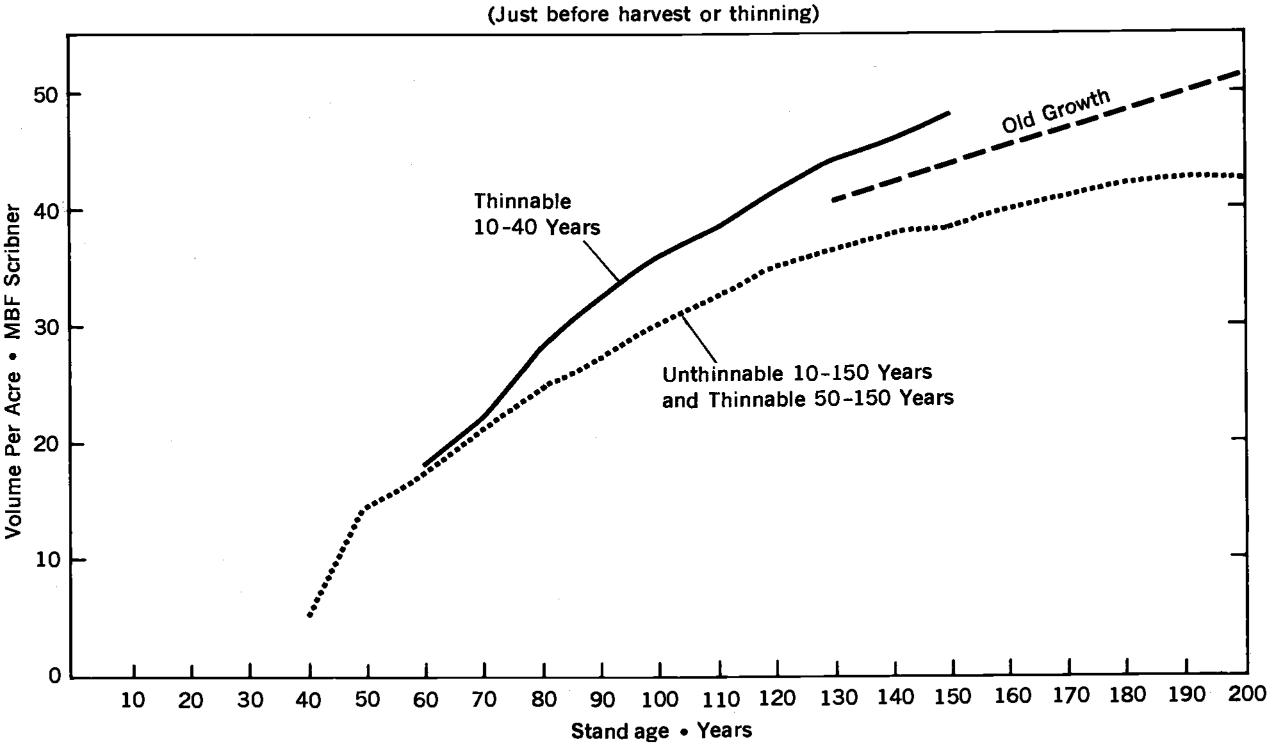


FIGURE 6.—Regenerated Timber Inventory Under Each Alternative for Standard Area

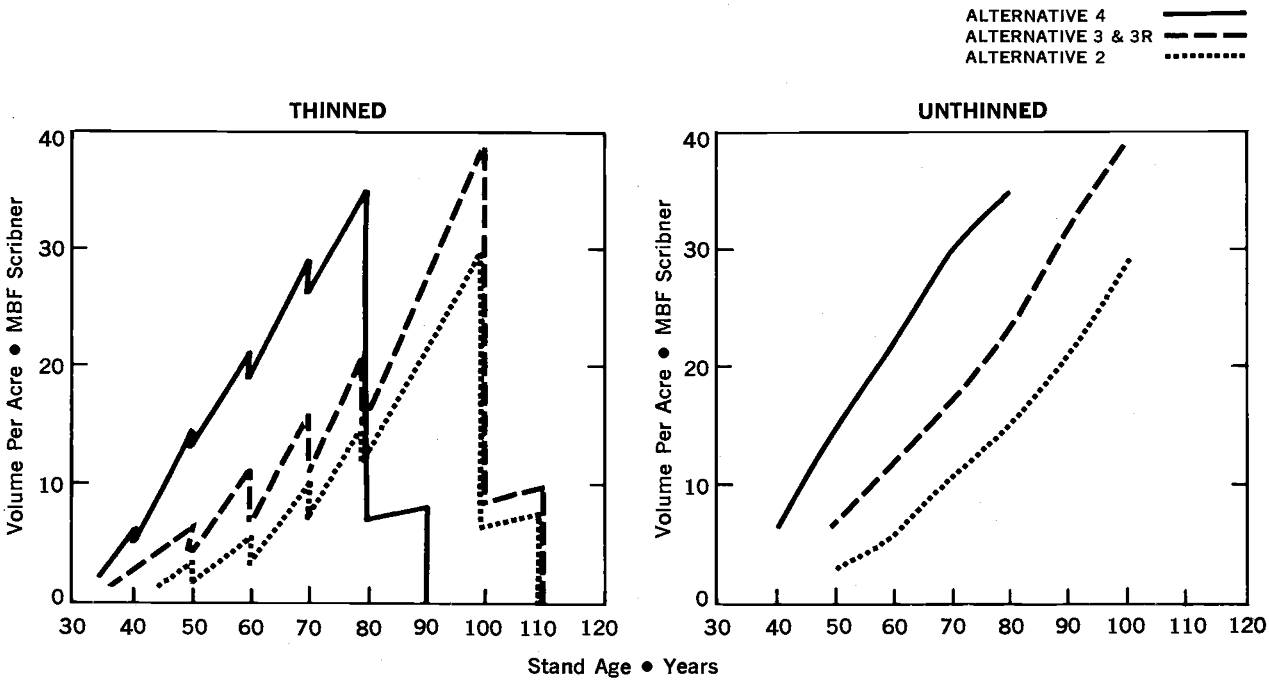



FIGURE 7.—Yields From Existing Thinnable Stands Age 10–40 Years for Standard Area

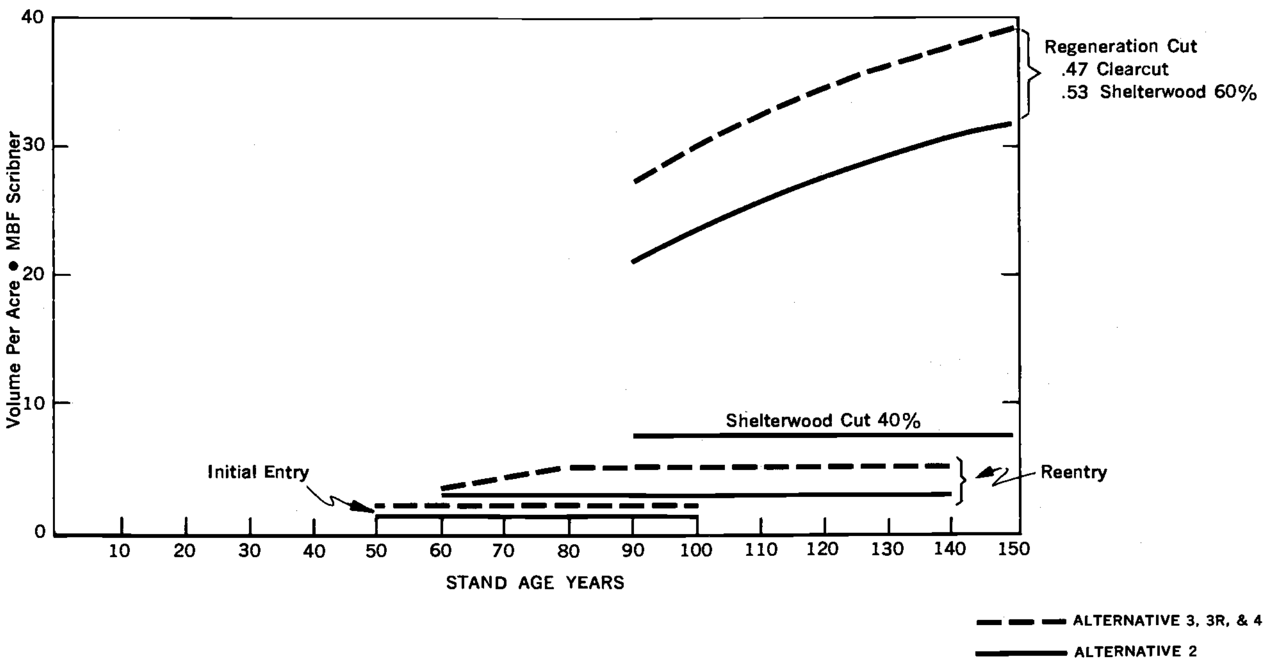
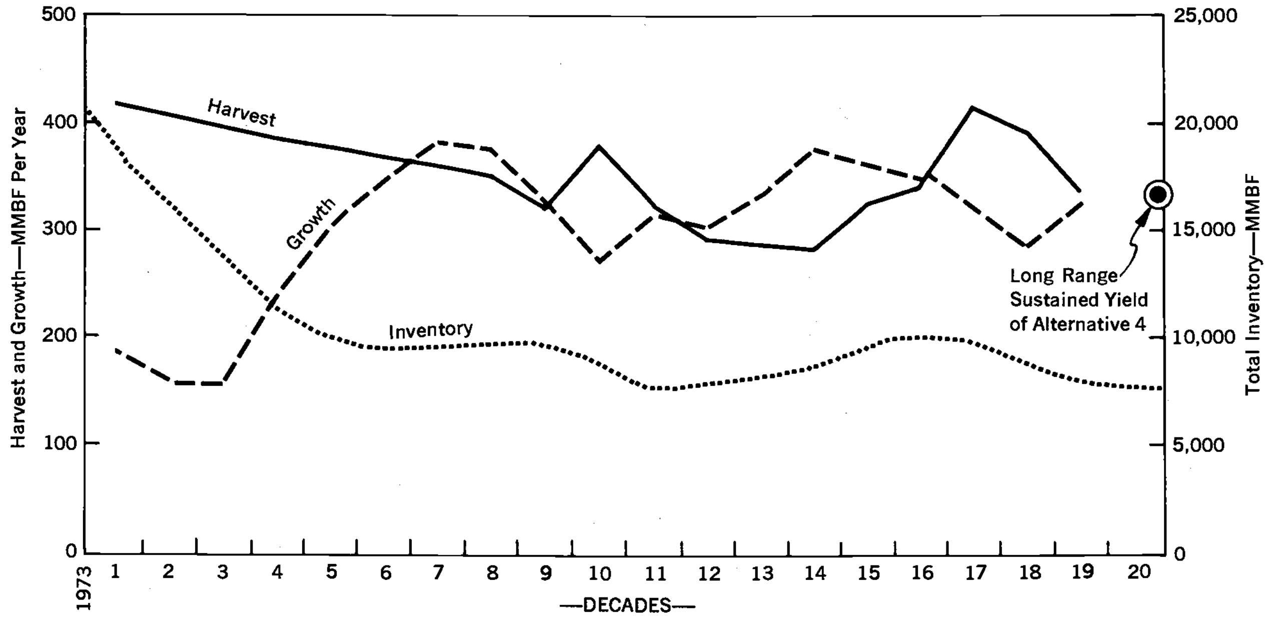


FIGURE 8.—Harvest, Growth, and Inventory for 200 Years for Standard Area Alternative 4 (616, 299 acres)




## TABLE A.—Summary of Estimated Volumes by Cut Category by 10-Year Cutting Cycle

[From all CFL acres before adjustments]

| Decade | Regeneration | | Overwood removal | | Comparison thinning | | Mortality salvage | | LP regeneration | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | Volume million board feet | Acres | Volume million board feet [1] | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet |
| 1 | 80,318 | 2,689.8 | | 315.4 | 38,060 | 428.9 | | 217.4 | 7,423 | 29.1 | 125,801 | 3,680.6* |
| 2 | 80,318 | 2,758.7 | | 919.5 | 60,645 | 406.0 | | 197.1 | 7,423 | 29.1 | 148,386 | 4,310.4 |
| 3 | 80,318 | 2,867.5 | | 807.4 | 58,087 | 162.9 | | 141.7 | 7,423 | 29.1 | 145,828 | 4,008.6 |
| 4 | 80,318 | 2,976.3 | | 800.8 | 57,972 | 132.4 | | 101.0 | 7,423 | 29.1 | 145,713 | 4,039.6 |
| 5 | 80,318 | 3,085.3 | | 830.1 | 89,507 | 184.6 | | 63.8 | 7,423 | 29.1 | 177,248 | 4,192.9 |
| 6 | 80,318 | 3,194.1 | | 859.3 | 160,195 | 317.8 | | 26.6 | 7,423 | 29.1 | 247,936 | 4,426.9 |
| 7 | 80,318 | 3,302.9 | | 888.6 | 210,930 | 497.7 | | | 7,423 | 29.1 | 298,671 | 4,718.3 |
| 8 | 80,318 | 2,820.2 | | 758.7 | 248,660 | 605.9 | | | 7,423 | 29.1 | 336,401 | 4,213.9 |
| 9 | 80,318 | 2,337.4 | | 628.9 | 288,754 | 720.9 | | | 7,423 | [2] 58.2 | 376,495 | 3,745.4 |
| 10 | 80,318 | 1,854.6 | | 499.0 | 307,713 | 775.3 | | | 7,423 | 58.2 | 395,454 | 3.187.1 |

[1] This volume is used to make up volume lost through shelterwood cutting of 0.6 of average volume per acre. No separate goal for overwood removal.
[2] Assumes double production with stocking level control.

*After multiple-use adjustments and exclusion of LP harvests, this would be 3,433.0 million bfm per decade.

| | *Million board feet per year* |
|---|---|
| Average total annual yields: | |
| Conversion period | 405.2 |
| Post conversion | 318.7 |

## TABLE B.—Alternative No. 2 as Developed by Mason, Bruce & Girard

[Summary of estimated volumes by cut category by 10-year cutting cycle based on separate Timber RAM runs for standard and special (after adjustments)]

| Decade | Regeneration | | Overwood removal | | Commercial thinning | | Mortality salvage | | LP regeneration [1] | | Total acres | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Excluding mortality | Volume million board feet |
| 1 | 114,546 | 3,742.6 | 32,132 | 315.4 | 40,726 | 449.2 | 137,308 | 114.0 | 7,423 | 29.1 | 194,827 | 4,650 |
| 2 | 83,711 | 2,875.5 | 72,023 | 1,299.8 | 50,498 | 156.2 | 79,072 | 43.9 | 7,423 | 29.1 | 213,655 | 4,404 |
| 3 | 79,583 | 2,742.6 | 47,078 | 914.9 | 86,145 | 459.8 | 17,320 | 11.8 | 7,423 | 29.1 | 220,229 | 4,158 |
| 4 | 82,476 | 2,986.5 | 38,176 | 756.3 | 114,752 | 309.5 | 17,575 | 13.7 | 7,423 | 29.1 | 242,827 | 4,095 |
| 5 | 74,940 | 2,678.0 | 40.974 | 811.8 | 149,832 | 452.0 | 30,089 | 22.7 | 7,423 | 29.1 | 273,169 | 3,993 |
| 6 | 67,021 | 2,646.4 | 32,150 | 636.9 | 271,026 | 539.9 | 53,125 | 42.1 | 7,423 | 29.1 | 377,620 | 3,894 |
| 7 | 61,769 | 2,334.3 | 35,268 | 698.7 | 393,076 | 778.0 | 1,062 | .6 | 7,423 | 29.1 | 497,536 | 3,840 |
| 8 | 60,513 | 1,875.4 | 27,490 | 543.3 | 436,313 | 1,255.8 | | | 7,423 | 29.1 | 531,739 | 3,703 |
| 9 | 71,071 | 1,880.6 | 32,072 | 544.0 | 449,219 | 1,158.0 | | | 7,423 | 58.2 | 559,785 | 3,640 |
| 10 | 76,457 | 2,020.4 | 37,553 | 597.8 | 334,188 | 1,097.8 | | | 7,423 | 58.2 | 455,621 | 3,774 |

[1] Same as Forest Service proposed plan.

| Average total annual yields: | *Million board feet per year* |
|---|---|
| Conversion period | 401.6 |
| Post conversion | 322.4 |
| Sustained yield | 334.0 |

## TABLE C.—Alternative No. 3R (Intensive Management on Standard Area) as Developed by Mason, Bruce & Girard

[Summary of estimated volumes by cut category by 10-year cutting cycle based on separate Timber RAM runs for standard and special (after adjustments)]

| Decade | Regeneration | | Overwood removal | | Commercial thinning | | Mortality salvage | | LP regeneration [1] | | Total per decade volume million board feet |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | |
| 1 | 123,075 | 4,028.2 | 2,132 | 315.4 | 40,726 | 449.1 | 194,638 | 161.6 | 7,423 | 29.1 | 4,983.4 |
| 2 | 89,785 | 3,084.1 | 130,796 | 1,389.3 | 50,498 | 156.2 | 130,327 | 71.6 | 7,423 | 29.1 | 4,729.4 |
| 3 | 85,130 | 2,940.6 | 92,496 | 978.7 | 101,718 | 490.9 | 63,028 | 35.6 | 7,423 | 29.1 | 4,474.9 |
| 4 | 83,354 | 3,019.1 | 77,578 | 814.6 | 163,117 | 480.3 | 74,540 | 61.0 | 7,423 | 29.1 | 4,404.0 |
| 5 | 77,259 | 2,767.0 | 78,187 | 821.0 | 184,791 | 613.8 | 79,482 | 63.7 | 7,423 | 29.1 | 4,294.6 |
| 6 | 66,904 | 2,660.8 | 62,979 | 661.3 | 285,291 | 820.6 | 29,416 | 16.3 | 7,423 | 29.1 | 4,188.0 |
| 7 | 68,403 | 2,270.9 | 66,904 | 702.5 | 352,766 | 1,124.5 | | | 7,423 | 29.1 | 4,127.0 |
| 8 | 59,705 | 1,769.3 | 66,146 | 833.5 | 381,504 | 1,350.7 | | | 7,423 | 29.1 | 3,982.6 |
| 9 | 61,072 | 1,671.1 | 59,705 | 499.8 | 418,622 | 1,683.8 | | | 7,423 | 58.2 | 3,913.0 |
| 10 | 56,920 | 1,818.2 | 68,407 | 763.2 | 341,456 | 1,399.8 | | | 7,423 | 58.2 | 4,039.5 |

[1] Same as Forest Service proposed plan.

| Average total annual yields: | *Million board feet per year* |
|---|---|
| Conversion period | 431.4 |
| Post conversion | 469.7 |
| Sustained yield | 476.1 |

## TABLE D.—Alternative 3 (Intensive Management and Accelerated Roading on Standard Area) as Developed by Mason, Bruce & Girard

[Summary of estimated volumes by cut category by 10-year cutting cycle based on separate Timber RAM runs for standard and special (after adjustment)]

| Decade | Regeneration | | Overwood removal | | Commercial thinning | | Mortality salvage | | LP regeneration [1] | | Total per decade volume million board feet |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | |
| 1 | 113,334 | 3,702.0 | 2,132 | 315.4 | 72,744 | 810.0 | 298,927 | 248.1 | 7,423 | 29.1 | 5,104.6 |
| 2 | 90,990 | 3,125.5 | 121,055 | 1,287.1 | 99,291 | 281.7 | 233,412 | 124.2 | 7,423 | 29.1 | 4,847.6 |
| 3 | 89,806 | 3,107.5 | 93,701 | 991.3 | 129,796 | 375.4 | 161,437 | 86.8 | 7,423 | 29.1 | 4,590.1 |
| 4 | 85,532 | 3,099.8 | 82,254 | 863.7 | 166,974 | 465.2 | 103,927 | 58.6 | 7,423 | 29.1 | 4,516.4 |
| 5 | 81,245 | 2,920.1 | 80,365 | 843.8 | 184,792 | 581.4 | 47,956 | 29.7 | 7,423 | 29.1 | 4,404.1 |
| 6 | 67,596 | 2,688.3 | 66,964 | 703.1 | 304,773 | 859.6 | 26,421 | 14.7 | 7,423 | 29.1 | 4,294.8 |
| 7 | 68,780 | 2,275.5 | 67,596 | 709.8 | 377,592 | 1,216.7 | | | 7,423 | 29.1 | 4,231.1 |
| 8 | 56,780 | 1,689.2 | 66,523 | 824.4 | 414,979 | 1,541.4 | | | 7,423 | 29.1 | 4,084.1 |
| 9 | 54,121 | 1,558.3 | 56,781 | 518.2 | 455,534 | 1,877.1 | | | 7,423 | 58.2 | 4,011.8 |
| 10 | 63,424 | 1,955.9 | 61,457 | 674.7 | 353,500 | 1,447.1 | | | 7,423 | 58.2 | 4,135.9 |

[1] Same as Forest Service proposed plan.

| Average total annual yields: | *Million board feet per year* |
|---|---|
| Conversion period | 442.0 |
| Post conversion | 469.5 |
| Sustained yield | 476.1 |

## TABLE E.— Alternative 4 (Intensive Management, Accelerated Roading and 80-Year Rotation on Standard Area) as Developed by Mason, Bruce & Girard

[Summary of estimated volumes by cut category by 10-year cutting cycle based on separate Timber RAM runs for standard and special (after adjustment)]

| Decade | Regeneration | | Overwood removal | | Commercial thinning | | Mortality salvage | | LP regeneration [1] | | Total per decade volume million board feet |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | Acres | Volume million board feet | |
| 1 | 121,706 | 3,982.4 | 2,132 | 315.4 | 72,744 | 810.0 | 290,555 | 241.2 | 7,423 | 29.1 | 5,378. |
| 2 | 95,272 | 3,272.6 | 129,427 | 1,375.0 | 118,392 | 319.9 | 220,758 | 117.6 | 7,423 | 29.1 | 5,114.2 |
| 3 | 93,786 | 3,249.6 | 97,983 | 1,036.3 | 161,018 | 456.9 | 144,803 | 78.1 | 7,423 | 29.1 | 4,850.0 |
| 4 | 89,732 | 3,255.4 | 86,234 | 905.5 | 184,792 | 532.0 | 83,094 | 47.7 | 7,423 | 29.1 | 4,769.7 |
| 5 | 82,753 | 2,965.3 | 84,564 | 887.9 | 291,774 | 727.6 | 70,264 | 41.3 | 7,423 | 29.1 | 4,651.2 |
| 6 | 76,343 | 2,867.6 | 68,472 | 715.1 | 396,900 | 918.0 | 9,607 | 6.0 | 7,423 | 29.1 | 4,535.8 |
| 7 | 94,477 | 2,780.2 | 76,343 | 776.1 | 409,634 | 880.6 | | | 7,423 | 29.1 | 4,466.0 |
| 8 | 84,414 | 2,389.2 | 92,220 | 1,040.5 | 419,291 | 854.4 | | | 7,423 | 29.1 | 4,313.2 |
| 9 | 113,823 | 3,159.3 | 84,414 | 724.3 | 351,250 | 1,086.3 | | | 7,423 | 58.2 | 5,028.1 |
| 10 | 94,282 | 2,566.9 | 121,158 | 1,165.8 | 307,810 | 1,011.3 | | | 7,423 | 58.2 | 4,802.2 |

[1] Same as Forest Service proposed plan.

| Average total annual yields: | *Million board feet per year* |
|---|---|
| Conversion period | 501.6 |
| Post conversion | 477.6 |
| Sustained yield | 477.3 |

MASON, BRUCE, AND GIRARD
CONSULTING FORESTERS
AMERICAN BANK BUILDING
PORTLAND, OREG.

DAVID T. MASON
KARL D. HENZE
GILBERT M. BOWE
LUCIEN B. ALEXANDER
GWYNNE H. SHARRER
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ROBERT J. KNEPPER

TELEPHONE 224-3445
AREA 503

*December 29, 1972.*

BOARD OF COUNTY COMMISSIONERS OF DOUGLAS COUNTY, OREG.,
*Courthouse,*
*Roseburg, Oreg.*

Attention Mr. Ray Doerner, chairman.

GENTLEMEN: You have asked me to review and comment to you on the draft environmental statement and the management plan which it supports, including the multiple-use plan. Your particular concern was whether the alternative being proposed was truly the best one with respect to the effect on Douglas County.

I have studied carefully the statement, draft plan, and supporting statistics, and in connection with work being done for the local forest industry I have made detailed computer computations of the Forest Service proposal and other alternatives, particularly one based on coordination of harvests with Douglas County private forest lands.

THE FOREST SERVICE PROPOSAL

The Forest Service proposes to establish a new programed allowable cut. Specific details are:

1. The proposed new cut will be 343.3 million fbm, which is about 65 million less than the recent level of actual harvest and 13.7 million less than the current allowable cut.

2. Regeneration harvests will be made using clearcutting on 47 percent of the area and 53 percent will be by shelterwood cutting. In the recent past about 90 percent has been by clearcutting, thus this plan provides for much more shelterwood cutting.

3. About 190,000 acres of commercial forest land were placed in the special category. These are landscape management and streamside management zones of various kinds. The decisions on the management of these lands were made in the multiple-use plan and apparently are not subject to question by the public in the draft environmental statement.

4. The present rate of roading will be continued under this plan and 85 percent of the forest will be accessible for timber harvest and multiple use by the end of the 10-year period.

5. A medium level of intensity of management is proposed. This provides for stocking control by precommercial and commercial thinning and aggressive mortality salvage.

SUMMARY OF FINDINGS AND CONCLUSIONS

Please refer to the enclosed copy of my report to the local forest industry. To the five findings listed on pages 1 and 2 of that report I would like to add the following directed specifically to your interests:

1. The statement and plan do not specifically evaluate intensive management alternatives that could yield higher levels of output as required in the governing laws and procedures. Omitted, for example, are accelerated roading and greater use of available special logging techniques such as helicopters.

2. The draft statement rejects an alternative high level of intensity of management which was based on fertilization and genetically improved planting stock. This was rejected because improved stock is not available in sufficient quantity and fertilization is not yet a proven management practice.

3. Several policy questions of importance to Douglas County are not answered in the plan nor in the draft statement. Such subjects as rotation length, even flow, community stability, and payments to the counties are either omitted or inadequately covered. Of particular importance to Douglas County is the relationship between the flow of national forest timber volume to the flow from other sources such as private lands. This was not dealt with in the impact statement nor in the proposed plan.

## Comments on Selected Subjects

*Accelerated Roading*

The completion of a carefully planned and constructed road system is based on a high-level sustained yield of all of the multiple uses on the Umpqua Forest. The proposed plan stresses this need in several places and projects that the present rate of roading will make 85 percent of the forest accessible at the end of the first 10 years. From information given in the plan, page 20, one can calculate that this will require the construction of about 163 miles of road per year during the plan period.

Very little is said about roads in the impact statement. In my opinion, the single paragraph on page 6 of the statement is inadequate treatment of an activity which the Forest Service says "may have more overall impact on the soil and water resources than the actual harvesting operation." There is no discussion of the number of miles of road to be constructed per year nor whether this is more or less than what has been constructed per year in the recent past. This would help the reader evaluate the proposed action program.

Neither the plan nor the statement explain the details of how the access road program is to be financed. Apparently timber sales are to be the primary source of road construction funds. It would be very informative to know whether an accelerated road program could be partially financed from the increased timber sales that greater accessibility would permit or whether appropriate funds would be necessary.

It would appear that an extra 71 miles of road construction per year would make the forest fully accessible for intensive management by the end of the plan period. A recent report by the Forest Service uses an average construction cost of $30,000 per mile on the Umpqua.[1] On this basis the cost would be $2,130,000 per year for 10 years. It seems to me that the Forest Service missed a good opportunity to make a case for more rapid roading of the Umpqua Forest in order to accrue the benefits of intensive management of more lands, faster mortality salvage, more thinning, and greater access for recreational use.

Likewise, the lack of quantitative information on road construction rates makes it difficult to evaluate the expected short-term, adverse environmental impacts of roadbuilding. We must accept their qualitative statements and assurances that the effects will be minimized by good location and design and low density. I suggest that you ask the Forest Service to present a more complete picture of the costs and benefits of both the proposed and an accelerated roadbuilding program.

*Intensive Practices*

On page 10 and elsewhere in my enclosed report I have pointed out that the plan and the statement do not indicate what increase in harvest could be made if full funding and staffing were available for the application of the standard and proven intensive management practices. Because of this omission the potential yield and programed allowable cut are equal in their proposal for the standard areas. Or is it possible that the Umpqua Forest has the funds and manpower and is planning to carry out all of the standard cultural practices on all of the available acres? I doubt that this is the case. Either the potential yield is too low or the programed allowable cut is too high.

I have compared their estimates of yield with the yield estimates by other agencies and companies for the same site quality. In my opinion, their potential yield is too low in relation to what could be done under more intensive management than the medium intensity which they propose. Please refer to figure 6 in my enclosed report.

*Fertilization and Genetics*

On page 15 of the statement the Forest Service briefly describes what they call alternative No. 4. In my opinion, this is not really an alternative as envisioned in the Environmental Policy Act. The way it is described by the Forest Service makes it appear that their own rules, procedures, and judgment eliminate it as an alternative. Specifically, this alternative was rejected because:

1. The acceptance of this alternative would require that we take present credit for future management techniques which, although they appear to be possible and even probable, have not, as yet, been proven to be effective on the ground, and
2. The increased rate of old growth harvest was also judged not to be acceptable.

It appears to me that any significant increase in the intensity of management above that proposed as "medium level," whether a proven practice or not, would be unacceptable to the Forest Service

[1] Payne, Brian R., 1972. "Accelerated roadbuilding on the north Umpqua—an economic analysis." USDA Forest Service research paper PNW-137, 32 pp., illustrated. Pacific Northwest Forest and Range Experiment Station, Portland, Oreg.

because it would substantially increase the rate of old growth harvest. However, they do point out that in the future "if techniques of logging are developed that will lessen the environmental impact of timber harvest," they might reconsider this alternative.

There seems to be a great deal of fuzziness with regard to what is a proven practice in intensive management and in techniques of logging. On page 6 of the statement they list skylines, balloons, and helicopters as being generally available logging systems on the Umpqua Forest. Currently, for example, region 6 of the Forest Service has a sales program in excess of 100 million fbm on which helicopter logging is to be required. This is certainly a large volume if this system is not yet proven in regard to its environmental impact.

In my opinion, the Forest Service should determine the potential benefits and costs of a fertilization program and of the use of genetically improved planting stock as a basis for reaching a decision within the Forest Service as to how avidly to pursue the development of these practices.

*Even Flow*

The Forest Service proposal provides for an uneven flow of total timber harvest from the Umpqua Forest for the next 100 years. It proposes declines in 4 of the first 10 decades. This must be interesting to you in comparison with the strict even-flow policy of the BLM in which that agency provided for no variations in total harvest for the next 400 years on management units in western Oregon.

In my opinion, neither of these two policies have given adequate consideration to what are stated Federal objectives; that is, the provision of raw material for a local economy which in turn is supplying the Nation's growing needs for wood products. Neither of these agencies took into consideration the relationship of their planned production to that of other local sources of timber supply. Furthermore, their proposal reduces the total harvest for the next 10 years by 65 million fbm from the current level, but then increases it in the second 10 years by about 60 million. (See table A in appendix of enclosed report.) In my opinion, if a decline in the future is necessary, it should be gradual and smooth as I have proposed in my alternatives. County industry and workers that are now available and productive should be given consideration.

The Forest Service also failed to explain in the draft statement and plan the relationship of the proposed harvest during the next 10 years with that from the Umpqua Forest during the past few years. For example, on page 15 the summary of alternatives fails to present the fact that during the last 7 years the actual cut has been about 408 million fbm. In their table they could have reported that this actual cut provided 1,632 jobs in the timber industry, and 3,264 jobs in the related industries which is better than any of their alternatives. Possibly, it would be even more interesting to see how they judged their past practices in that table of alternatives relative to the impact on fisheries, large game, etc. Was it better or worse than the proposed medium level of intensity?

In my opinion, even flow to achieve community stability is not very meaningful if it starts out with a proposed 16 percent reduction in the harvest level. If such a reduction is really necessary for some reasons such as environmental impacts, then a much stronger and better supported document is needed for public evaluation of the soundness of such an important decision.

*Rotation*

In my enclosed report, on page 7, I have discussed the lack of support to their decision in selecting a 100-year rotation. In the Forest Service report, footnoted earlier, an accelerated roadbuilding program on the north Umpqua was found to be economically undesirable because the earning rate on the necessary investments was less than 3.6 percent while the "minimum rate that should be considered for Federal investments is probably around 5 percent."

Numerous research reports by the Forest Service and others have documented that rotations which culminate the mean annual increment of volume growth are, in effect, investing increments of growing stock which earn a zero rate of return. Their rejection of an accelerated roadbuilding program and the acceptance of 100-year rotation based on the culmination of mean annual increment indicates that the Forest Service must be using a double standard.

The Forest Service manual provides instructions for determining rotation, but these are not very specific. One criteria is to grow timber of a sufficient size to be utilized for the kinds of wood products needed in the future. As I have pointed out in my other report, this is a subject in which the public has as much or more expertise as foresters or public administrators. It is not clear in the proposed plan how much consideration was given to this criteria in selecting the 100-year rotation. I suggest that you urge the Forest Service to reconsider rotation including both economic and desired-product criteria.

### Relationship to Other Sources of Supply

As you pointed out in your July 29, 1972, letter to the forest supervisor about one-half of the Douglas County timber harvest comes from the private commercial forest land.

I was able to obtain from the Forest Service experiment station information on the private age-class distribution and inventory. Three primary factors will control the rate of future harvesting from the private forest lands. These are:

1. The distribution of timber age classes,
2. The owners' decisions regarding the time and kind of harvesting with respect to timber age, and
3. The volume yields and management intensity.

If the private lands were all under one ownership and had management and yields like the Forest Service, it is possible that the age-class distribution might complement the national forest age classes in such a way that the timing of peaks and troughs in the harvest would also be complemental. The table on the next page presents the age class distribution for the private lands and for the standard area on the Umpqua National Forest.

Using the Forest Service's Timber RAM computer program I have analyzed a preliminary computation of the harvest schedule resulting from the combination of the private and the Umpqua National Forest standard area lands. In that preliminary computation the yields used for the national forest lands were the same as those used in alternative No. 2 and described in my other report. For the private lands I used a 70-year rotation, regeneration by clearcutting only, full accessibility, volume per acre yields similar to the Forest Service and a program of restocking the nonstocked slowly during the next 50 years. I used separate timber classes for the private and the national forest for each age class so that I could tell from the computer output when cutting was scheduled for the private versus the national forest lands.

Based on this preliminary run, it is my opinion that some benefits could be gained from this type of harvest schedule. I am well aware that the Forest Service lacks control of the timing of private timber harvests. Nevertheless, it is possible to get a considerable insight into when private timber will be more available than the other times from a more complete analysis of the type which I made.

I intentionally refrained from using intensive management yields in my preliminary run so that I would not confuse the benefits of coordinated harvesting with the benefits of more intensive management.

I suggest that you ask the Forest Service to make this type of an analysis in order that you and they will have a much better basis for the decision as to how national forest timber harvesting should be scheduled to give the maximum public benefits in Douglas County. I will be glad to make my preliminary input information for Timber RAM available to the Forest Service as a starting point for them in such an analysis.

### Economic Considerations

The draft environmental statement has a section on the economic and social aspects of the proposed plan on page 9. Again, on page 15, references to employment are made in the comparison of alternatives. On page 4, additional remarks are made about the dependent industry in southwestern Oregon. This treatment of the economic and social aspects of this plan, although desirable, is not very thorough. The orientation is also aimed entirely at the local benefits to the exclusion of the national benefits of the timber harvest and neglects completely to treat the dollar cost side of the economic picture for either the alternative chosen or for those rejected. The evaluation of the alternatives omits the cost side of the economic picture and only generally describes the action programs which are required to achieve the selected alternative. Surely the costs of the several alternatives described in the statement differ appreciably in their costs, especially those for which appropriated funds are necessary and which are thereby paid for by the citizens of the entire Nation.

The draft statement does not present the effect of the various alternatives on the payments to the counties from the expected timber receipts. The proposed reduction in harvest of about 16 percent could have a significant impact on the taxpayers of these counties who will have to make up the difference for the support of roads and school sys-

**ESTIMATED 1978 Age Class Distribution—Douglas County, Oreg.**

| Age class | Douglas County, private | | Umpqua National Forest, standard area | |
|---|---|---|---|---|
| | Acres | Percent | Acres | Percent |
| Old growth | 421, 840 | 34. 55 | 429, 763 | 69. 74 |
| Years: | | | | |
| 100 | 26, 190 | 2. 16 | 16, 733 | 2. 72 |
| 90 | 30, 938 | 2. 54 | 12, 925 | 2. 10 |
| 80 | 28, 836 | 2. 36 | 14, 965 | 2. 43 |
| 70 | 51, 290 | 4. 20 | 9, 251 | 1. 50 |
| 60 | 46, 921 | 3. 84 | 8, 706 | 1. 41 |
| 50 | 54, 471 | 4. 46 | 8, 571 | 1. 39 |
| 40 | 54, 470 | 4. 46 | 18, 639 | 3. 02 |
| 30 | 150, 056 | 12. 29 | 21, 224 | 3. 44 |
| 20 | 143, 585 | 11. 76 | 34, 691 | 5. 63 |
| 10 | 102, 855 | 8. 42 | 19, 796 | 3. 21 |
| Nonstocking | 109, 426 | 8. 96 | 21, 035 | 3. 41 |
| Total | 1, 220, 878 | 100. 00 | 616, 299 | 100. 00 |

tems within the counties. An understanding of this might assist some of the local citizens in judging the importance of the expected environmental impacts of various timber harvest alternatives.

Additional sources of revenue for local governments is a nationwide problem. I suggest that you ask the Forest Service to include a thorough presentation of the expected effect on payments to your county under their selected alternative.

### The Multiple-Use Plan

The Multiple Use Act of June 12, 1960, includes such phrases as "utilized in the combination that will best meet the needs of the American people" and "to conform to changing needs and conditions." In this act, and elsewhere in laws and regulations governing the national forests, references are made to the wants and needs of the people of the Nation. My examination of the multiple-use planning process leads me to believe that the major consideration in the classification of Umpqua National Forest lands for multiple use was the location and capability of the land and that very little, if anything, was done to analyze the needs of the American people as a basis for determining multiple-use management "so that they are utilized in the combination that will best meet the needs of the American people."

To the best of my knowledge, no documentation was made of needs either past, current, or future. For example, no measure was made of the Douglas County citizens' attitude toward the landscape along the highways and waterways or of their needs for local recreational lands and facilities. The Multiple Use Act calls for a sustained yield of all the products and services. Most of us are well aware that it is difficult to measure national forest output of wildlife, water, recreation, and so forth. The Forest Service's attempt on page 15 to give qualitative indications of the benefits of these other uses is a small step in the right direction. Such a qualitative evaluation may be sufficient when the Federal action program being proposed and evaluated under the Environmental Policy Act does not have much impact on man's economic and social environment. But, when changes of this magnitude are involved, a much better description of the sustained yield of the other products and services is required if a sound decision is to be made on an alternative action program. For example, I would document the current amount of recreational use and facilities and compare several alternatives, including the selected one, with that level. Again, I stress that the best base for the public's consideration of a proposed future action program is to examine it in relation to the current or recent past program and the outputs from that program.

I hope that this report and my enclosed report to the forest industry will provide you with a basis for making worthwhile suggestions to the Umpqua National Forest that will lead to a program of Federal action which gives full consideration to the effects on Douglas County and to its citizens.

Sincerely,

Carl A. Newport.



505-287 O - 73 - 15

# appendix G

BY CARL NEWPORT

# Timber Sales Policies and Procedures on National Forests in Relation to Shortrun Timber Supply



## INTRODUCTION

The President's Advisory Panel on Timber and the Environment has posed the following compound question:

> What changes in policy for administering timber sales on national forest might be adapted for the purposes of expediting sales, increasing total utilization of timber within the sale area, reducing waste and the need to burn slash, and to increase the flexibility of supplies so as to reduce upward pressure on lumber prices during periods of rising demand and to generally reduce price fluctuations?

The purpose of this report is to more thoroughly examine a recommendation of the task force on softwood lumber and plywood and to consider the details of its implementation. The recommendation states:

> The Forest Service—as well as the agencies responsible for other Federal forest lands—should develop and implement plans to provide greater flexibility in the adjustment of timber sales to fluctuations in demand, within the long-term constraints of sustained yield. This should include increasing the pipeline of stumpage available for sale and cutting in any year on areas with adequate roads, as well as moderate adjustments in the level of annual sales in response to existing and foreseeable market conditions. If present housing projections are to be realized at reasonable prices, prompt action in this direction will be necessary. This should include the willingness to adjust annual sale offerings to meet emerging situations. Such adjustments may be upward or downward, but should be compensated as promptly as feasible so that the aggregate cut over a period of years remains in line with sustained yield objectives.

This recommendation was directed toward ameliorating the historic shortrun wide swings in lumber and plywood prices. Obviously, the task force has attributed a significant amount of these fluctuations to an inflexible shortrun timber supply situation, more specifically to Federal timber supply as manifested in timber sales programs and practices. Before proceeding, it is necessary to describe the framework within which Federal timber sales take place, particularly Forest Service sales. This description is given in the form of the following eight conditions that prevail.

1. Softwood lumber and plywood production and marketing takes place in a classically competitive industry. There are many producers, many wholesalers and retailers, and many consumers. In contrast to other basic commodities, such as steel and aluminum, lumber and plywood prices are not administered by the producers, but are determined

by the interaction of supply and demand in the market.[1]

2. The supply of lumber and of plywood which most directly influences prices is that supply which is in transit to or at markets, in warehouse inventory, in production, and about to be produced from logs now on hand or currently being logged. It also includes standing timber under contract or otherwise available for immediate harvest. The total of these makes up the sellers' supply and is the principal determinant of his ability to accept orders and to set prices for lumber and plywood. The other determinants are the availability of plant capacity, labor supply, and local weather conditions.

3. The supply of standing timber yet to be harvested (the raw material for lumber and plywood production) also influences the shortrun lumber and plywood supply. This standing timber supply is the raw material not yet under contract or not yet available but is expected to be, such as the public allowable cut. The probability of it becoming part of the real supply is often highly uncertain. For those lumber and plywood producers dependent upon public or other owner's timber, the probability of this local standing timber currently and continually becoming a part of their raw material supply strongly influences the stumpage prices which are bid for timber currently being added to the real supply, described in No. 2 above. Among the uncertainties of these probable additions to real supply are the constraints under which it may become available. Public allowable cuts are coming under more rigid constraints, timberland is being withdrawn from use, and open market private timber is becoming more scarce. This outlook of lumber and plywood producers for continuing raw material supply influences their actions in accepting orders and in setting prices. This same outlook, when the knowledge spreads to lumber and plywood buyers, also affects their eagerness to order and willingness to accept change in price.

4. The Forest Service and other Federal timber selling agencies traditionally have remained aloof and attempted to be neutral as factors affecting the economy. There is nothing in Forest Service policies and procedures about responding to or influencing price levels. On those rare occasions when responses have been made these have been at the special direction of Congress or the administration. Sustained yield and annual even flow have been the unquestioned guides in planning and carrying out timber sale programs and fair market value has been the guiding principle in setting advertised timber prices.

5. Historically private timber has absorbed the pressure of shortrun supply shortages by responding most promptly. Public timber supply has tended to absorb the excesses, that is, public timber harvests have tended to decline relatively more than private when demand falls. These relationships occur in relatively small timber supply areas due to the high cost of transporting timber. Therefore, they may not be observed readily from sectional, regional, or national data, although a recent report by the Forest Service shows this tendency in parts of Oregon and Washington.[2]

6. Rather long periods of time elapse between national forest timber sale program formulation and actual fully operational cutting of timber. This process may range from 3 to 5 years long and is tending to get longer as environmental constraints increase. In a response to the Director of the Cost of Living Council dated November 3, 1972, the Forest Service said:

> * * * timber sales are seldom cut during the year they are sold. Typically, the purchaser builds the access roads during the first year, and logs the timber during the second, third, and fourth years of the contract.

To this must be added the one or more years of advanced planning and sale preparation. Shortcutting the preparation process may increase the possibility of damage to the environment.

7. The degree of total utilization of timber from a given Forest Service timber sale area tends to improve and decline with increases and decreases in lumber and plywood prices. On most national forests the purchasers use almost all the material suitable for lumber and plywood on each sale area. Further increases in the level of utilization is primarily dependent on and limited by the residue uses for fiber products. Most of what is being lost from, but which is suitable for, lumber and plywood manufacture is on areas other than timber sale areas and is in the form of damage, decay, and mortality. In periods of strong lumber

[1] Mead, Walter J., "Competition and Oligopsony in the Douglas-fir Lumber Industry," University of California Press, Berkeley, 1966, p. 131, 276 pp.

[2] Wall, Brian R., "Log Production in Washington and Oregon—An Historical Perspective." USDA Forest Service Resource Bulletin PNW-42, 89 pp., illustrations, Pacific Northwest Forest and Range Experiment Station, Portland, Oreg., 1972.

and plywood demand the utilization of low-grade logs, the contents of which are mostly or entirely suitable only for pulp, may decline temporarily. This is due to two factors: Lack of logging equipment which is fully occupied with harvesting higher grade logs for lumber and plywood; and residual pulpchips are more readily available when lumber and plywood production is high, thus reducing the pulpmills' need for low-grade fiber logs.

8. Factors other than amount and timing of timber sale offerings limit the ability of industry to respond to the shortrun fluctuations in demand for lumber and plywood. These are factors such as the weather, the season, the availability of labor, strikes, and local mill capacity.

In my opinion these eight conditions greatly limit the possible effect that changes in policies and procedures for administering timber sales may have in ameliorating short-term lumber and plywood price fluctuations. Nevertheless, some improvements are possible and these are presented in the remainder of this report.

Condition No. 3 above, particularly the uncertainty and/or inflexibility of public allowable cuts, is a condition which could and should be changed to help reduce the wide fluctuation in lumber and plywood prices. This is covered in a separate report to PAPTE.

## CHANGES TO EXPEDITE SALES AND INCREASE FLEXIBILITY

### Volume Under Contract

The greatest flexibility in public timber supply for immediate impact on the lumber and plywood market is that flexibility which can be and is exercised by those producers with timber actually under contract. This has been referred to in condition No. 2 described earlier. If this volume is relatively low, it will limit both the producer's opportunity and inclination to increase his harvest. If it is relatively high, the reverse is true.

Under current procedures purchasers of Forest Service and other Federal timber sales have some latitude for varying the rate of timber cutting on existing timber sale contracts.[3] The well-established purchaser dependent on public timber will have two to three times his average annual needs under contract. This is the result of and is limited by the Forest Service's objective of having about this much under contract. However, the Forest Service has controlled this by the length and size of sale and by the total amount of annual offerings. They have done this for several reasons, none of which are associated with timber supply problems as now envisioned by PAPTE. Two important reasons are: (1) to control overcutting; i.e., to limit cutting to the allowable cut, and (2) to provide for local competitive bidding by purchasers of varying size and strength by offering relatively numerous small, short-term sales each year.

Any proposal to substantially increase the volume under contract relative to the allowable cut must include some device to control overcutting and must avoid large-sale offerings that could or would only be purchased by a few large purchasers. The latter can be accomplished by continuing at about the current sizes of sale offerings. As the total amount under contract increases, controlling overcutting[4] is more difficult, particularly when continued upward secular trends in total timber demands are anticipated. The Forest Service now can and does put cutting rate limitations in sale contracts. However, if these are made too stringent, then the purpose of flexibility cannot be accomplished as desired by PAPTE.

A suggested change in procedure is to set specific annual volume limitations in each contract, which could be exceeded only by the payment of a graduated premium stumpage price for all volume cut in excess of the limit. As pressure increased for timber supply through increased lumber and plywood prices, the purchasers could respond by cutting faster on sales on which he was still within the limit. As they increased cutting still further, the premium would be in effect and some timber price increase would result. As lumber and plywood prices decline, purchases would tend to save their timber supply by reducing cutting below the contract cutting rate. Several years would be required to bring this into full effect because the existing contracts without such a provision will not terminate for several years. This premium could be a part of the contract terms, as is escala-

[3] This latitude is limited by the time needed to construct roads and by the weather. Consequently, a purchaser with 3 years' cut under contract may actually have immediate access to only 1 or 2 years of timber under contract.

[4] Overcutting is defined here as continued cutting at rates in excess of the annual allowable cut and does not mean nor imply damage to the soil, site nor environment.

tion. Therefore, it would not be a penalty but a privilege for which payment is to be made.

The above-suggested procedure should make it possible for the Forest Service to increase the volume under contract to as much as five times the allowable cut. Also, in order to avoid the necessity for so many sale contracts, the average size of sale should be increased somewhat and length of contract should be increased by about 2 years.

There is another advantage to having more volume under contract, even if annual cutting were limited. The current average of less than 3 years of assured supply is far short of what is needed for the financial strength necessary for investments in improved logging and mill utilization, which is also a stated objective of the Forest Service in recent reports to PAPTE and the Cost of Living Council. The Forest Service practice of making numerous small short-term sales is the result of congressional recommendations in 1956[5] and subsequent pressure from the GAO to maintain the competition which will provide for top stumpage prices wherever possible. Incidentally, this maintenance of competitive pressure on stumpage prices is not in keeping with the Forest Service's November 3, 1972, response to the Cost of Living Council in which they contend that their stumpage offerings and prices are not a factor exerting upward pressure on lumber and plywood prices.

### Salvage and Thinnings

Salvage and thinning have been proposed as an important source of increased timber supply. Of all the material being lost to utilization these have relatively higher portions of material suitable for lumber and plywood than do the low-grade, small-sized logging residues on regular timber sales. On several recent occasions of strong demand the Forest Service has responded to direction to increase sales of this material. Again, however, the process is slow and probably has little, if any, effect in ameliorating shortrun price increases. Furthermore, this kind of material generally requires logging methods and equipment and mill facilities that are not available at least not with sufficient capacity to make significant supply responses.

Most of the thinnings and salvage material not now in sale programs is economically marginal. Regular Forest Service appraisals frequently result in negative stumpage rates for these sales. When this result is expected, the tendency of the Forest Service is to refrain from preparing the sale in order to save time and effort for other sales. The cost per unit of volume for preparing these sales is also high relative to other sales.

A procedure is needed for making this material continually available so that it can quickly be brought onto the market when prices justify the costs of harvesting and processing. It is recommended that some type of longer term contract or "hunting license" be developed to facilitate prompt response by the purchaser and the Forest Service in capturing this raw material when the price is right.

Stumpage prices for this material could be set high enough to cover the costs of sale administration, but low enough to encourage its use when markets are good. Much of it could be sold by weight for ease of control and payment. Sales could be for all salvage or thinnings or both from a selected area or compartment of a national forest for a period of 5 to 10 years. The sales could be offered to the highest bidder on the basis of bids of a basic guaranteed annual payment to the Forest Service. In other words, the price per unit would be fixed but the minimum annual payment would be bid upon by purchasers. Removals would be credited against the annual minimum payment and would require additional payment at the fixed unit rate beyond that amount. Minimums would be set to achieve a rate of salvage in keeping with the rate of mortality loss and to achieve rates of thinning in keeping with the need for stand release.

This recommended procedure would have four advantages. First, it would provide a volume of timber readily available for prompt response by industry to fluctuations in prices. Second, it would guarantee sufficient time and volume over which to amortize investments required for the special harvesting and processing equipment. Third, it would stimulate the purchaser to help the Forest Service search out salvage and thinning opportunities for which the Forest Service now has limited manpower, high cost per unit volume, and low incentive. Fourth, it would increase timber growth on thinned acres.

[5] U.S. Congress, House Committee on Government Operations. "Federal timber sales policies," 31st intermediate report. Union Calendar No. 1212, 84th Cong., 2d sess., House of Representatives, Report No. 2960. July 27, 1956. 54 pp.

These two types of harvesting have the advantage of very little environmental impact and in fact may enhance the environment, regardless of the sales procedure.

Salvage of catastrophic losses due to wind, insect epidemics, or other causes needs separate treatment. When these occur within areas under the above-recommended contracts, special clauses could be used to provide for different stumpage rates or for separate sale offerings.

## Roads

Roads are needed on national forests for expediting sales, increasing timber sale and harvest flexibility, and for improving utilization.

Much of the time spent in selecting, planning, preparing, and operating timber sales is spent on roads. If the Forest Service were fully funded by appropriation for its road program and permitted to carry it out, the timber sale program would be expedited. Road construction by timber purchasers has limited road development to areas of high value timber and to periods of high prices.

If a more complete road system were now in place on the national forests, it would be much easier for the Forest Service and the industry to promptly respond to fluctuations in demand for wood products. Submarginal timber could be sold, more partial cuts and more salvage and commercial thinnings could be made. In addition, more areas of timber needing treatment to increase growth would become accessible for such programs.

Studies of advanced roading on national forests and on other public lands have concluded that it is not economic.[6] However, these were tested against earning rate guides now being used on other Forest Service investments such as holding excess growing stock, K–V expenditures, and to some of the currently financed road program. Furthermore, these studies did not include the benefits of moderating lumber and plywood price fluctuations. In view of these factors the low earning rates of 2 to 6 percent for advanced roading appear to be more than sufficient justification for a significant program.

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[6] Payne, Brain R. "Accelerated Roadbuilding on the North Umpqua—An Economic Analysis." USDA Forest Service research paper. PNW–137, 32 pp., illustrates Pacific Northwest Forest and Range Experiment Station, Portland, Oreg., 1972.

It is recommended that the Forest Service more specifically document the cost of and resulting extra yield from more rapid roading on a forest-by-forest basis. This would provide the basis for grassroots pressure on Congress and OMB to get the necessary financing and would relate performance directly to extra timber supply, including the advantages of flexibility.

## Sale Preparation and Administration

Quick, shortrun increases in timber sales have frequently been recommended, and sometimes used, to relieve lumber and plywood supply pressures. Currently, a serious limiting factor to prompt responses in the timber sale program, as well as to getting more volume under contract (as recommended above) is the shortage of personnel and funds on the national forests for sale preparation and administration. This is further complicated by the increasing number of environmental considerations required. For example, stricter limitations on clearcutting and the need for less disturbance by road construction will increase the time and effort required in preparing timber sales.

Even when adequate staffing is available, these are not fully qualified nor experienced. The obvious solution to inadequate staffing is more funds and more personnel and these are needed. A much less obvious part of the solution is to keep the staff on a national forest long enough to become experienced. It would also help greatly if greater use were made of technicians to assist the professional foresters, engineers, and others.

All of the above solutions will take considerable time to implement. In the short run it is recommended that consultants under contract could be used to help prepare timber sales. The laying out of road locations, sale boundaries, mapping, cruising, and timber marking are procedures that could easily be done under contract without jeopardizing any Forest Service objectives nor relinquishing of basic management responsibilities and control.

Because forestry consultants currently do most of their work for forest industry, Forest Service administrators have been heard to say that this would be like "letting the fox guard the chickens." Yet, the Forest Service currently proposes to the Cost of Living Council to encourage timber sales on nonindustrial private lands that:

Forestry consultants (be contracted to) provide nonindustrial landowners with management assistance including softwood sawtimber marking, marketing, and sales administration services.

They go on to say in their proposal that,

Experience has proved that professional forestry assistance can alleviate these concerns and promote sound forest management as well as increase flow of logs.

It would seem that what is good for the private landowners would also be good for the Forest Service. Or, to use another metaphor, "what is good for the goose is good for the gander."

## CHANGES TO IMPROVE UTILIZATION AND REDUCE WASTE

The basic requirement for improved utilization of national forest timber is profitability. Consequently, lumber and plywood price increases themselves can and have helped to improve utilization. However, the two kinds of price increases and their characteristics are: (1) shortrun increases which have been typically followed by decreases, and (2) longrun increases which have been accompanied by, and largely offset by cost increases in harvesting and processing. Both of these two characteristics tend to dampen or negate the otherwise positive influence of lumber and plywood price increases on improved utilization. Stability of lumber and plywood markets would help considerably to bring about improved utilization.

Timber sale practices can also encourage better utilization. The Forest Service has made progress in this area recently with such things as per acre pricing of small material and required yarding of unutilized material. They have said that some of these practices have "met considerable resistance from the industry." If so, this resistance should be interpreted as inability of the industry to carry out the utilization at a breakeven cost or profit. It should not be interpreted as industry's disagreement with the objective of increased wood supply.

There is a tendency for, and often a pressure on, the Forest Service in administering its sale program to seek "full and fair market value" for all timber removed. This is a laudible objective but in actual application it can easily conflict with the objective of improving utilization. Basically, there must be an incentive for the purchaser.

The current timber sale contract in use on national forest timber sales contains an incentive by permitting the removal of smaller than contract minimum size material free of charge or at a low per-acre rate. Timber sold between 1965 and July 1971 was under a contract which permitted free removal of material unmerchantable due to defect but charges are made at regular contract rates for logs smaller than the contract minimum size. The Forest Service is authorized to modify those earlier contracts to permit free removal of smaller logs. They should be directed to automatically modify all of those contracts as an incentive for more complete utilization.

The previous proposal regarding longer term sales of thinnings and salvage would also contribute toward improved utilization as well as to supply flexibility.

Lump-sum (tree measurement) sales have already been proposed as a method to increase utilization on Forest Service sales. The Forest Service has increased its use of this practice, but still relies primarily on the basic log scale procedure for payment. Inaccurate sale volume estimates by inexperienced Forest Service cruisers has been a continuing problem and purchasers are protected from this by log scale sales. Lump sum sales would require increased intensity of cruising by more experienced cruisers and would also require careful cruising by each prospective purchaser. If more lump-sum sales were used, the Forest Service also could save manpower and time and greatly improve the volume estimates by contracting for the cruising.

In lump-sum sales the incentive for complete utilization continues up to the point at which the extra material costs more to remove than it is worth. In log scale sales no incentive may exist for those species on which the contract price is high relative to its value. However, in some scale sales, the contract (bid) price for some species may be low enough to permit the complete utilization of that species. Even when the bid price is high complete utilization occurs on scale sales because the market is strong. Therefore, when the market demand is strong there will be little, if any, difference in the degree of utilization between lump-sum and scale sales.[7]

The improved utilization of defective and small logs will require substantial investments by the

[7] Beuter, John H.; Arney, James D. "Log-Scale and Lump-Sum Timber Selling on Federal Lands in Western Oregon." School of Forestry, Oregon State University. Research paper 12. September 1972, 16 pp.

industry to harvest and process this material because it is not suited to the existing equipment and processes. The pricing policies and sales procedures must provide for sufficient profit and sufficient volume to encourage this type of investment.

## OTHER CHANGES IN POLICY

### Special Logging Methods

Large amounts of national forest timber could be made available if special harvesting methods were practical for removal without environmental damage from road construction and yarding of logs.

For example, on nine western national forests which have new proposed allowable cuts pending approval, 409.2 million fbm of cut per year is scheduled from the marginal and special land classes.[8] This is 24 percent of the proposed potential yield on these forests. Most of it is not available for harvest unless special methods, such as long skylines, balloons, helicopters, or similar methods are used. As further example of the large amount requiring special harvesting, regions 5 and 6 (Pacific coast) have a proposed program of 331.3 million fbm of timber sales on which they intend to require helicopter yarding of logs during fiscal year 1973.

The need for special harvesting methods is not only supported by the potential extra timber supply but also for the environment reasons. Much of the current public controversy and concern over forestry and forest land management stems from the public's complaints about examples of poor harvesting practices. Some of these have been due to the wrong application of the right equipment, but much can also be blamed on the lack of the right equipment or on equipment that requires too much roadbuilding.

A research program to develop new and improved methods of harvesting has been proposed by the Forest Service including studies of helicopters, skyline, etc. Although funds have been appropriated, these funds have not been released for expenditure. They should be because the program has merit. Industry cannot justify the necessary research and development expenditures. The equipment developer must have some assured way to recover the initial investment. This is not possible under the regular Forest Service appraisal and sales procedures.

Currently, helicopter yarding of logs is physically possible but economically infeasible or at best marginal. Yet the Forest Service is offering helicopter sales under business as usual bidding procedures. This has forced prospective purchasers to bid away whatever small margin of profit that may have existed. The successful bidder is thereby forced to operate under financial pressure. This is not at all conducive to the successful development and refinement of new operational methods, especially when large investments are required for the final equipment.

The Forest Service must innovate new procedures for selling timber where these special logging methods are required. They should recognize that, even after research has developed practical methods, considerable investments and risks are necessary on the part of timber purchasers of sales where these methods are required. The usual competitive bidding procedures during periods of timber supply shortages will surely result in financial and operational failures using these new and untried methods.

The research branch of the Forest Service has spent many years and a lot of funds and manpower to develop improved logging methods. In addition, the administrative branch has attempted to offer timber sales or otherwise encourage the development of these special logging methods.

Many years ago the Wyssen system of skyline logging was tried out in the Rocky Mountain region under a procedure in which the Forest Service purchased and operated the system. It did not prove to be satisfactory but one could not be entirely sure whether the reason was the system or the lack of experience and know-how on the part of the Forest Service operators.

Another procedure used for new and untried methods was to use three-way cooperative agreements between the research branch, the administrative branch, and the timber purchaser. This procedure was intended to develop research information on performance under more or less typical operating conditions and to give the purchaser experience as well as to supply him with timber. The Forest Service experience with these cooperative arrangements has not been good. For example, in the case of balloon logging, in Oregon, difficulties arose for a number of reasons. Factors at play

[8] These are the following national forests: Cibola, Flathead, Kaniksu, Gallatin, Shasta-Trinity, Rogue River, Wallowa-Whitman, Umpqua, and Siskiyou.

were: (1) The balloon manufacturer's desire to have a patentable balloon configuration, (2) the timber purchaser's desire to have a profitable franchise for the sale of these balloons, (3) the administrative branch's tendency to treat the balloon sale in a business-as-usual manner, and (4) the research branch's inability to directly control the method of operation. Many of the desired benefits of the cooperation were lost due to these fatcors.

Another procedure which has been used is to negotiate and administratively award timber sales in which these special methods are required. This was used recently to try helicopter logging in Oregon. It permitted the Forest Service and the operator to negotiate a low stumpage price without competition so that the operator had a better economic opportunity to make a success of the system. This was halted after one sale due to objections from others dependent on local timber supply.

The Forest Service now has a large program of timber sales in three western regions on which they are requiring helicopter yarding. At first these sales were being offered competitively in essentially the same manner as the regular timber sales (except some were by sealed bids rather than the usual oral auction). The prospective purchasers were required to demonstrate that they had, or would have before the sale is awarded, access to a helicopter suitable for the type of yarding required. This was necessary, they thought, because the local industry wanted a fair opportunity to purchase competitively this much-needed timber. A purchased could bid then work out later his arrangements for helicopter logging before the sale award.

Under these circumstances it was not possible for the Forest Service to negotiate the price with one or a few helicopter operators. Many of the sales which were offered had appraised at or less than the minimum stumpage price acceptable to the Forest Service, even with their conservative estimates of the unknown cost of yarding. Several of these sales were in areas where timber supply is very short and where local operators do not have helicopters. As might be expected in this situation, the bidding on several of these sales raised the stumpage price far beyond that under which the operator could expect to recover helicopter yarding costs and definitely beyond where a profit could be made. The Forest Service was helpless in preventing this because they had specified that the bidders had 30 days following the sale in which to demonstrate their ownership or access to a helicopter.

Apparently, if the high bidder did not demonstrate this within 30 days the sale was to go to the next highest bidder. This resulted in some bidding by one company under two or more names. If these bids happened to be the highest and the second highest bids, it is conceivable that the high bid offer of this company could be avoided by the lack of availability of a helicopter to that company, yet the same company under another name could accept at its next lower bid.

In some of these sales the local purchasers dependent upon this timber bid with the idea that they would retain one of the few helicopter companies to yard for them if they were the successful bidder.

More recently, the Forest Service has revised its procedure in light of these problems. Now each bidder must submit his qualifications to log by helicopter and receive certification from the Forest Service in order to be able to bid. This has resulted in further objections from dependent local industry, including the threat of a lawsuit based on the contention that no authority exists for such a procedure. At this point in time, the Forest Service will sell only those helicopter sales already advertised and will reconsider further sales. In the face of this action the helicopter companies are seriously worried about protecting investments already made in helicopters with high lift capability.

In my opinion, all of the procedures tried thus far have failed to stimulate the desired development of efficient and economical new methods to carry out the special harvesting required. A principal reason for the failures has been due to the financial pressure brought upon the timber operator because he has agreed to pay a price for the stumpage, is faced with the uncertainties of the log, lumber, and plywood markets and must log with an expensive yet untried method. The timber supply situation today has greatly increased this pressure on the operator in these special harvesting sales.

The only way for a purchaser who has paid a relatively high price for stumpage on a helicopter sale to make a success of the operation is to have the log, lumber, and plywood prices increase substantially. If this is necessary in order to carry out these special logging operations, it will defeat the purpose of controlling the rapidly increasing wood product prices.

Under these sales arrangements the self-imposed pressure of stumpage prices on the purchaser will surely lead him to operate the timber sale as cheaply as possible. This eliminates any chance he had for making the special system work and jeopardizes the Forest Service's objective of getting a good logging job done without environmental damage.

It is recommended that the Forest Service adopt a procedure to be applied for a limited period of time, say 2 or 3 years, to the considerable amount of volume to be sold where helicopter or other special yarding is to be required. This procedure should be made up of two phases: A sale of delivered logs and a contract for harvesting. Each special harvesting area should be laid out and cruised in the regular manner.

The first part of the procedure should be the offering at public oral auction of the logs expected from the harvesting area. The purpose of oral auction is to protect local dependent mills. This auction could be done on the basis of prices by species and log grade where log grading is done. The Forest Service could establish a basic minimum price for each species and log grade. The high bidder should be determined by multiplying the prices bid for each species and grade times the cruise estimate of the volume of these grades to be developed. The Forest Service could permit bidding on logs by separate groups and award the sale to several bidders.

These log sales could be set up so that 100 percent escalation could be used. Log buyers could use the same small business protection now provided under SBA. Additional details for these log sales can easily be worked out to protect both the Forest Service and the log purchasers.

In the second part of the procedure all of the special requirements for harvesting the area should be drawn up into the form of a service contract and offered to a previously selected list of qualified firms who would be asked to bid on the job of felling, bucking, helicopter yarding, and hauling to a predetermined point such as a scaling station. The contract would be awarded to the lowest bidder among those qualified bidders. The selection of the qualified bidders should be based on the helicopter operator's demonstrated experience and competence in helicopter operation and on his ownership of a suitable helicopter or his financial ability to obtain one.

Harvester would be given specifications for log lengths, etc., before bucking begins, based on requirements of the successful log purchaser. Delivery points could be specified in the log sale contract and the harvester's contract could be drawn up to provide for payment of hauling cost from scaling point to delivery point by successful log buyer. Minimum and/or maximum rate of volume delivery could be specified. Any log storage required could be supplied by the log purchaser, thus eliminating the need for public concentration yards. If a company or individual bids on the harvesting contract, it might be wise to exclude him from bidding on the logs and vice versa.

This proposal has several advantages:

(*a*) It would remove the pressure of the stumpage price and the wood products markets which now places undesirable pressure on the purchasers of these special timber sales.

(*b*) The local industry could protect its source of supply by purchasing advanced supply of logs in addition to standing timber under ordinary logging conditions.

(*c*) The helicopter operators who bid to do the harvesting can have an assurance that they will receive the amount which they bid. This certainty of income will give them considerable incentive to make the operation practical and economical. The Forest Service can make their special requirements an essential and primary part of the contract.

(*d*) The operators performance can be monitored and judged in terms of his agreement to carry out these operations. Cultural operations, otherwise financed by K–V funds could be included in the service contract.

(*e*) Another advantage is that, as the operations are bid on and carried out, the Forest Service will be able to determine directly the expected cost of these operations. The procedure will eliminate the tendency of the purchasers to delay their operations awaiting better markets and the tendency toward other manipulations and maneuvering to avoid the high bid stumpage cost or to take advantage of a good market.

This proposal also has some disadvantages that can be overcome:

(*a*) One disadvantage, or rather a limitation, to the procedure is the difficulty that may be encountered in attempting to select qualified helicopter companies. However, this can be overcome because similar procedures are now being used by the Forest Service and the Government in other situations.

(*b*) Appropriated funds or a revolving fund may be needed to finance the payments for logging under the service contract. Special legislation may be required for this. However, objections from groups concerned with the environment should be minimized or overcome because of the added control this procedure gives over the quality of logging.

(*c*) Payments to counties of 25 percent of stumpage receipts is required by law. Since stumpage is the residual after logging costs are subtracted from product value, it would be appropriate to pay the counties 25 percent of the difference between total log sale income and the contract logging cost.

(*d*) Some sales may not yield as much log sales income as the logging will cost. This will leave nothing for distribution to counties. However, to the extent that this timber would not be sold under the regular stumpage sale method, there is no lost income to the counties under this proposed procedure.

The problems which have been encountered during the last 10 or more years in attempts to promote and develop improved logging systems under standard timber sales procedures are too great to be overcome by makeshift adjustments within a business-as-usual procedure. This recommendation is worthy of any significant changes in procedure and legislation necessary to try it.

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# New Contractual Concepts for Sale of Public Timber[1]



Increased Forest Service emphasis on close timber utilization, and on various logging and road construction controls to lessen environmental impacts of timber harvesting, has raised questions as to the adequacy of the contractual relationships now employed in national forest timber sale contracts. This memorandum explores some new contractual concepts as possibilities for consideration. They are presented as modules which can be added as units to the contractual relationship under existing authorities and funding. Various combinations are possible. Each module should be considered separately.

## BASIC RELATIONSHIPS

### Scaled Timber Purchase

This is the major and classic way in which the national forest timber is sold. It puts emphasis on payment rates and the volume of timber removed by the purchaser. Trees designated for cutting which are not cut and portions of trees cut but not removed which meet utilization standards must be paid for. Specifications and restrictions are set up to control how the purchaser cuts and removes the specified timber. Costs of complying with such requirements are regarded as incidental logging expenses of the purchaser.

### Lump-sum purchase

This is the predominant method used by the Bureau of Land Management. Under the term "tree measurement," a slight variant of this system is used by the Forest Service in the South. The purchaser assumes the risks or gains from variance between the standing tree volume estimate and the volume of product outturn, including the absorption of waste loss or the capture of volume gains resulting from the intensity of utilization he practices.

### Service contract

One possibility which was explored by industry but has not been put to significant use is for the

[1] Prepared by members of the staff of the President's Advisory Panel on Timber and the Environment. The Panel believes use of these modular concepts of contractual timber harvesting can effectively lead to increased utilization of timber and more environmentally sound harvesting.

public land managing agency to specify the cutting and cultural treatments it wants on a specified area and solicit bids on the basis that the contractor is entitled to the trees designated for cutting. While this procedure should wind up with the same results as a lump-sum sale, it places emphasis on the performance of cultural measures and the services supplied to the Government.

### Logging contract

The above procedure can be modified into a contract to provide cultural treatments and to cut and deliver logs to specified destinations for a cash payment. If a logging contract is used, there is complete separation of log production and sales. For operation of this system it would be necessary to have sufficient appropriations or a revolving fund to finance the logging contracts and the cultural measures (there would be no way to get K–V deposits), unless a means could be developed to give the logging contractor a first mortgage on his log outturn.

### Product sales

The sale of logs from roadside delivery points is a normal practice in Europe. Its use in the United States has been confined primarily to disposal of decked logs from right-of-way or other clearings. Nearly a decade ago, Walter Mead proposed that public timber be delivered by logging contract to concentration yards where logs would be sorted for sale by species, size, and grade.[2] A much more flexible system would be to sell "camp run" (unsorted) logs on loaded trucks which would be routed beyond a specified delivery point to a destination determined by the log purchaser at a stated log hauling tariff. A major difficulty for any scheme of product sale is the coordination of log delivery with processing plant production schedules when these two activities are not under a common control. This problem prevented consideration of Mead's 1960 proposal.

### The compound contract

This is a new proposal in which a logging contract and a product sale contract would become two divisions of a single contract. In many respects it is similar to the service contract described above. It is a more flexible arrangement on which various contract modules can be conveniently attached. In the logging division the emphasis would be on the furnishing and payment for services performed by the contractor. In the sale division, the contractor would agree to purchase the product outturn in accordance with a payment schedule developed from bidding. A transaction account would offset the credits earned by the contractor in logging and cultural services against the value of the product outturn and thus establish payments to the Government due from the contractor (or in unusual circumstances from the Government).

## MODIFICATION MODULES

Examples of modification modules are the currently used escalation and rate determination procedures. Both of these two items are self-contained provisions which can be added to most of the basic contract relationships. Some modification modules go naturally with certain basic contract relationships but are difficult to apply to others. For instance escalation fits well into scaled timber purchases, is somewhat awkward to use in lump-sum purchases, and would be quite difficult to introduce into service contracts.

Some new or expanded module possibilities which may be useful in resolving the new stresses in contractual relationships are discussed below:

### Stated value schedules

The purchaser credit system in specified road construction which has been in effect since 1965 is an example of a stated value schedule module. A stated schedule of values for road construction is made a part of the contract with provision for credit recognition to the purchaser as he accomplishes the specified construction. The successful operation of this system suggests that its application might well be broadened. This same procedure can be applied to the entire logging process or any part of it.

Whatever activity is placed under a stated value schedule is isolated from bidding pressures. The system eliminates incentives for the contractor to escape or slough performance. It requires the Government to put a price tag on the services or other performance it wants from the contractor.

A bidder may expect to perform an activity at less or more than the stated value schedule. Under competitive conditions, this variance will be reflected in his bid, but he knows that his performance will be evaluated by the schedule and that if he avoids performance he forfeits compensation.

[2] Walter Mead, 1964. "A Positive Proposal to Strengthen the Lumber Industry." Land Economics, 40(2) : 147.

There are important advantages in placing woods operations under stated value schedules. The Forest Service is now stressing quality performance. One way to get it might be to spell out what is wanted and to put a price tag on it through a stated value schedule in the contract. Competitive bidding, regardless of how severe, will not change the credit earned for measured accomplishment. The system forces a classification of performance requirements into tangible categories which can be priced and measured.

As a minimum there should be three types of stated value schedules: specified road construction, log production and delivery to a stated destination, and cultural or protective measures which do not contribute to the log production process.

Complete coverage of woods activities by stated value schedules can best be provided under the compound contract basic relationship. Under this type of contract organization, it would be clear that the only margin from the woods operation for competitive bidding is the performance of the various items at less cost than those established in the stated value schedules. A place is reserved for full play of competitive forces in determining the awardee in division 2 of this contract arrangement.

### Utilization incentives

Close timber utilization has suddenly become an overriding consideration. Not only does the Forest Service want a complete job of removal of all material with only marginal possibilities of economic utilization, but also the yarding of unutilizable material. This new enthusiasm has led the Forest Service to considerations of switching from scaled to lump-sum sale contracts. In scaled sales with high stumpage prices, there are incentives for purchasers to break or otherwise waste small or rough logs which are not worth their stumpage price plus the out-of-pocket cost of their removal. In lump-sum sales, the purchaser is gaining as long as the material he removes is worth out-of-pocket costs of removal. In many sales in the Douglas-fir region the differential between these two situations is $100 or more per million fbm.

The following contract module would right this situation and put scaled and lump-sum sales on the same footing in respect to utilization incentives. Its use would avoid the need for switching from scaled to lump-sum sales under conditions where scaled sales are otherwise preferable.

Establishment of minimum scaling dimensions for which stumpage payment would be required at substantially above minimum utilization requirements can solve this utilization incentive problem. Removal down to minimum utilization specifications would be required and the scale of all such material would be maintained. Payment would be required only on material above the payment size (profitable size) specifications. The payment size specification would be set at a size which clearly is nonmarginal material. There would be no change in present appraisal procedures. Stumpage rates thus developed would be increased by multiplication by a factor, the numerator of which is the estimate of total volume meeting utilization specifications and the denominator the estimated volume meeting the payment size specifications. Thus, if the estimates in this factor are reasonably correct, the same total stumpage payment will be collected as would have been obtained if the appraised stumpage rate had been charged for the total volume meeting utilization standards. In other words, there would be no charge on the small material and an overcharge on the larger, more valuable, material. This incentive arrangement could be extended to defective as well as small-sized logs. Minimum utilization specifications which would require removal of all logs at least one-third sound could be provided, but no payment could be required for logs more than 50 percent defective.

This module can be used in regular scaled timber purchases or in division 2 of the compound contract. An additional module to establish further removal incentives in logging contracts and division 1 of compound contracts is as follows:

If a stated value schedule is used for woods activities in division 1 of a compound contract, a higher rate of credit for log production and delivery of material of less than payment size specifications than for larger material can be provided in the value schedule. The cost estimates developed for the value schedule can be adjusted in a similar manner as for stumpage rates so that total credit for log production of both size classes would equal the cost estimate.

For logging contracts, a provision could be included for adjustment in rates of payment to establish a stated differential (perhaps $5 per million fbm) for removal and delivery of material of less than payment size, and for a compensating downward adjustment in the rate of payment for material above the payment size so that estimated total compensation at the rates bid would remain unchanged.

### Noneconomic removals

The Forest Service has indicated that it is giving serious consideration to requiring removal by timber purchasers of small or defective material which admittedly has no economic value. Costs of such removal must be recognized in timber appraisals. If the timber purchaser is also responsible for disposal of such material, this cost must also be included. A contract module will be necessary if noneconomic removals should be required. Any attempt to insert requirements for noneconomic removals without a specific compensation provision to the timber appraisal would fail. The contract module should contain a provision for the measurement of required noneconomic removals and a rate of compensation to the timber purchaser for accomplishment of such removals. For national forest scaled timber contracts such compensation can readily be expressed as a purchaser credit (a credit that can be used against the stumpage payments due). For lump-sum contracts where no provision is made for output measurement (scaling) while removal activities are in progress, there will be problems in equitable administration of noneconomic removal requirements. A suitable module can be readily developed for logging contracts or compound contracts.

The extreme of noneconomic removal is the collection and transport of material which lacks the size or strength to be loaded on a log truck. If the Forest Service wants a timber purchaser to engage in collection and hauling which requires shovels and dump trucks, the terms and conditions of performance and compensation should be spelled out in a separate contract module.

## SAMPLE PROPOSAL

As an illustration of module combinations and a specific suggestion for reform of contractual relationships and selection of module options to meet the new trends toward more severe utilization and work performance requirements in the woods, the following contract outline has been developed:

For a basic contract relationship the compound contract is selected. Since in division 1 of the compound contract the successful bidder appears as a contractor who cuts and delivers logs and furnishes a variety of protective and cultural services to the public timberland managing agency, and in division 2 the same bidder appears as the purchaser of logs or other delivered forest products, the awardee is designated in the contract as "first party" rather than as purchaser. Correspondingly, instead of Forest Service (or other agency) the term "second party" should be used. The account which links activities of the two divisions should be designated "transaction account" in place of "timber sale account." The basic contractual relationship is that first party agrees to furnish services and cut and deliver designated timber in accordance with provisions of division 1, and to accept delivery, purchase, and pay for logs and other forest products delivered in accordance with division 1 at payment rates specified in division 2. Second party agrees to designate and make timber available for cutting, to measure output delivered by first party, to furnish such other services and to discharge such obligation as may be specified in division 1, and to credit first party for log delivery and other services rendered in the transaction account at rates and as specified in division 1. Second party also agrees to sell logs or other forest products delivered in accordance with division 1 to first party at rates specified in division 2. At transaction termination, the party with a debit balance in the transaction account shall offset it by a cash payment to the other party.

### Division 1

The modules recommended for use in this division are:

Stated value schedules for: (1) Log production and delivery, (2) specified road construction, and (3) cultural and protective measures which do not contribute to log production.

Utilization incentive, a higher rate of credit, for delivery of logs smaller than the minimum size for payment as specified in division 2.

Noneconomic removal (if demanded by Forest Service) for: (1) Logs and chunks, and (2) dump truck material.

(NOTE.—It is feasible but not recommended to write division 1 without stated value schedules for any or all activities for which quantity or volume estimates are available. Provision must then be made to fix rates for such items through the bidding process. For bid evaluation, the total amount bid for logs under division 2 minus total costs for bid items in division 1 should be used.)

**Division 2**

Only the utilization incentive module is recommended for addition to the conditions normally employed in the particular locality or circumstance. (Use of such modules as escalation or rate determination would not be affected.) The utilization incentive module would specify a minimum payment size. Material of less than this size but meeting utilization standards would be scaled and appear in the timber cutting reports, but would carry no stumpage payment.

The stumpage payment schedule would be the rates bid by the awardee with adjustment to offset the no charge for material between minimum utilization standards and minimum payment size.

The minimum acceptable rates in the advertisement for bids on the transaction should be appraised on the basis of log value loaded on trucks at the scaling station or other specified delivery point in division 1. Thus the only cost allowances used in the determination of minimum acceptable price will be costs of transportation from delivery point to mill and for manufacturing and selling.

Payment and accounting procedures would be quite similar to those now in use under Forest Service Form 2400-6 with one exception. That exception is a provision that if on termination of the transaction first party has a credit balance, second party will pay that amount from appropriated funds.

## COMMENT

This proposal will:

1. Put cutting and removal of timber on a service type contractual relationship.
2. Put rates of payment for the performance of cutting and removal of timber on a cost-analysis basis which cannot be distorted by the bidding process.
3. Retain the equivalent of the present purchaser credit system for road construciton.
4. Establish a schedule of credit recognition for protective or cultural measures or services not contributing to log production and required by the contract or otherwise requested by the second party.
5. Establish a premium payment rate for removal of the smaller and more defective logs as an incentive to close utilization.
6. Provide a means for payment for noneconomic removals if the second party (Government) so desires.
7. Establish a service type of contractual relationship for cutting and removal of timber without requiring use of appropriated funds. (Unless total services exceed amount bid for delivered log output.)
8. Eliminate problems of how to sell log output.
9. Eliminate problems of coordination of rate of log production with processing plant schedule.
10. Concentrate bidding pressures on the premium bidder is offering for logs on trucks at the delivery point.
11. Provide further incentive for close utilization by use of a minimum scaling size in the log payment schedule.
12. Provide for payment to the contractor in event he has a credit balance at contract completion, thus eliminating the continuing controversy over unused purchaser credit.
13. Allow purchaser to control log delivery schedules.
14. Be possible under existing authority.



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# appendix I

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# Improving the Productivity of Nonindustrial Private Woodlands

TABLES

FIGURES



## HISTORICAL DIGEST OF PROBLEM

Dissatisfaction with the way a given segment of a nation's forest land is being managed is nothing new. John Evelyn in his "Silva" delivered to the Royal Society on October 15, 1662, offered some dire predictions with respect to the supply of timber. Commenting on both overcutting and waste, he said:

> And this devastation is now become so epidemical that unless some favourable expedient offer itself, and a way be seriously and speedily resolved upon, for a future store, one of the most glorious and considerable bulwarks of this nation will, within a short time, be totally wanting to it.[1]

Dr. A. Hunter in his republication of Evelyn's work in 1812 noted:

> * * * there is some reason to apprehend that the persons appointed to the superintendence of the Royal Forest Chases have not strictly and diligently attended to their charge, otherwise the nation would not at this day have reason to complain of the want of Oak * * * This loss, however, would not have operated so severely, had the principal Nobility and Gentry been as solicitous to plant, as to cut down their woods.[2]

A. H. Hillhouse, in his translation of Michaux's "North American Silva" published in the early 1800's, says:

> Though three-fourths of our soil (North America) are still veiled from the eye of day by primeval forests, the best materials for building are nearly exhausted. With all the projected improvements in our internal navigation, whence shall we procure supplies of timber fifty years hence for the continuance of our marine? The most urgent motives call imperiously upon Government to provide a seasonable remedy for the evil.[3]

James Brown, in his book "The Forester" published in Edinburgh in 1851, points out that the British Government was at that time already providing loans for the conversion of wasteland into forest plantations.

Secretary of Agriculture Henry A. Wallace, in his letter of transmittal to the President of the famous Copeland report "A National Plan for American Forestry," said, "* * * practically all of the major problems of American forestry center in, or have grown out of, private ownership."[4]

[1] John Evelyn, "Silva," ed. Alexander Hunter (York: Thomas Wilson & Son, 1812), p. 2.

[2] Ibid.

[3] James Brown, "The Forester" (Edinburgh: William Blackwood & Sons, 1851), p. 4.

[4] U.S., Congress, Senate, "A National Plan For American Forestry," 73d Cong., 1st sess., 1933, Doc. 12, p. V.

Between the date of the publication of the Copeland report and "Timber Resources for America's Future" in January 1958, the definition of the problem had changed from that of private land ownership to the nonindustrial private ownership category. In a discussion of ownership as related to productivity, the "Timber Resources" report says:

The conclusion that cutting of farm and other private forests generally results in low productivity is supported by evidence from some of the earlier surveys. In Arkansas, Louisiana, and Mississippi, for example, it was found that "current cutting practices have so depleted the forest capital on nonindustrial lands that they are producing only about one-third of their potential capacity." * * * In general farm and "other" private forest owners are making no substantial investments in stand improvements on forest lands other than those recently cut. In the period 1947–53, only 2 per cent of these owners were supplementing commercial logging by such measures as girdling or poisoning cull trees on such lands.[5]

The "Timber Resources" publication in summarizing the importance of nonindustrial lands has this to say:

In appraising the problems and opportunities for future timber supplies, it is evident that farm and miscellaneous private ownerships are of first importance. They represent sixty-one per cent of all commercial forests. Because of their extent, potential productivity, and location with respect to markets, these lands should be expected to provide the greater part of the nation's future needs. This will require solution of difficult problems, however. Most of these ownerships are small size, productivity of recently cut lands is relatively low, and for various reasons management efforts are limited or lacking. Increasing the productivity of the farm and "other" private holdings is a challenge for American foresters.[6]

Albert C. Worrell, in his book "Economics of American Forestry" published in 1959, continued with the same line of reasoning used by the "Timber Resources" report. Worrell says:

* * * Small owner will be defined as one who has management problems which are a direct result of the small amount of land he owns. * * * It is characteristic of all small forest owners that the management of their forest land is not their prime activity and interest. Their properties are too small to provide a full-time forest enterprise. So their major interest is concentrated elsewhere and forest management is at best a side-line activity.

Usually the small landowner may be classified as a poorly informed seller. Unfortunately, most of his dealings will be with well-informed buyers and he is likely to receive less for timber than he would in a perfectly competitive market.

Secondly, the quantity he has to sell may be so small that buyers have to offer a lower price in order to handle it. Some fixed costs of logging or operating a portable sawmill—such as moving to the area and setting up equipment—must be spread over the volume cut from the specific tract. If this volume is small, these costs are high per unit. The operator can make up for this only by reducing the price he pays for the stumpage.

Small owners are characterized by a high alternative rate of return. They are individuals and their planning is done primarily in terms of their expected lifetimes. Every man's future is uncertain and this uncertainty increases rapidly as he looks further into the future. The small owner is tempted to convert his timber to cash and enjoy its consumption now. He may be interested in forestry activities which promise a return in ten or twenty years. But he hesitates to consider investments which will not yield a final return for fifty or sixty years.[7]

John Muench, in a 1964 study quoted in "The South's Third Forest," also dealt with the lower productivity achieved by small landowners. Muench says:

Since a person's alternative rate of return is usually inversely related to his income, owners in high income groups would ordinarily be more content with the low rate of return common to forest investments than would those in low income groups. When a farmer is paying interest in excess of ten percent on time payments for a major household appliance, a forest investment returning less than half that rate is not very attractive. Furthermore, the needs of current debts are often so pressing upon the farmer that they take precedence over any nonmonetary returns such as aesthetic and inspirational values he may get from his forest.

The return on forest investment when figured as a percentage of current liquidation value is, in general, poorer than most people realize * * * Perhaps the poor participation rate from low-income groups is a good clue that the low income forest landowner has been more rational in rejecting ACP forestry practices than society has been in recommending them.[8]

What would appear to be the only dissenting opinion with respect to the low productivity of small landowners was voiced by James M. Vardaman, a consulting forester, writing in the November 1970, issue of American Forests magazine. Vardaman began his article with this statement:

A small landowner at a forestry meeting must feel like a lady of ill repute at a Sunday school picnic. Everyone there thinks he is a problem and complains about his

[5] Forest Service, "Timber Resources for America's Future," Report No. 14: Ownership of Forest Land and Timber (Washington: U.S. Government Printing Office, 1958), p. 312.

[6] Ibid., p. 314.

[7] Albert C. Worrell, "Economics of American Forestry" (New York: John Wiley & Sons, Inc.. 1959), pp. 408–411.

[8] "The South's Third Forest," report of the Southern Forest Resources Analysis Committee (1969), p. 34.

conduct, or at least about why he doesn't do what they want him to do. Many, with little knowledge of his business, propose schemes for changing his ways and then complain because they don't work. Others have decided that his case is hopeless and say so at every opportunity.

First we should recognize that landowners are the smartest fellows around. Anyone who thinks otherwise is headed for trouble. We must watch what they do (it may not match what they say in public) and understand that their actions express a collective intelligence of great magnitude. We must stop trying to teach them and start trying to learn from them.

Once we comprehend this, we will realize that private landowners will grow whatever timber this country needs, as long as they can make money doing so. If they can't make money at it, the country doesn't need the timber as bad as some say it does. They are sophisticated investors. If tree farming is profitable, we cannot possibly keep them out of it; if it isn't, we cannot possibly keep them in it.[9]

Private landowners, then, have been controversial in forestry literature for at least 300 years. Reasons cited for the problem vary and, as has been shown, one writer disagrees that there is a problem. The purpose of this study is to draw from the most authoritative sources available the facts on what the situation is and the scope of the problem or problems, if any; to present the characteristics of nonindustrial landholdings; to determine what should be changed; and, lastly, to develop a plan for changing them.

## CURRENT STATUS OF WOODLANDS

The total importance of nonindustrial private land ownership to the forest economy, can be illustrated by a study of the acreage, inventory, growth, and removals of all classes of ownership. A good point of reference for such a study is an unpublished table developed by the U.S. Forest Service showing potential growth as compared to actual growth. This is presented in table 1.

From this table it is apparent that in the Rocky Mountains and Pacific Coast regions, other private lands are being utilized as well as, if not better than, national forest lands. On the other hand, other private lands in the South and North fall below national forest lands in use of their capacity.

Forest statistics used in this chapter were obtained from the Forest Service publication "Timber Resources for America's Future"[10] (1952 data), "Timber Trends in the United States"[11] (1962 data), and "Forest Statistics for the United States by State and Region"[12] (1970 data).

A comparison of other private figures with total ownership values is presented in table 2. This table demonstrates that the other private cut for softwood as well as all species is far below the potential as just presented. Further, the removal percentage for other private is dramatically high in relation to inventory.

A comparison of total inventory, growth, and removals by ownership class shows that the majority

[9] James M. Vardaman, "The Smartest Fellow Around," American Forests, LXXVI (November 1970), 5 and 63.

[10] Forest Service, "Timber Resources for America's Future" (Washington: U.S. Government Printing Office, 1958).

[11] Forest Service, "Timber Trends in the United States" (Washington: U.S. Government Printing Office, 1965).

[12] Forest Service, "Forest Statistics for the United States, by State and Region, 1970" (Washington: U.S. Government Printing Office, 1972).

**TABLE 1.—Potential and Current (1970) Net Growth per Acre by Owner, Class, and Section**

[Net cubic foot growth per acre]

| Section, 1970 and potential | National forest | Other public | Forest Industry | Other private | All owners |
|---|---|---|---|---|---|
| North: | | | | | |
| 1970 | 38 | 33 | 40 | 29 | 31 |
| Potential | 66 | 59 | 72 | 69 | 68 |
| South: | | | | | |
| 1970 | 55 | 45 | 53 | 42 | 45 |
| Potential | 70 | 71 | 81 | 80 | 79 |
| Rocky mountains: | | | | | |
| 1970 | 23 | 23 | 47 | 25 | 24 |
| Potential | 65 | 54 | 70 | 50 | 61 |
| Pacific coast: [1] | | | | | |
| 1970 | 31 | 63 | 65 | 58 | 49 |
| Potential | 88 | 100 | 107 | 94 | 99 |

[1] Exclusive of Alaska.

**TABLE 2.—Comparison of Other Private Category to Total Ownership**

| Species | Year | Percent of total | | | |
|---|---|---|---|---|---|
| | | Acreage | Inventory | Net Growth | Removals |
| Softwood growing stock | 1952 | 59.8 | 22.1 | 44.6 | 46.9 |
| | 1962 | 60.3 | 23.2 | 45.1 | 39.4 |
| | 1970 | 59.3 | 25.6 | 47.8 | 38.8 |
| Softwood sawtimber | 1952 | ------------ | 17.0 | 40.0 | 39.4 |
| | 1962 | ------------ | 17.7 | 41.4 | 30.0 |
| | 1970 | ------------ | 20.1 | 44.0 | 30.3 |
| Hardwood growing stock | 1952 | ------------ | 73.7 | 74.3 | 82.2 |
| | 1962 | ------------ | 71.3 | 73.0 | 78.3 |
| | 1970 | ------------ | 70.6 | 71.6 | 79.5 |
| Hardwood sawtimber | 1952 | ------------ | 75.1 | 77.1 | 83.0 |
| | 1962 | ------------ | 72.6 | 74.5 | 79.4 |
| | 1970 | ------------ | 71.5 | 72.8 | 80.5 |
| Total growing stock | 1952 | ------------ | 37.4 | 57.7 | 59.0 |
| | 1962 | ------------ | 38.3 | 57.1 | 53.3 |
| | 1970 | ------------ | 40.6 | 57.9 | 51.6 |
| Total sawtimber | 1952 | ------------ | 27.4 | 58.8 | 50.4 |
| | 1962 | ------------ | 28.4 | 52.5 | 42.4 |
| | 1970 | ------------ | 31.0 | 53.5 | 42.3 |

of both total growth and removals is in the other private category. Other private also has the largest total growing stock inventory although national forest is a close second. On the other hand, other private total sawtimber inventory is only slightly less than national forest total sawtimber inventory.

The reasonableness of forecasts of future growth rates and inventories can be tested by comparing them with what has been achieved historically by the various land ownership classes. Table 3 is a coded summary of the changes that occurred in inventory, growth, removal, and acreage figures in the four regions of the United States for all owners, forest industry, and other private ownership classes between 1952 and 1970. To highlight important changes that have occurred, +'s and −'s are used as increments of change. As an example, between 1952 and 1970, softwood sawtimber volumes on other private ownerships in the South increased by 50–60 billion fbm. In that same period, the change in softwood sawtimber volumes on all owners ownerships in the South was 90–100 billion fbm.

Figures 1 and 2 represent graphically the changes that occurred in inventory, growth, and removal for all ownership classes in the four regions of the United States. Inventory, growth, and removal figures by ownership classes were presented in the 1952 "Timber Resources for America's Future," the 1962 "Timber Trends in the United States," and the 1970 "Forest Statistics for the United States."

The change in inventory between 1952 and 1970 includes the total effect of all the factors that influence volume. Included are gross growth, mortality, and cutting. Even though it is obvious that removals vary from year to year, for forecasting purposes it is satisfactory to assume that removals increased or decreased in a uniform manner between benchmark dates. Using this assumption, the amount of growth on a compound basis that is necessary to provide for the removals can be calculated. In a similar manner, the difference between inventories can be converted to a compound rate of change. Rates achieved in the 1952–70 period are shown by ownership classes in table 4.

In summary, growing stock has been building up on the nonindustrial private lands, but this buildup has occurred mostly on trees below sawtimber size. Further, growing stock on nonindustrial land is low on a per-acre basis, especially so in sawtimber sizes. On a per-acre basis, the growth on nonindustrial private lands exceeds considerably that on public lands, especially that on national forests. It does not, however, attain the levels that occur on industrial lands on a per-acre basis. This means that there is a real opportunity for a substantial increase in timber supplies through manipulating growing stock and improving practices on nonindustrial private lands.

**TABLE 3.—Inventory, Growth, Removal, and Acreage Changes by Region and Ownership Class Between 1952 and 1970**

[In billions]

| Region and ownership | Acreage changes (acres) | Volume changes | | | | Growth changes | | | | Removal changes | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Softwood | | Hardwood | | Softwood | | Hardwood | | Softwood | | Hardwood | |
| | | Growing stock [1] | Saw-timber [2] | Growing stock | Saw-timber | Growing stock | Saw-timber | Growing stock | Saw-timber | Growing stock | Saw-timber | Growing stock | Saw-timber |
| North: | | | | | | | | | | | | | |
| Industry | +A | +A | +A | +A | +A | +A | +A | +A | +A | +A | +A | +A | +A |
| Other private | +A | +A | +A | +C | +E | +A | +A | +A | +A | −A | −A | +A | +A |
| All owners [3] | +A | +B | +C | +D | +G | +A | +A | +A | +A | −A | +A | +A | +A |
| South: | | | | | | | | | | | | | |
| Industry | +A | +A | +B | +A | +A | +A | +A | +A | +A | +A | +A | +A | +A |
| Other private | −A | +B | +F | +A | −A | +A | +A | +A | −A | +A | +A | −A | −A |
| All owners | +A | +C | +J | +A | +A | +A | +A | +A | +A | +A | +A | −A | −A |
| Rocky Mountains: | | | | | | | | | | | | | |
| Industry | −A | +A | +A | +A | −A | +A | +A | +A | +A | +A | +A | −A | −A |
| Other private | −A | +A | +A | +A | +A | +A | +A | +A | +A | −A | −A | −A | −A |
| All owners | −A | +A | −B | +A | −B | +A | +A | +A | +A | +A | +A | +A | +A |
| Pacific Coast: | | | | | | | | | | | | | |
| Industry | +A | −B | −J | −B | −I | +A | +A | +A | +A | +A | −A | +A | −A |
| Other private | −A | −A | −C | +A | −B | +A | +A | +A | +A | −A | −A | −A | −A |
| All owners | −A | −A | −L | −B | −K | +A | +A | +A | +A | +A | +A | +A | +A |

[1] Growing stock units are in cubic feet.
[2] Sawtimber units are board feet, international rule.
[3] All owners includes national forest, forest industry, other private, and other public lands.
Legend:
A=0 to 10,000,000,000.
B=10,000,000,001 to 20,000,000,000.
C=20,000,000,001 to 30,000,000,000.
D=30,000,000,001 to 40,000,000,000.
E=40,000,000,001 to 50,000,000,000.
F=50,000,000,001 to 60,000,000,000.
G=60,000,000,001 to 70,000,000,000.
H=70,000,000,001 to 80,000,000,000.
I=80,000,000,001 to 90,000,000,000.
J=90,000,000,001 to 100,000,000,000.
K=150,000,000,001 to 160,000,000,000.
L=170,000,000,001 to 180,000,000,000.

## CURRENT AND PROPOSED GOVERNMENTAL PROGRAMS

### History

In recent years, Federal and State Governments have reached the conclusion that nonindustrial private forest landowners will have to furnish a major part of the timber needed to meet the increasing demand for stumpage and they will not do so without increased incentives. In order to assist the nonindustrial forest landowner in the production of timber to meet the demand, Federal and State Governments have created certain programs and authorized the expansion of some existing programs to assist the landowner with forest practices such as timber stand improvement and tree planting. Programs involved are the cooperative Forest Management Program, the Rural Environmental Assistance Program, the Soil Conservation Service, the Farmers Home Administration, the Extension Service, the Federal Land Bank, and the Naval Stores Conservation Program. Two recently proposed bills that would create new programs with similar objectives are the American Forestry Act and the Forest Incentives Bill.

Many existing programs, excluding the Cooperative Forest Management Program, were not created solely for the purpose of assisting forest landowners but were created as assistance programs for farmers and small landowners. The amount of forestry assistance that is given by these programs each year is a small percentage of the amount of total assistance that is given.

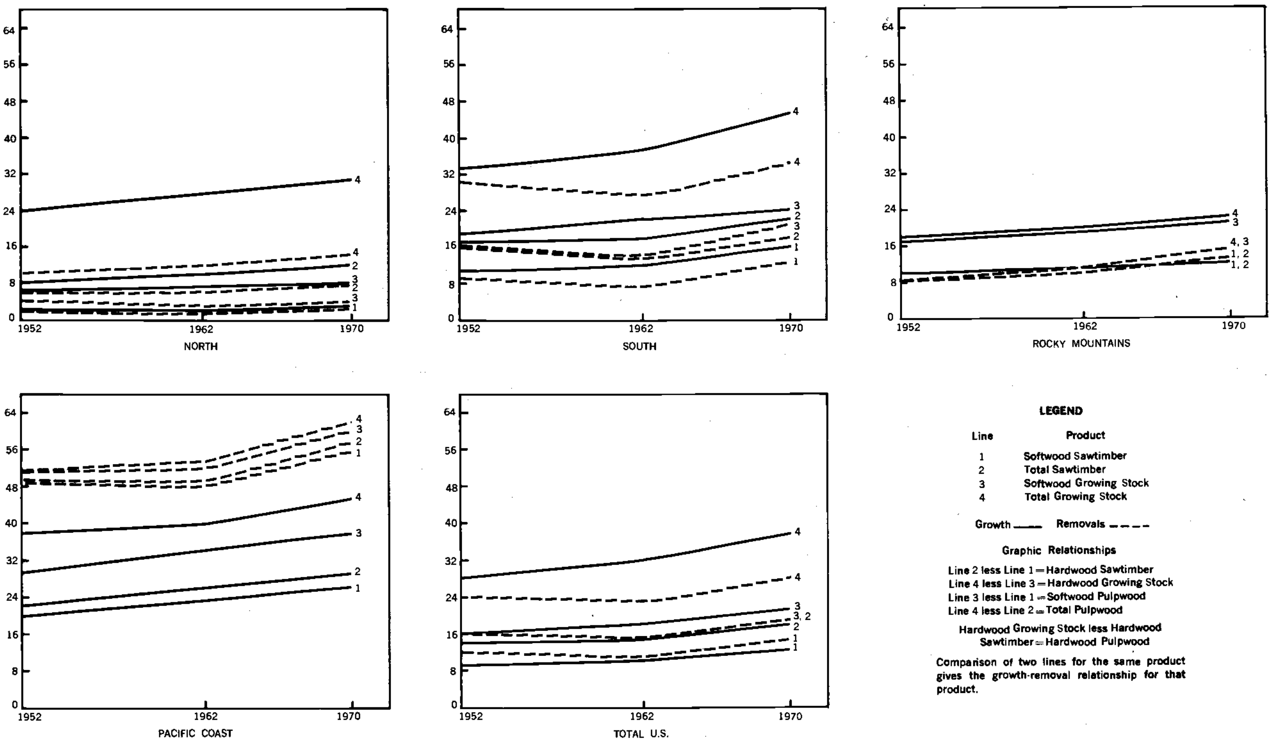
The philosophies and mechanics of the various programs were obtained from materials that are published by the several agencies each year showing accomplishments and goals. Partial information was obtained from bulletins published by the agencies to inform landowners of the existence and availability of the programs.

#### Federal Programs

*Cooperative Forest Management Program*

The Cooperative Forest Management Act of 1950 is a joint effort between the Federal and State governments to provide private landowners with technical advice and assistance in the management

**FIGURE 1.—Growth and Removals per Acre in Cubic Feet—All Ownerships**




of their forest lands for continuous multiple use production and profitable operation. A secondary goal of the program is to enhance nontimber benefits such as wildlife habitat, recreation, grazing, and environmental quality.

State employed professional foresters advise landowners on preparing multiple use management plans and on various forest management problems including selection of trees for cutting, timber stand improvement, and reestablishing forests through planting, seeding, and natural regeneration. State foresters also assist landowners, loggers, and mill operators in harvesting and marketing of forest products.

In cases where the Service forester feels that a job is too large to be handled in the short period of time alloted to one landowner, he will refer the landowner to a consulting forester in the area.

In the 1971 fiscal year, 125,505 woodland owners were assisted by 867 Service foresters through this program, involving 7,935,535 acres. Management plans were devised for 2,382,749 acres. As a result of Cooperative Forest Management Programs in the United States, 152,397 acres of timberland underwent timber stand improvement operations, 151,792 acres of land were planted or seeded, and 182,364 acres of timberland were managed for special forest products.

The popularity of the Cooperative Forest Management Program has increased so rapidly that foresters are unable to provide services to many of the landowners who requcst them. There were 15,406 requests for assistance at the end of the 1971 fiscal year for which no assistance had been given.

*Rural Environmental Assistance Program*

The Rural Environmental Assistance Program (REAP) replaced the Agricultural Conservation

FIGURE 2.—Comparison of Total Inventory, Total Growth, and Total Removals by Ownership Class

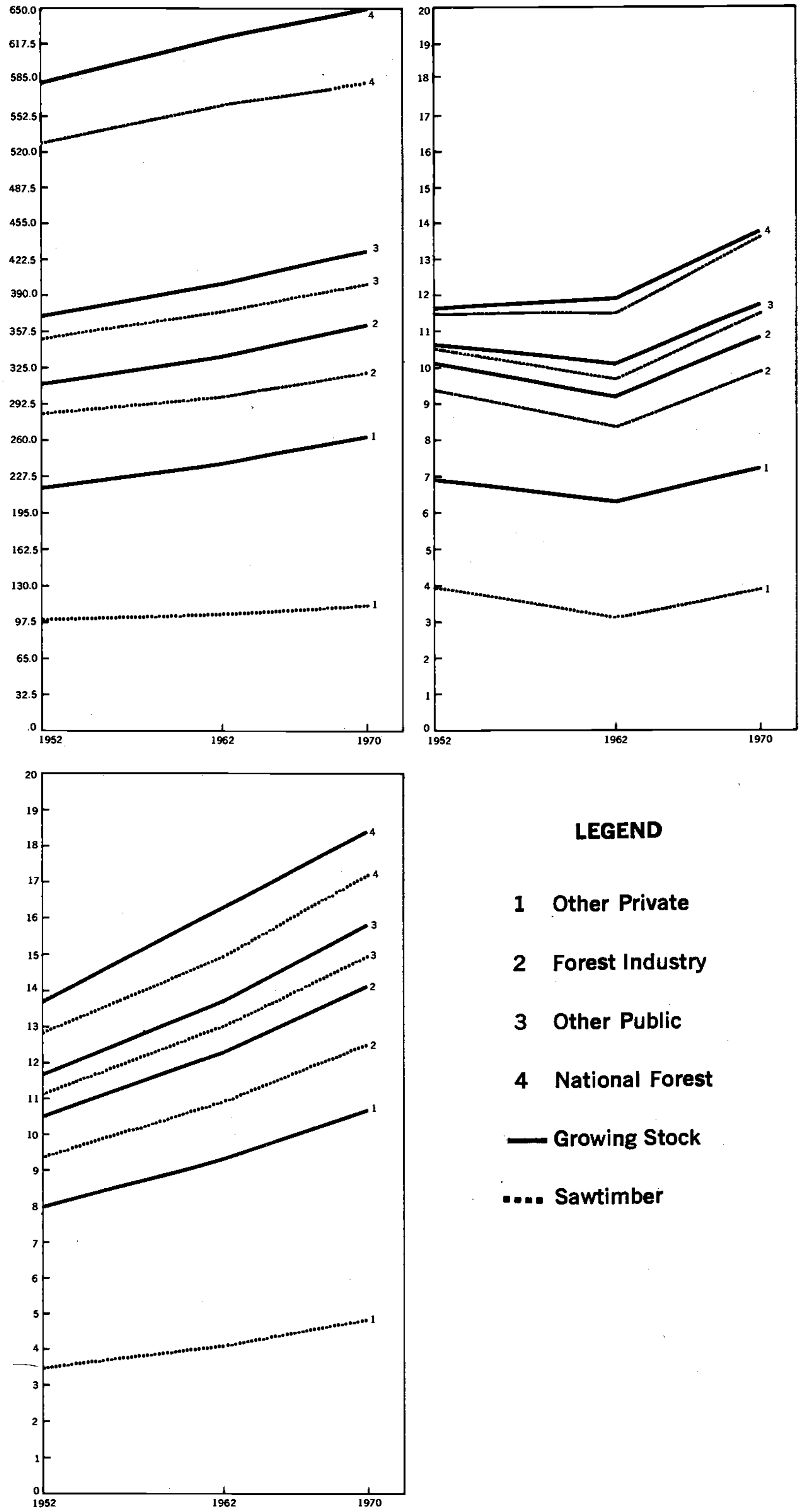


**TABLE 4.—Compound Growth Rates by Product Species, Region, and Ownership Class—1952–70**

[In percent]

| Region—ownership class | Softwood | | Hardwood | |
|---|---|---|---|---|
| | Pulpwood | Sawtimber | Pulpwood | Sawtimber |
| North: | | | | |
| National forest | 0.6 | 2.3 | 0.6 | 1.4 |
| Other public | 1.0 | 1.7 | 4.5 | 3.6 |
| Forest industry | 1.7 | 2.5 | 1.3 | 2.0 |
| Other private | 1.8 | 2.4 | 1.4 | 3.0 |
| All owners | 1.8 | 2.4 | 1.4 | 2.2 |
| South: | | | | |
| National forest | 1.3 | 1.9 | .3 | 1.3 |
| Other public | 3.1 | 3.2 | 2.5 | 2.4 |
| Forest industry | 3.1 | 3.5 | 3.1 | 3.1 |
| Other private | 3.9 | 4.9 | 2.6 | 2.9 |
| All owners | 3.7 | 4.2 | 2.4 | 2.9 |
| Rocky Mountains: | | | | |
| National forest | .2 | .9 | .0 | .0 |
| Other public | .4 | 1.0 | .0 | .0 |
| Forest industry | 1.2 | 2.7 | .0 | .0 |
| Other private | .5 | 1.1 | .0 | .0 |
| All owners | .2 | 1.1 | .0 | .0 |
| Pacific Coast: | | | | |
| National forest | .2 | .9 | .0 | .3 |
| Other public | .2 | 1.3 | 1.2 | .6 |
| Forest industry | 1.0 | 2.6 | 1.0 | 1.3 |
| Other private | 1.1 | 2.1 | .5 | 1.8 |
| All owners | .6 | 1.5 | .4 | .8 |
| Total United States: | | | | |
| National forest | .2 | .9 | .2 | 1.1 |
| Other public | .7 | 1.2 | 1.4 | 1.6 |
| Forest industry | 2.1 | 2.9 | 2.4 | 2.6 |
| Other private | 2.5 | 2.9 | 1.9 | 2.6 |
| All owners | 1.5 | 1.7 | 1.5 | 2.4 |

Program in 1971 as a result of amendments to the Soil Conservation and Domestic Allotment Act. It was discontinued by Executive order on December 22, 1972.

The purpose of REAP was to assist ranchers and farmers in conserving agricultural soil, water, woodland, and wildlife, and in preventing agricultural-related pollution of water, land, and air. Program objectives were reached by encouraging agricultural practices that establish, improve, and sustain a long-lasting protective soil cover and reduce land and water pollution.

In 1971, almost 95 percent of REAP funds were spent for enduring conservation measures, as compared with 92 percent in 1970 and 87 percent in 1969. Pollution abatement practices required $8.8 million, in comparison with $1.4 million in 1970. REAP funds used for tree planting and timber stand improvement increased from 2.8 percent to 5.2 percent. Cost-shares for timber stand improvement and tree planting increased from $4.7 million to $7.0 million. Wildlife conservation practice cost-sharing was 2.0 percent of the total allocation for 1969, increased to 2.2 percent for 1970, and 2.8 percent for 1971.

REAP funds were authorized annually by Congress. These funds were allocated to State Agricultural Stabilization and Conservation (ASC) committees on the basis of their State's conservation needs as determined by the Secretary of Agriculture. The State ASC committee then distributed the funds to the county ASC committees. The ASC usually paid about 50 percent of the cost of carrying out practices on projects approved for cost-sharing. This percentage was increased to 80 percent for low-income farmers and emergency cases.

The percentage of the cost paid by the ASCS could have gone to 90 percent when the operation involved tree planting and timber stand improvement. For temporary practices, cost-share assistance was usually limited to 30 percent of the cost.

A farmer who wished to participate in REAP was required to file a request with the ASC county committee before starting the project for which he desired cost-share assistance. If the committee approved the request, the project had to meet certain installation specifications to qualify for REAP funds. After the farmer had completed the project, he was required to maintain it. The farmer notified the county office when the practice was completed and cost shares were issued in the form of a check or a purchase order.

Of the $134,629,092 in cost-shares that were issued by REAP in 1971, only $6,731,455 were used for tree planting and timber stand improvement.

*Naval Stores Conservation Program*

The Naval Stores Conservation Program was authorized by the Soil Conservation and Domestic Allotment Act in 1936. The purpose of the program is to conserve and protect soil, water, and timber resources, and to improve the naval stores industry.

The program provides for technical assistance and cost-sharing in applying naval stores practices on private turpentine farms, non-Federal land, and on certain Federal lands not acquired or reserved for conservation purposes. The Federal cost-share rates are established annually for each practice. The Agricultural Stabilization and Conservation Service employes Forest Service technical assistance and facilities, as well as State foresters in administering the program.

The production of gum naval stores has steadily and drastically decreased in recent years. Factors such as expansion of paper mills in the South, with the production of tall oil rosin as a byproduct; the exodus of labor from rural areas; and the enticements of welfare have entered into the decline of the gum naval stores industry.

*Soil Conservation Service*

The Soil Conservation Service (SCS) is a technical service agency that assists landowners in the field of soil and water conservation, watershed protection and flood prevention, and resource development. The SCS works through soil and water conservation districts which are legally organized subdivisions of States.

SCS technical staffs are assigned to the conservation districts to provide assistance to landowners and operators in planning an integrated soil, water, and plant conservation program for their lands. SCS staffs also give assistance in the initial application and maintenance of conservation practices.

The SCS makes its major contribution to woodland resources development by assisting landowners in fitting their land use patterns and management goals to the physical features of their land. SCS technicians interpret soil maps for woodland owners who need information concerning the suitability of their soils for tree farming. One of the most common forms of woodland interpretations shows soils combined into areas of similar woodland suitability. These areas are made up of soils having common characteristics with respect to species suitability, tree growth, and management. Other soil map interpretations identify management hazards or limitations, woodland site quality, species suitability, plant competition, or erosion susceptibility. Soil maps can also be used to establish frequency of thinnings, length of cutting cycles, and the most economical crop tree size. In fiscal year 1971, forestry projects dealing with reforestation and woodland improvement were administered by the Soil Conservation Service on approximately 2½ million acres of land.

*Farmers Home Administration*

The Farmers Home Administration (FHA) makes operating loans and gives technical management assistance to operators of family farms to aid them in making improvements in their farm and home operations necessary for successful farming. The FHA and its predecessor agencies have been making loans for forestry purposes since 1937 under the Bankhead-Jones Farm Tenant Act, the Water Facilities Act, and now the Consolidated Farmers Home Act.

The bulk of FHA forestry loans were made under a program that was in operation from 1962 through 1969. That program provided loans at a 3 percent interest rate on a 40-year term for family farmers. However, the program was discontinued in 1969 because the majority of the family farmers needed income immediately and were not interested in waiting 10 to 40 years for timber income.

Currently, loans for forestry purposes are made under three broad programs—farm ownership at an interest rate of 5 percent, soil and water at 5 percent, and farm operating at 6⅝ percent. Money from the loans may be used to buy or develop forest land, refinance debts on land to be used for forestry purposes, pay the initial costs of carrying out approved forestry practices, clear land and plant trees, and pay harvesting costs. Farm ownership and farm operating loans are available only to family farmers actually operating a farm. Soil and water loans are available to all farm owners, but they may be used only for operating expenses. Very few loans have been made for forestry purposes under these programs. The low-interest loans provided by the FHA are available only to operators of family-sized farms.

*Extension Service*

The Federal Extension Service is an educational agency of the U.S. Department of Agriculture and functions in cooperation with the State Extension Services of land-grant universities. The program is administered by the Federal Extension Service working through State Extension Foresters and County Agricultural Agents.

The Extension Service provides educational assistance in tree planting, forest protection, timber stand improvement, and the harvesting and marketing of forest products. Training methods used by the Extension Service include forestry demonstrations, home visits, community and 4–H club meetings, short courses and workshops, exhibits, publications, radio, and television. Extension Service foresters can consult university research and teaching personnel as well as professional people in private forestry to provide expert advice and continuing adult education programs and youth programs.

*Federal Land Bank*

In recent years, business experiences have shown that tree growing may be undertaken with the expectation of a fair return on money invested. The prospect of increased forest product and stumpage prices, the scarcity of high-grade timber, the rapid growth of certain valuable species, and industry's dependence on nonindustrial private woodlands as sources of raw material are factors that have led the financial community to believe that such a return is possible. This has resulted in availability of private credit in forest development and operation.

The Federal Farm Loan Act of 1916 authorized the establishment of 12 district Federal land banks and the organization by farmers of numerous local Federal land bank associations. This act established a basis for long-term credit to individual farmers through local cooperatives. The capital stock of the 12 district land banks is held entirely by the land bank associations.

Loan applications are made through the association responsible for the area in which the timber collateral is located. Each association has a resident manager and is chartered to serve a specific territory—usually several counties.

Successful applicants must meet normal credit prerequisites for a sound bank loan, be financially solvent, and have substantial equity in the property offered as collateral. Applicants must have some experience in managing timberland, including protection against hazards and operation for optimum returns. All banks making timber loans require that tracts offered as collateral be self-supporting. Expected timber growth and harvest during the term of the loan must be sufficient to provide enough income to pay all operating costs, fixed costs, and loan installments. Each land bank requires a working management plan, although the plan need not be written. The management plan must provide for protection and for sufficient sustained production to insure orderly retirement of the loan. A first mortgage is required by law on any property offered as collateral for a land bank loan and the amount loaned cannot exceed 65 percent of the appraised value of the property. Interest rates vary with the condition of the money market but are the same for timber loans as for other types of lending. Repayment schedules can be adapted to cutting cycles and are generally arranged to the borrower's individual needs. Fully amortized and partially amortized loans may be made for terms of 5 to 40 years. Nonamortized loans, where the payment of the entire principal is made at the end of the loan term, are limited to 10 years.

## Proposed Federal Programs

*American Forestry Act*

A bill entitled the American Forestry Act was introduced in the first session of the 92d Congress by Senator Mark Hatfield. This bill grew out of consultation with State Foresters, conservation groups, professional foresters, and industry officials. The emphasis of the bill is placed on increased production and improved management on both public and private lands. It is designed to reforest and restore the quality of public and private forest lands; to enhance and expand recreational opportunities on such lands; to provide financial incentives for the improvement of management of State and private forest lands; to establish a Federal forest lands management fund; to facilitate public participation in Federal resource management; and to improve the quality of the environment and the resources of the public lands.[13] An American Forestry Policy Board would be established by this bill and the Secretary of the Interior and the Secretary of Agriculture would institute the programs to carry out the objectives of the bill.

Under the American Forestry Act, the States would be required to develop plans for administering the programs. The Federal Government would establish guidelines and provide matching funding for the programs.

*Forestry Incentives Act of 1972—Stennis*

A bill entitled the Forestry Incentives Act of 1972 was recently introduced into Congress by Senator John C. Stennis. In the bill, the Secretary of Agriculture is authorized to develop and carry out a forest incentives program to encourage the protection, development, and management of small nonindustrial private lands and non-Federal public forest lands. The purpose of the proposed program is to encourage landowners to apply practices that would provide for afforestation of nonforest lands and reforestation of cutover lands. The incentives program would also promote intensive multiple-use management and protection of forest resources to provide for production of timber and other benefits.

The Stennis bill would provide Federal cost-sharing of up to 80 percent for owners of nonindustrial private forest tracts under 5,000 acres for tree planting and cultural treatments. Cost-sharing would be limited to a maximum of 500 acres under one owner in 1 year. The bill also provides for cost-sharing up to 50 percent for similar work on State and county forest lands.

In addition, the bill authorizes pilot testing of a variety of loan programs as a means of stimulating larger investments of private capital in forestry. These loans would include low interest rates, deferred payment plans, nonrecourse provisions, long-term repayment provisions, and a provision under which a portion of the principal and interest would be waived at maturity under circumstances determined by the Secretary of Agriculture.

*Forestry Incentives Act of 1972—Foley*

The forestry incentives bill introduced by Senator Stennis was rewritten by Congressman Foley and introduced in the House of Representatives. The bill states that the growing national demand for forest and land resources cannot be met through intensive forest management only on national and industrial lands. A forestry incentives program is cited as a necessity to supplement the existing forestry assistance program in order to encourage small nonindustrial landowners to manage their forest lands so that the national demand can be met.

The purpose of the incentive program is to encourage landowners to use practices which will provide for afforestation of nonforest lands and reforestation on cutover lands, for intensive multiple-purpose management and protection of forest resources to provide for production of recreational and other environmental values, and for protection of watersheds, fish, and wildlife habitat.

The bill makes cost-sharing available to small nonindustrial private forest landowners and non-Federal public forest landowners who provide the practices to carry out the previously stated purposes. The Federal contribution will not be more than 50 percent of total cost. No one landowner may receive more than $2,500 in 1 year.

Cost-sharing is also available to small nonindustrial private forest landowners for the purpose of providing the manpower, equipment, planting stock, and supplies to carry out the program practices. The Federal contribution will not exceed 50 percent of total cost.

The Secretary of Agriculture is authorized to use State and local committees established by the Soil Conservation and Domestic Allotment Act to obtain the facts relative to the distribution of cost-sharing funds. The Secretary may appoint advisory members who include small nonindustrial private forest landowners, private forest managers or consulting foresters, and wildlife or other resource interests, to these State and local committees.

[13] U.S. Congress, Senate, "An Analysis of Forestry Issues in the First Session of the 92d Congress," 92d Cong., 2d sess., 1972, p. 15.

The funds available to a county may be allocated to owners on a bid basis. First priority for funds would go to those owners contracting to carry out approved forestry practices with the smallest Federal cost-share.

Appropriations for the program will not exceed $25 million.

### Forest Practice Regulation

Theoretically, one way to improve the productivity of private woodlands, both industrial and nonindustrial, is to pass legislation requiring forest practices designed to improve timber growth. In the early days of European forestry, autocratic directives and limitations on what the forest owner could or could not do on his own land were general. Many ordinances during the 14th and 15th centuries decreed specific forest practices such as the replanting of cutover areas, leaving seed trees of a valuable species, restrictions on felling in young stands, and the use of valuable woods for fuel. Most of these forest practice laws in Europe were largely abolished or rationalized under the spread of liberal ideas and parliamentary government following the French Revolution.

The use of forest practice laws to regulate forest practices in Europe was not totally abolished, however, and was widely employed in continental Europe in providing protective forestry on mountain watersheds. Forest practice laws were employed in the First and Second World Wars to control the available volume, distribution, and pricing of timber products.

In the United States, regulation of cutting practices by the Federal Government has been advocated continually by some groups and some individuals since the turn of the century. It was intensively promoted in the late thirties and again in the late forties.

During the second term of Franklin Roosevelt, the Forest Service began a strong drive for better management of private woodlands. Federal cooperation in the field of district assistance in the management of farm wood lots was prescribed in the Farm Forestry Act of 1937. In 1938, President Roosevelt urged an inquiry into public regulatory controls that would adequately protect private and public interests in all forest lands. A joint congressional committee under Senator Bankhead held extended hearings and focused public attention on action to stop destructive cutting on private lands. A bill was introduced by Senator Bankhead that proposed Federal regulation of timber harvesting methods.

A current effort is being made through a bill entitled the "Forest Lands Restoration and Protection Act of 1971," introduced in the first session of the 92d Congress. The bill would authorize a broad range of regulatory practices including compulsory licensing of foresters and mandatory harvesting plans for private forest owners. Current Federal contracts to clearcut timber would be reviewed and those deemed unsound would be terminated. Foreign export of logs would be prohibited. A timber management fund for Federal forest management practices would be established. The fund would be supported by the proceeds from Federal timber sales.

Most of the laws that regulate cutting practices today are strictly State affairs. These laws specify certain compulsory practices such as leaving seed trees, that are applicable to landowners or loggers. The practices prescribed by law are usually those needed to reestablish a stand after cutting.

Silvicultural practices are usually adapted to immediate local environmental conditions. Attempts have been made to apply a specific set of silvicultural rules over extensive areas, but they have proved to be unsuccessful. Some States' laws have attempted to overcome this problem by having the cutting practices developed and specified by local forestry boards.

Sixteen States now have cutting practice legislation of some sort. In nine of the States, the practice laws were developed by the State legislature in basic acts with statewide application. In seven States, the laws were developed by some form of a district forest practice board. Most of the laws are still enforced to some degree. A summary of current State laws regulating cutting practices appears in the appendix.

The National Forest Products Association Board of Directors has called for prompt establishment of State forest practice standards where they do not exist and a review of the adequacy of existing State forest practice standards.

### State Programs

In addition to forest practice laws, some States have initiated programs to assist the nonindustrial private landowner in improving the production of timber on his land. Three States that have instituted major programs are North Carolina, Texas, and Virginia. The programs are the North Carolina program, Texas aggregates, and the Virginia rehabilitation program. Although only three States have major programs eight other States have passed some form of incentive legislation. These programs are summarized in the appendix.

### North Carolina Program

North Carolina's plan for improving the productivity of nonindustrial woodlands is described by State Forester Ralph Winkworth as providing for "Active participation by the State Forest Service in any type of forestry service required by individual private landowners to improve the productivity of the State's forest resources."[14] Services are offered either through State Forest Service crews on a custom fee basis or through equipment rentals to qualified contractors.

The program was funded in 1969 by a $700,000 2-year appropriation. Plans called for a lower amount for the 2 succeeding years and a reduction to the amount required for overhead only. By that time the program should be able to operate on funds from payments for services.

The program plans a production level of 40,000 acres per year using three field units. More than two-thirds of the funds for the first year were spent on equipment.

While waiting for equipment needed to begin major field work, the Forest Service organized hand crews to perform jobs such as tree planting, prescribed burning, and railroad right-of-way burning. Two drum choppers were purchased for rental to contractors. Within a year seven choppers were made available by using rental receipts for additional units.

By 1970 there were three mechanized crews operating. Plans have been completed for an expansion in staff sufficient to activate a second major field unit.

#### *Status*

Fees are reportedly competitive with private contractors and consulting foresters. State Forester Winkworth believes that there is plenty of work for all and that the demand for consulting forestry services outside the program will not be reduced.

North Carolina has 245,000 ownerships of less than 500 acres. Winkworth does not anticipate reaching all of these ownerships but believes that the 40,000 acres per year objective for 40 years is attainable. This would mean that only 10 percent of the nonindustrial private forest land would be involved.

### Texas Aggregates

A relatively new approach to the nonindustrial problem was described by Mason C. Cloud in his talk to the 1970 Auburn Forestry Forum. He defines a "forest landowner aggregate" as a:

> * * * vehicle for organizing small, private, nonindustrial forest landowners for the purpose of increasing the quality and quantity of forest capital thereon; and to market the timber being produced in an even, orderly, sustained manner for the mutual benefit of the owner and the forest industries that depend on this wood.[15]

The program began in 1964 after a study of a 1958–63 program promoting forest management with owners of medium-sized land holdings.

Emphasis is on holdings ranging in size from 100 to 500 acres, but larger and smaller ones may be included.

Typically, in the establishment of an aggregate, the Texas Forest Service selects a geographical area in which a forest products firm is located. A local consultant is selected to lead the aggregate. Landowners are classified as to their potential for membership. The area consultant and the Texas Forest Service forester explain the aggregate in detail to landowners. After 100,000 acres are signed up in one area, the aggregate is released to the consultant for operation.

Marketing assistance receives emphasis over management services according to the contract, but experience shows that members want both services performed.

As soon as an aggregate program is launched, the first step is to make an inventory of forest holdings and idle open land by owner and county. The cost of this phase is about $25,000. Information collected is placed on computer cards, hence can be updated periodically.

After this information is compiled, forest and land areas are separated. These data are collected from the files of various agencies and from questionnaires. From this, the forest ownership pat-

[14] Ralph C. Winkworth, "A State Program To Aid Private Forest Landowners in Site Preparation and Planting" (speech, 1970 Auburn Forestry Forum, Auburn, Ala.).

[15] Mason C. Cloud, "Forest Aggregates—An Aproach to Better Management of Small Forest Landownerships" (speech, 1970 Auburn Forestry Forum, Auburn, Ala.).

tern is developed. The purpose according to Cloud is to estimate, for planning purposes, the area available for: (1) Intensive forest management, (2) moderate forest management, or (3) little forest management.

*Status*

The best analysis of the potential of aggregates is provided by Cloud himself. He says that the aggregate is not the only way to provide more efficient management on these tracts, but it is considered to be the most efficient and effective way to obtain measureable results in the shortest period of time.[16]

VIRGINIA REHABILITATION PROGRAM

*Description*

Still another approach to the small woodland problem has been put into effect in Virginia. According to Thomas G. Harris, vice president of Woodlands, Chesapeake Corp. of Virginia, the plan is a landowner assistance program to encourage and assist the landowner to get his nonproductive pine land into production.[17]

A fund consisting of two parts has been set up in the State treasurer's office. The first part increased the forest products tax levied on pine cut, and paid by the first manufacturer, of 20 cents per cord or 50 cents per thousand board feet. A matching amount from the Virginia general fund is the second part of the fund. If the tax is not matched, it will be returned to the taxpayers. The State is obligated to provide $100,000 for administrative costs, but these costs cannot exceed 10 percent of total costs.

At least one-half of the tax money from a county must be available for spending in that county.

Funds are used to encourage and assist the small landowners to prepare their nonproductive pine land for reforestation and to plant tree seedlings If the seed tree law applies on a tract, assistance funds are not available.

*Administration*

A nine-man Reforestation Advisory Committee, appointed by the Governor, makes recommendations to the Board of Conservation and Economic Development about the program. The Virginia Division of Forestry administers the program and buys equipment for landowners to use at cost. Foresters from the division are available to help landowners decide what steps to take and estimate costs.

The options for cost-sharing are as follows:

Option I: The State will pay 50 percent of the cost when State equipment, materials, and personnel are used to prepare and reforest land. The total State share cannot exceed $20 per acre.

Option II: Under this option, State equipment, materials, and personnel are not used or are only partially used. The landowner either carries out the project himself or hires a contractor. Upon the completion of a reforestation project, the State forester determines the cost of the project and pays the landowner up to 50 percent of that cost, not exceeding $20 per acre.

Option III: The State will lend the landowner 75 percent of the cost, which is determined by the State Forester, or $30 per acre, whichever is less, upon completion of a reforestation project. The work may be done by the landowner, contractor, or State. A lien is placed upon the property for 30 years. The loan must be repaid before any timber is cut.

*Results of the first year's operation*

For the first operational year, July 1, 1971, through July 1, 1972, the reforestation of timberlands program sponsored a total of 478 projects, averaging 41.4 acres in size. The breakdown by option is as follows:

| Option | Projects | Acres |
|---|---|---|
| I | 1 | 18.0 |
| II | 474 | 19,645.7 |
| III | 3 | 336.5 |
| Total | 478 | 20,000.2 |

Eight types of projects were undertaken. A list of the projects under option II and the acres involved in each is as follows:

| *Project:* | *Acres* |
|---|---|
| Drum chopping, prescribed burning, and planting or seeding | 8,095.6 |

[16] Ibid.

[17] Thomas G. Harris, "The Virginia Plan for Rehabilitating Unproductive Private Forest Land" (speech, 1971 Auburn Forestry Forum, Auburn, Ala.).



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| *Project*—Continued | *Acres* |
|---|---|
| Aerial spraying (herbicide) prescribed burning and planting | 1, 127. 3 |
| Prescribed burning of fresh logging slash and planting | 2, 777. 2 |
| Bulldozing, disking, or chopping without burning and planting | 2, 121. 1 |
| Aerial spraying and planting | 279. 0 |
| Open field planting | 1, 705. 2 |
| Spot planting (no site preparation) | 1, 076. 0 |
| Aerial release of natural or planted stands | 2, 464. 3 |
| Total | 19, 645. 7 |

During the first year under the program, a total of $670,745.57 was spent. For the second year, 397 projects involving 22,169.4 acres are already approved and an estimated 5,000 acres are expected to be added during the spring.

*Status*

Virginia forestry leaders believe that the money appropriated from the general fund will be returned many times through taxes on increased amounts of timber and wages.

## EFFECTIVENESS OF EXISTING PROGRAMS

### An Allocation of Results Achieved

The "National Inventory of Soil and Water Conservation Needs of 1967," which for convenience of reference may be referred to as the National Inventory, lists 398,234,000 acres of non-Federal commercial forest land in the United States. Included in that acreage are 116,064,000 acres having adequate management; 103,581,000 acres needing stand establishment or reinforcement; and 178,589,000 acres needing timber stand improvement.

"Forest Statistics for the United States, by State and Region, 1970" [18] lists 499,697,000 acres of commercial forest land in the United States in 1970. Excluding 101,219,000 acres of national forest, Bureau of Land Management, and miscellaneous Federal land from that figure results in a total non-Federal commercial forest land acreage of 398,478,000 acres in 1970. This acreage is comparable to the acreage listed in the National Inventory Therefore, it can be assumed that there was no significant change in the non-Federal commercial forest land acreage between 1967 and 1970. With this assumption, the acreages cited as needing treatment in the National Inventory can be used as a basis for comparing goals with accomplishments.

In contrast to the 103,581,000 acres of non-Federal commercial forest land now needing stand establishment or reinforcement, only 34,014,936 acres were planted through 1971 by industrial, other private, and all public ownerships. This figure was developed by analyzing the year-by-year reports of acres planted by ownership classes as published by the Forest Service in "Forest and Windbarrier Planting and Seeding in the United States" [19] and its predecessor reports. The results of this analysis are shown for the United States as a whole in table 5 on page 34. The total non-Federal commercial forest land planted through 1967 totals 24,656,698 acres. Most of this planting occurred between 1947 and 1967. If this rate is maintained, it would take 83 years to make up the 103,581,000-acre deficit. Averaging planting totals for 1968 through 1971 from table 5 and excluding certain Federal acreages from the all public figures yields a total of 5,263,941 acres for the 3-year period. At this rate, it would take 79 years to make up the deficit. The annual area planted during the years 1967 to 1971 is roughly the same as that planted during 1951 to 1955.

In 1967, the national inventory listed 178,589,000 acres on non-Federal commercial forest needing timber stand improvement. The rural environmental assistance program (REAP), the Cooperative Forest Management Program (CFM), and the Soil Conservation Service (SCS) are three Federal agencies providing services in the area of timber stand improvement. From 1967 to 1971, farms covered by the REAP program, formerly the Agricultural Conservation Program, were responsible for timber stand improvement work on 595,680 acres. In that same period, CFM program cooperators were responsible for timber stand improvement on 629,274 acres.

Timber stand improvement work, under Soil Conservation Service farm plans, has been done on 14,872,701 acres since the establishment of the SCS in 1935. The average is thus 413,131 acres per year. Using this average figure, it can be assumed that SCS farm plans were responsible for timber stand improvement work on approximately 1,652,524 acres between 1967 and 1971.

The total amount of timber stand improvement work for which REAP, CFM, and SCS programs were responsible, if there were no duplications in

[18] Forest Service, "1970 Forest Statistics."

[19] Forest Service. "Forest and Windbarrier Planting and Seeding in the United States," 1950–71.

**TABLE 5.—Summary of Acres Planted by Season, Region, and Ownership Category—Yearly Totals**

| Season | Industrial | Other private | All public | All classes |
|---|---|---|---|---|
| Pre-1950 | 821, 287 | 2, 905, 174 | 3, 426, 871 | 7, 153, 333 |
| 1950 to 1951 | 134, 492 | 224, 914 | 93, 672 | 453, 078 |
| 1951 to 1952 | 164, 421 | 240, 309 | 114, 892 | 519, 622 |
| 1952 to 1953 | 267, 618 | 304, 712 | 137, 767 | 710, 097 |
| 1953 to 1954 | 310, 813 | 374, 639 | 122, 758 | 808, 210 |
| 1954 to 1955 | 291, 677 | 359, 887 | 127, 740 | 779, 304 |
| 1955 to 1956 | 303, 077 | 438, 157 | 145, 183 | 886, 417 |
| 1956 to 1957 | 371, 497 | 596, 186 | 170, 673 | 1, 138, 356 |
| 1957 to 1958 | 441, 918 | 883, 308 | 207, 508 | 1, 532, 734 |
| 1958 to 1959 | 494, 103 | 1, 388, 287 | 234, 301 | 2, 116, 691 |
| 1959 to 1960 | 616, 679 | 1, 218, 721 | 264, 619 | 2, 100, 019 |
| 1960 to 1961 | 667, 915 | 786, 648 | 306, 099 | 1, 760, 662 |
| 1961 to 1962 | 513, 390 | 502, 241 | 350, 152 | 1, 365, 783 |
| 1962 to 1963 | 537, 706 | 415, 575 | 372, 051 | 1, 325, 332 |
| 1963 to 1964 | 559, 005 | 386, 173 | 367, 508 | 1, 312, 686 |
| 1964 to 1965 | 526, 036 | 390, 456 | 368, 838 | 1, 285, 330 |
| 1965 to 1966 | 542, 940 | 356, 842 | 381, 044 | 1, 280, 826 |
| 1966 to 1967 | 587, 072 | 396, 383 | 389, 318 | 1, 372, 773 |
| 1967 to 1968 | 680, 534 | 360, 848 | 397, 227 | 1, 438, 609 |
| 1968 to 1969 | 737, 639 | 310, 043 | 383, 629 | 1, 431, 311 |
| 1969 to 1970 | 887, 420 | 297, 266 | 391, 986 | 1, 576, 672 |
| 1970 to 1971 | 973, 381 | 302, 596 | 391, 116 | 1, 667, 093 |
| Totals | 11, 430, 620 | 13, 439, 362 | 9, 144, 954 | 34, 014, 936 |

reporting, is approximately 2,877,478 acres. This figure represents 2 percent of the 178,589,000 acres needing timber stand improvement in 1967.

In a 1970 timber program issue paper, "Opportunities for Expanding Timber Production on Nonindustrial Private Forest Lands," published by the U.S. Department of Agriculture, it was stated that an:

> * * * allocation of ACP (later REAP) funds to forestry practices is largely a local determination reflecting local alternative uses of the same funds. It would require a national allocation of ACP funds for forestry practices to assure they would be used where they would have maximum national cost-effectiveness for timber production, largely in the South.[20]

A majority of the 398,234,000 acres of non-Federal commercial forest land is in nonindustrial private holdings. A typical rotation for the South is 30 years; for the North, 60 years; for the Rocky Mountains, 60 years; and for the West Coast, 45 years. Thus, a typical rotation for the Nation as a whole approximates 40 years. With 80 years needed to overcome the deficit that has already been pointed out, and with the typical rotation for the Nation being 40 years, it is obvious that there will be a sustained period of time in which the actual production of timber will be one-half or less of the potential. At this rate, the nonindustrial private forest lands cannot possibly meet the projected demands for timber.

The key to increased total forest productivity is therefore increased production on the nonindustrial private ownerships.

## MISCELLANEOUS PRIVATE EFFORTS

### Scope of Programs

A number of special programs have been developed in an attempt to improve timber production on various classes of forest land. Sponsors include associations, local groups, and specific forest industry firms. The associations generally aim at all forest lands, local groups at lands held by their own members, and forest industry firms at land owned by other private owners in the industry's supply area. Programs included are the American Tree Farm System, the tree farm family programs, forest cooperatives, and the Trees for People Program.

[20] U.S. Department of Agriculture, "Opportunities for Expanding Timber Production on Nonindustrial Private Forest Lands," timber program issue paper (June 12, 1970).

Information concerning the objectives and administration of the programs was obtained from published articles or bulletins distributed by the supporting organizations themselves.

## The American Tree Farm System

The American Tree Farm System was initiated in 1941 by forest industries in an effort to develop an interest in forest management among woodland owners. The system is administered through the American Forest Institute. Tree farms are voluntarily dedicated by their owners to the growing and harvesting of repeated forest crops.

Before a tract is certified as a tree farm, it is inspected by a professional forester assigned by the State tree farm committee. The forester examines the property to see if it meets the qualifications, discusses the condition with the owner, and reports his findings to the committee. The three main qualifications are private ownership; management for growth and harvest of repeated forest crops; and adequate protection from fire, insects, disease, and destructive grazing. If the State committee gives its approval, the tract becomes a certified Tree Farm. Management standards must be maintained or certification will be withdrawn.

Forest industries assist local woodland owners with their management planning, protection programs, planting, and harvesting.

The American Tree Farm System began in 1941 with one Tree Farm covering 120,000 acres and by July, 1969, had increased to 33,459 farms covering 73,829,267 acres in 48 States.

## Tree Farm Family Program

The tree farm family program is the name given to the industry practice of assisting neighboring landowners in managing their timber and in growing trees as a crop. The tree farm family program was, at least in name, an outgrowth of the American tree farm system.

The type of agreement between the company providing the services and the landowner can range from an oral agreement to a formal forest management agreement as described in the section entitled "Lease and Purchase Agreement Mechanics" presented later in this report.

Through the tree farm family program, a landowner within the supply radius of a forest industry may receive forest management services in return for which the landowner gives first refusal rights to his timber to the company when the timber is ready for harvest. The industry provides the management services to the landowner at cost. Services to landowners include long-range planning, tree planting, site preparation, and timber stand improvement.

## Forest Cooperatives

Forest landowner cooperatives have been widely cited as a solution or at least a partial solution to low productivity on nonindustrial forest lands. Recent articles or speeches in favor of this concept have come from E. M. Bacon, Deputy Chief, State and Private Forestry, Forest Service; Edward P. Cliff, former Chief, Forest Service; Richard L. Knox, Forest Service; Beryle Stanton, Divison of Information; and Gordon D. Fox, Deputy Assistant Chief, Forest Service.

### History

In the 1920's and 1930's the U.S. Department of Agriculture first began efforts to develop forestry cooperatives. Many failed because there was no well-grounded operation plan. To be effective, a cooperative has to be founded on good business principles and sound management practices.

Since beginning efforts were made, about 200 forestry-related cooperatives have been formed. Some of those that have been successful are Forest Owners, Inc., in Yazoo City, Miss.; Forest Management & Sales Association, Inc., in Chehalis, Wash.; and Plyco, in Mississippi.

### How Cooperatives Work

A look at these examples shows that the exact approach varies but one that is fairly typical is described by Beryle Stanton in the June, 1966 issue of News for Farmers Cooperatives. Forest Owners, Inc., provides both management and marketing services for its landowner members.

The management services are performed for a fee of 10 cents per woodland acre per year of an 8-year contract. A timberland cruise by a forester from the cooperative initiates the management program. A preliminary forest management plan is then developed. It presents such information as location, acreage, stand description, and species occurrence on a detailed map. Information on accessibility, fire control, and animal damage is also presented.

The forester then makes recommendations for improvement of the timberland, analyzes timber sales possibilities by product type now and in the future, and makes recommendations for marketing the timber.

If a member decides to sell his timber, marketing functions will be performed. A forester marks the timber that is to be cut and estimates what will be produced from the cut. The cooperative sends a prospectus to a list of potential buyers and arranges dates to show the timber. The owner selects the bid to accept, usually the highest. The cooperative is responsible for handling deeds and cutting contracts as well as cutting progress inspections. A final check for contract compliance is made after cutting is completed.

Payment from the buyer goes to Forest Owners. The cooperative deducts its fee, usually 10 percent, and issues the owner a check for the balance. If no bid is accepted, Forest Owners receives no commission.

Forest industry, public, and landowners are all represented in the membership of Forest Management & Sales Association, a second cooperative illustrative of a slightly different type. Its operations are based on an agreement with Weyerhaeuser Co. Weyerhaeuser provides members a list of prices they will pay for each product. Weyerhaeuser has the right of first refusal of timber in exchange for free management service. This agreement provides that if the owner can locate a market with a 10 percent higher price, Weyerhaeuser has a specified period of time to meet the higher price or lose the right to buy the timber.

Another cooperative, Plyco, has been formed in Mississippi. This is a plywood cooperative in which owners of up to 300,000 acres of pine lands can buy shares for $10 per acre of ownership to raise part of the capital. The outstanding feature of this cooperative is the assurance offered that the plant will have the necessary raw material it needs to operate from cooperative owned timberland.

#### Advantages of a Cooperative

These examples of successful cooperatives illustrate that there are potential advantages. Large numbers of landowners can be persuaded to adopt good forest management practices; to improve production and marketing efficiency of small-scale woodland owners; to provide the small entrepreneur with services he could not afford as an individual; to provide a better bargaining position for buyers and sellers; and to provide the landowner with the technical and operational basis for periodically scheduled returns.

#### Disadvantages of Cooperatives

The Vardaman article in American Forests, mentioned earlier, suggests that the small landowner is against cooperatives. The cooperative is looked upon as a scheme which takes away his independence and flexibility. These two characteristics are what make the small landowner's business a good one and he will not give them up easily. Vardaman quotes a forester who has worked in a cooperative as saying the cooperative cannot operate economically with ownerships of less than 300 acres. The cooperative was organized to help small landowners who now find that cooperative leadership has classified them as hopeless cases and are trying to blame the characteristics of small landowners for failure.[21]

#### Current Status

In the late 1960's there were 143 cooperatives involved in forest-related education, management, and marketing. Of these, 36 were Christmas tree associations and 41 were educational. The remaining 66 were marketing and service cooperatives in all areas of forest products including such diverse activities as timber growing, worker-owned plywood plants, and maple syrup collection and processing.

#### The Outlook for Cooperatives

Two conclusions may be reached concerning cooperatives. First, there are too few cooperatives now to have much effect with respect to increasing the output from small landowners. Second, cooperatives probably will not grow to be a significant factor because of the amount of organizational effort and the high level of management skill required to conduct successful operations. Persons possessing such abilities would be more likely to be attracted to an enterprise providing more rewards than do cooperatives.

### Trees for People

Trees for People is a project of the American Forestry Association whose stated principal objective is to do something about the 4 million acres of private, nonindustrial forests that are poorly managed; the 75 million acres that need planting; and the 148 million acres that need cultural treatment. Leaders of the project are from other con-

[21] Vardaman, p. 62.

servation associations, landowners, forest industries, public agencies, and legislative bodies.

Other objectives, as outlined by Trees for People Chairman Kenneth B. Pomeroy, are to help meet the Nation's needs for forest products; to maintain productivity on private, nonindustrial land through conservation measures; to maximize benefits to the owners of this land; and to promote wildlife, water, recreation, esthetic, and other environmental values.

The project has developed several suggestions for achieving its objectives. Better communications with forest owners are seen as essential to the success of a management program. One way to better communications is to establish an educational program for forest owners. The estimated cost of such a project would be $5 million or $1.25 per owner.

Protection of the forest is cited as a basic necessity. There are three problems relative to this area. They are: (1) Inadequate fire protection programs, (2) lack of availability of emergency funds for disasters, and (3) difficulties in insect and disease control arising from bans on pesticides.

The project takes the position that technical assistance for forest owners on an individual basis is the most effective way to achieve better forestry practice. However, there are many owners who cannot be reached with the number of foresters available. An increase in the Cooperative Forest Management (CFM) budget would allow an increase in service foresters, but efficiency also needs to be increased. There are plans to give financial support (on a test basis) to new private consulting firms. The project supports, in principle, assistance of the soil conservation districts.

The project approves of cost-sharing as previously described as being offered through REAP (formerly ACP) to landowners in return for doing work that is in the public interest. Trees for People, however, suggests a separate forestry program with the following features: (1) programs in the public interest, (2) cost-sharing in areas in which the landowner is unlikely to undertake the project himself, (3) technical advice provided with the owner following a management plan long enough for it to be effective, and (4) cost-sharing coupled with an intensive educational effort.

The project has taken the position that loans should be made as available to forest owners as they are to owners of family-sized farms and that insurance should be available to owners of forests. The project suggests that such insurance could be provided through the Federal Crop Insurance Corporation.

Trees for People leaders feel it is desirable for ad valorem taxation to be based on present use of land, land classification, and zoning ordinances and that capital gain provisions of the Federal income tax should be retained.

Services to improve forest production are believed to be essential. Some States are providing these services at cost. Soil conservation district services could be used for forestry work more than they are now. Some forest industries provide landowner assistance.

Consolidation of holdings into cooperatives or aggregates is suggested as a possible solution to the problem of small-sized holdings. A market for forest products in the future is cited as an inducement for woodland owners to grow more and better products. Leasing has received attention from the project as an answer for those who desire an annual income but do not wish to manage the forest themselves.

These are the elements Trees for People has developed for a program to increase productivity on privately owned, nonindustrial land.

## ACTIVITIES OF INDIVIDUAL FOREST INDUSTRY FIRMS

### Background

The most effective alternative for improving nonindustrial private lands is for industry to obtain the land by purchase or through some form of long-term leasing or cutting contract. Forest industry landholdings increased from 59,547,000 acres in 1952 to 67,341,000 acres in 1970, an increase of almost 8 million acres. Prof. Z. W. White, formerly of Yale University and presently a consulting forester, conducted a study of pulp and paper company land ownership in the South in 1967 in connection with his work with the Southern Forest Resource Analysis Project. Although a great deal of his information was actually used in the final report of this project, he distributed certain other information independently. Table 6 reproduces some of his findings in this report dealing with the historical relationship between acres controlled and cords used. The Southern Forest

Resource Analysis Project estimated that 27,889,000 acres in the South would be owned by forest industry in 1970. This compared to actual forest industry ownership of 35,325,000 acres in 1970. However, nonindustrial private holdings are still four times as great in area as forest industry.[22]

Long-term leasing and cutting contracts can drastically improve the production on nonindustrial private forest land and reduce the cost of controlled supply to wood using industries. Numerous studies have shown that most small and medium-woodlands are undermanaged. Nonindustrial woodlands currently being leased or contracted to industry are being managed with approximately the same intensity as fee lands.

Absentee owners are particularly good prospects for industrial agreements, especially if contracts include provision for intensive management by industry. Most would welcome the security of a periodic income from their woodlands, coupled with the knowledge that their holdings were being properly managed and that all rights leased would eventually pass to their heirs. Recreational and mineral rights can be retained by the owner. Trusts and estates might also find advantages in leases and long-term cutting contracts.

## Forest Management Philosophy

The type of forest management practiced on industrial ownerships is dictated by a number of economic pressures. They include cash flow requirements and full utilization of growth potential. This leads to practices which can be instituted only on relatively large blocks of woodland. Conventionally all timber growing lands are put into full production at the earliest possible time after acquisition. The usual action in understocked stands is to:

1. Remove and sell any existing merchantable products;
2. Site prepare;
3. Plant with genetically improved seedlings.

### Maximizing Through Scheduling

An important technique available to the owners of large woodland acreages relates to the scheduling of forest stands for liquidation. This scheduling can be done either on the basis of maximizing financial returns or of maximizing sawtimber yields, whichever appears appropriate. So that scheduling can be done precisely, stands are mapped and inventoried according to stand conditions. Growth rate forecasts are then made on a stand basis.

Scheduling is usually based on maximization of present worth. Some of the criteria that are employed are as follows:

*Characteristics occurring singly or in groups for stands which should be cut early in the liquidation period—*

1. Those with heavy sawtimber volume and slow growth;
2. Those with a low but operable cut of merchantable products already stocked with desirable reproduction;
3. Those with low but operable cut of merchantable products in areas where regeneration costs would be significantly below average;
4. Those with slow growth and in which the unit product values will remain stable or decline.

*Characteristics occurring singly or in groups for stands which would be cut late in the liquidation period—*

1. Those combining satisfactory stocking in merchantable sizes with a high rate of growth;
2. Those with inoperable volumes that will develop operability within a reasonable period of time;
3. Those for which regeneration cost would be significantly above the average;
4. Those containing trees which will have changes in the highest and best use and hence marked increases in unit values.

### Beyond the Forest

The long-term objective is to grow timber in stands in which all timber can be removed in a single logging operation and all of the material carried to one point for basic processing. Even now logging and marketing costs using this approach are less than having separate operations to remove pine and hardwood, saw logs and pulpwood, all by different purchasers.

The removal of all merchantable products in a single operation is called the "Total Product of the Forest Concept." In order for this concept to work, a consumer must be able to purchase the total cut

[22] Zebulon W. White, private communication with author.

**TABLE 6.—Pulp Companies in the South 10-year Record: Acres Controlled Versus Cords Used**

| Year | Pulp company forests [1] (acres in thousands) | Pulp production [1] capacity (daily tons) | Owned acres per daily ton | Annual [2] cords used (in thousands) | Cords used per acre owned |
|---|---|---|---|---|---|
| 1956 | 18, 492 | 38, 332 | 483 | 20, 345 | 1. 10 |
| 1958 | 20, 386 | 44, 502 | 460 | 20, 233 | . 99 |
| 1960 | 21, 810 | 50, 313 | 434 | 23, 551 | 1. 08 |
| 1962 | 21, 889 | 52, 146 | 420 | 25, 586 | 1. 26 |
| 1964 | 23, 058 | 56, 530 | 406 | 28, 826 | 1. 25 |
| 1966 | 25, 169 | 64, 726 | 390 | 33, 061 | 1. 31 |

RATIO: CORDS OF "ROUND" PULPWOOD USE TO OWN ACRES

| Year | Pulp company forests, (acres in thousands) | Round pine (in thousands) | Cords per acre | Round hardwood (in thousands) | Cords per acre |
|---|---|---|---|---|---|
| 1966 | 25, 169 | 20, 778 | 0. 82 | 6, 522 | 0. 26 |

[1] Southern Pulpwood Conservation Association, 12 Southern States.
[2] U.S. Forest Service, includes residuals.

from any given tract of timber and direct it to one location for processing. The processing of the whole tree allows each cord of wood to be used in the manufacture of the product for which it is best suited and which will give the greatest combined value of chips, lumber, plywood, or any other wood classification. This is a course of action previously categorized as being unavailable to the small owner.

The total product concept has been put into practice by forest products firms in many different ways. The type of equipment and machinery used varies with the requirements of different locations and manufacturers. However, regardless of the system used, the goal remains the same—the best utilization of each unit of volume.

The concept begins with the harvesting of timber and the practice of tree-length logging. Here again, the methods vary but the overall objective remains the same—to bring the entire merchantable length of any tree to the processing facility. Loggers strive to cut and haul all merchantable tree lengths with a minimum amount of handling. This eliminates the costly practice of cutting, sorting, loading, and hauling saw logs and short wood by species groups.

It should be pointed out that this concept should not be confused with pulpwood operations that handle tree lengths in pulpwood and small saw log classes only. In the total product concept, all merchantable trees are handled in the same manner regardless of size, class, or quality.

After the tree length logs reach the processing facility, they must be handled smoothly and efficiently. A typical example of how this is being done is an operation consisting of two highly automated slashing rigs. The entire slasher operation is run by two men stationed at the loaders. As tree length logs reach the concentration yard, they are unloaded and separated in bulk by a log lift. Materials that are suitable only for short wood go to one storage area while those that contain saw logs go to another. The same log lift also places the tree length logs on the live log decks that supply the slashers. From the log decks, the logs move to the slashers, which are fed by hydraulic loaders. The slashing operation is automatic and consists of hydraulically operated stops and 66-inch circle saws which are set by electrical controls to cut desired lengths. One slasher is used only as a short wood slasher while the other handles material suitable for logs. The short wood from the wood slasher and the tops from the log slasher, if short enough, are carried directly to a drum debarker by means of a conveyor or returned to the wood slasher if further processing is necessary. The saw log material is picked out and transported to the sawmill storage yard by the same log lift that unloads trucks and feeds the slashers.

In order for the concept to be fully effective, all logs that contain material suitable for saw logs or veneer blocks must go through the log slasher so that they can be cut to length and separated. These separations cannot be properly made in bulk and, at best, will have to be made in small groups of logs.

Total utilization typically results in a greatly reduced raw material cost. The approach results in cheaper logging, hauling, and less handling at the mill. The use of slashers has also eliminated the need to move the short wood from trucks to storage piles and from storage piles to the mill. Further, a much greater control over the quality of materials that go into lumber production has been achieved. All materials not suited for lumber production can be diverted directly into pulpwood. At the same time, a large percentage of the high grade materials that have formerly gone into pulpwood can be recovered and used for the production of lumber.

The high speed cant machines and chip and saw headrigs now in use allow many sawmills to use high grade material in diameter classes that, until now, were too small for profitable conversion into lumber. It should be emphasized, however, that the success of this system is dependent on having all of the conversion facilities under one ownership and located conveniently with respect to the slashers. Log concentration and sorting yards depending on the re-sale of round materials have not been profitable.

## Other Methods of Timberland Control

### Background

In addition to fee simple acquisition of land by industry, an important second method of improving productivity is the acquisition of some type of control over the land through various forms of long-term agreements. This section defines the most commonly used types of agreements and presents some of the major reasons for their existence from both the landowner and the forest products company point of view.

### Lease and Purchase Agreement Mechanics

Agreements used, most of which are in the South, fall into five general types. These types and their primary philosophies are:

1. Timber purchase agreement—purchaser agrees to pay for timber according to outturn by one or more measurement units;

2. Combination timber purchase agreement and land lease—timber is bought on an outturn basis and land is leased for an annual per acre fee;

3. Timber inventory purchase plus land lease—timber existing at the time of execution of the agreement is bought and paid for and land is leased for a per acre payment;

4. Forest management agreement—purchaser assumes responsibility for forest management activities and pays for timber as it is cut. Seller reimburses purchaser for management costs; and

5. Straight timberland lease—purchaser obtains cutting rights irrespective of volume cut through annual per acre payment.

The definitions just given refer to the pure form of such agreements. When such agreements cover long periods, safeguards of various kinds for both purchaser and seller are usually added. The addition of safeguards results in a cloudy tax picture. Typical applications of the five types with their usual safeguards are shown in table 7.

### Pulp and Paper Company Motivation

Information accumulated through informal study has led to the formulation by the author of four major reasons for forest products firms to enter into long-term agreements.

Table 8 shows the relative ranking of the four categories in the opinion of the author.

### Landowner Motivation

A forest products company planning to seek out long-term agreements or one that has such agreements in effect needs to know why such agreements would appeal to landowners. Examples of motivations showing the author's opinions of their importance are shown in table 9.

### What Does It Cost To Lease

Trends in leasing and agreements can be illustrated by a tabulation of specific contracts according to companies and landowners. Such a tabulation appears in table 10.

### Tax Treatment

It is obvious that the tax treatment of proceeds from timber sales is one of the most important factors that is considered by the landowner in making his long-range plans. In this connection, it is helpful to review several decisions that have been made by Federal courts relating to long-term agreements on timberlands. Two of the most important decisions concerned the Dyal agreement with Union Camp and the Crosby agreement with St. Regis. Union Camp was probably the first pulp and paper company to enter into long-term agreements for the cutting of timber. St. Regis

**TABLE 7.—Principal Standard Forms of Timberland Leases and Timber Purchase Agreements in the South**

| Item | Timber purchase agreement (TP) | Timber purchase agreement plus land lease (TP+L) | Timber inventory purchase plus land lease (TI+L) | Forest management agreement (FMA) | Straight timberland lease (L) |
|---|---|---|---|---|---|
| Payment to landowner: | | | | | |
| Keyed to growth | Usually | Usually | | | |
| Minimum per acre per year | do | do | | | |
| Flat rate per acre per year | | | Usually | | Usually. |
| Initial or installment payment for inventory. | | | do | | |
| Supplemental flat rate per acre per year. | | Usually | | | |
| Annual payment escalated by an index. | Usually | do | Usually | | |
| Market value at time of cutting for products cut. | | | | Usually | |
| Initial bonus payment | Occasionally | Occasionally | | | |
| Costs: | | | | | |
| Overhead paid by Lessee or Purchaser | Usually | Usually | Usually | Usually | Usually. |
| Development paid by Lessee or Purchaser. | do | | do | | |
| Development paid by Landowner | | | | Usually | Usually. |
| Ad valorem tax paid by Lessee or Purchaser. | Usually | | Usually | | |
| Ad valorem tax paid by landowner | Occasionally | Usually | | Usually | Usually. |
| Limited ad valorem tax paid by Lessee or Purchaser. | do | Occasionally | Occasionally | | |
| Landowner's tax treatment: | | | | | |
| Capital gains on all proceeds | | | | Usually | |
| Capital gains to extent of initial fair market value of timber thereafter as ordinary income. | Usually | Usually | Usually | | Usually. |
| Capital gains on initial payment | | | do | | |
| Annual payments treated as ordinary income. | | | do | | |
| Supplemental payments treated as ordinary income. | | Usually | | | |
| Miscellaneous: | | | | | |
| Final inventory must equal initial inventory. | Usually | Usually | | | |
| Backlog permitted | do | do | | | |
| No restrictions on time or amount of cutting. | | | Usually | | Usually. |
| Cutting based on "good forestry" | | | | Usually | |
| Lessee's or purchaser's tax treatment: | | | | | |
| Initial payments | Capitalized | Capitalized | Capitalized | | Capitalized. |
| Annual payments | Expensed | Expensed | Expensed | | Expensed. |
| Development costs | Capitalized | Capitalized | Capitalized | | Capitalized. |
| Operating costs | Expensed | Expensed | Expensed | Expensed | Expensed. |
| Stumpage payments | | | | do | |

**TABLE 8.—Company Motivation**

| Class | Motivation | Order of impor-tance[1] |
|---|---|---|
| I | The rate of return on investment from the use of fee land solely for timber-growing operations is low. Timber purchase agreements generally reduce the amount of capital investment without significantly reducing net cash flow. Therefore, the use of long-term agreements is a vastly more efficient use of capital. | 4 |
| II | There is no objection to the purchase of forest lands per se, but there just aren't enough capital funds available to cover mill construction and expansion and to buy lands at their current prices. | 2 |
| III | Some landowners are unwilling or unable for legal reasons to sell their lands outright. Long-term agreements are negotiated with these owners because this is the only way to acquire control of important lands. | 1 |
| IV | As a rule, long-term agreements contain options or the right of refusal at some time in the future, usually 15, 20, 25 years, or longer. These options are often at highly favorable prices and also may be the only way to obtain ultimate fee simple ownership. | 3 |

[1] 1=most important; 4=Least important.

**TABLE 9.—Landowner Motivation**

| Class | Motivation | Order of impor-tance[1] |
|---|---|---|
| I | In the long run the return from leases or agreements provides a reasonable return on investment. This rate of return will generally move with changing prices and values and the owners are relieved of management responsibilities. | 1 |
| II | Timberland is a good long-range inflation hedge and a long-term lease or agreement is a good way to get some cash out of a timberland holding while waiting for a dramatic increase in value. | 2 |
| III | The ownership of timberland meets an emotional need. A long-term agreement enables the owner to avoid selling the land. The proceeds from the agreement while admittedly low help to salve the financial conscience of the owners. | 3 |
| IV | The tax impact of selling a large tract of land is so great that the owner elects to accept a lower return as an alternative. | 5 |
| V | A long-term timberland agreement is really an indirect way of setting up a "spendthrift trust". | 4 |
| VI | Legal factors make it impossible to sell the land and a long-term agreement avoids differences among fractional owners while providing a net return. | 6 |

[1] 1=most important; 6=least important.

began making such agreements soon after Union Camp and probably has a greater acreage under such agreements than any other single firm. The Dyal decision was heavily dependent on a prior Federal court decision involving the Lawton lands which were under lease to Union Camp. The major impact of these decisions is that proceeds from such leases must be treated as ordinary income early in the lease term.

## Long-Term Agreements in Summary

The material summarized in this section indicates that a decision by a forest products firm to lease timberland arises from expediency rather than as a result of a financial decision making process. This conclusion is supported by the failure of the companies to make formal forecasts of the expected future behavior of stumpage and delivered wood prices or, if they do, they do not make them available to those staff members who are negotiating leases or long-term agreements.

Invariably both woodlands managers and financial managers consider that the purchase of forest land in fee simple is a better investment than leasing or long-term timber purchase agreements. Further, companies resort to leasing only because control of a desirable tract can be obtained in no other way or because there is insufficient cash to buy on a fee simple basis.

Among firms using a price escalation device in their leases or agreements, the Wholesale Commodities Index is heavily preferred. Still there has been no attempt to compare either the past or future performance of this index with the actual or projected behavior of wood prices.

Although there have been no formal studies, the companies that have used leases or agreements appear to believe that stumpage so generated will cost less than comparable open market stumpage.

Experience has shown that in many cases leases and agreements lead to fee ownership. For example, a leasing pioneer has had a total of 300,000 acres under lease for one mill and has purchased, or exercised options to purchase, 100,000 acres of that total.

**TABLE 10.—Some Examples of Long-term Agreements or Leases in the Southeast**

| Owner | | Lessee or timber purchaser | | Acreage | Location | Initital year | Intial annual return to landowner per acre | Lump sum per acre |
|---|---|---|---|---|---|---|---|---|
| Number | Incentive class | Number | Incentive class | | | | | |
| 1 | I | 1 | III | 23, 255 | Clinch & Ware Cos., Ga. | 1946 | $0. 75 | |
| 2 | IV | 2 | III | 15, 966. 57 | Columbia & Union Cos., Fla. | 1948 | 2. 75 | |
| 3 | I | 1 | III | 2, 747. 64 | Ware Co. Ga. | 1952 | 2. 00 | $30. 00 |
| 4 | I | 3 | III | 4, 518. 75 | Florida | 1952 | 1. 24 | |
| 5 | I | 4 | I | 1, 551 | Ware Co., Ga. | 1952 | 1. 75 | |
| 6 | I | 3 | III | 7, 270 | Escambia Co. Fla. | 1955 | 3. 30 | |
| 7 | I | 5 | III | 19, 514 | Walker Co. Ala. | 1956 | 1. 25 | |
| 8 | I | 1 | III | 5, 406 | South Carolina | 1956 | 3. 50 | |
| 9 | I | 1 | III | 1, 354 | do | 1956 | 3. 50 | |
| 10 | I | 6 | I | 61, 694 | West Louisiana | 1957 | 1. 10[1] | |
| 11 | I | 1 | III | 2, 639 | Georgia | 1957 | 3. 17 | |
| 12 | I | 7 | I | 3, 200 | Gilchrist Co. Fla. | 1958 | 1. 25 | 72. 82 |
| 13 | I | 8 | I | 3, 970 | Florida and Georgia | 1960 | 3. 22 | |
| 14 | I | 3 | III | 111, 259 | Mississippi | 1960 | 1. 98 | 1. 48 |
| 15 | I | 3 | III | 27, 349 | do | 1960 | 2. 00 | |
| 16 | VI | 9 | III | 8, 200 | Hale & Surrounding, Ala. | 1966 | | |
| 17 | I, V | 8 | III | 4, 200 | Barbour, Ala. | 1966 | 6. 00 | |
| 18 | III | 10 | III | 855 | Marengo, Ala. | 1966 | 4. 21 | |
| 19 | III | 10 | III | 163 | Wilcox, Ala. | 1966 | 4. 01 | |
| 20 | VI | 8 | III | 1, 002 | Barbour, Ala. | 1967 | 4. 63 | |
| 21 | II | 8 | III | 269[3] | Walton, Fla. | 1967 | 6. 16[2] | |
| 22 | I | 8 | III | 1, 340[3] | Jackson Co. Fla. | 1967 | 2. 00[4] | |
| 23 | III | 10 | III | 1, 595 | Choctaw, Ala. | 1967 | 6. 50 | |
| 11 | I | 11 | III | 10, 000 | East Tennessee | 1968 | 2. 50 | |
| 24 | III | 10 | III | 1, 200 | Dallas, Ala. | 1968 | 7. 00 | |
| 25 | III | 10 | III | 1, 084 | Autauga, Ala. | 1968 | 4. 58 | 71. 91 |
| 26 | III | 10 | III | 440 | Choctaw, Ala. | 1968 | 6. 75 | 68. 18 |
| 27 | III | 10 | III | 1, 627 | Wayne, Miss. | 1968 | 6. 00 | |
| 28 | III | 12 | II | 103, 000 | Alabama | 1968 | 3. 00 | |

[1] Plus $4 cord inventory.
[2] Guaranteed overcut $6.50 per cord escalated.
[3] Plantation.
[4] No overcut.

Even though there has been very little sophistication in the decision making involved in leasing and purchase agreements, it should be basically a financial decision. Some of the major questions that need answering are:

1. How does leasing or purchase agreement activity affect the fair market value of fee simple title?

2. How can the total cost of the acquisition of land through the leasing route be forecast?

3. How can stumpage costs of wood from the open market, fee simple holdings, and leases or purchase agreements be compared?

These questions must also be considered in the formulation of any plan for improving the production performance of nonindustrial woodlands.

## NONINDUSTRIAL FOREST MANAGEMENT DISINCENTIVES

### Classification

Forest management disincentives can be placed in two categories. General disincentives apply to all forest land. Others apply only to nonindustrial forest land. Low rates of returns on market values apply to all owners equally. Those that apply only to nonindustrial lands relate to tract size and to the characteristics of the owners themselves.

Some of the most important disincentives are high ad valorem taxes, increasing land prices, and low returns from productivity improvements.

The difference between making money or losing money from timberland investments is frequently know-how. Nonindustrial woodland owners need to know the value of their land and how it may be affected by future real estate activities. They also need to know the value of their timber and its probable future rate of growth.

High ad valorem taxes can be one of the biggest deterrents to investing money in improving the productivity of timberlands. For this reason, ad valorem taxation, the economics of woodland ownership, and return from productivity improvements will be discussed in detail.

### Ad Valorem Taxation

The ad valorem tax is a tax assessed on ownership of property and varies with the value of that property. Most States constitutions require that ad valorem taxes be levied in exact proportion to value. Usually ad valorem taxes are based on the fair market value of the property being assessed or some percentage of fair market value. A widely used definition of fair market value is as follows:

> * * * Fair market value is the amount that would in all probability have been arrived at between an owner willing to sell and a purchaser willing to buy, and in ascertaining that figure, there should be taken into account all considerations that fairly might be brought forward and reasonably given weight in such bargaining.[23]

There are three approaches commonly used in reaching an estimate of fair market value. These approaches are cost, market data, and income. In the cost approach, two components of value are recognized—the site value and the depreciated value of any improvements. For forest land this becomes the value of the timber plus the value of the land. In the market data approach, the value estimate is based on prices paid for similar property on the open market. In the income approach, an indication of value is obtained by capitalizing a net income stream.

Once the fair market value has been established, the value is multiplied by the assessment ratio, or the percentage of the value of the property upon which the property tax is levied. In Florida, for example, the law says 100 percent. In Alabama, the law says 60 percent, but in actual practice the figure is much less. The product of the valuation and the assessment ratio is the assessment. The assessment is multiplied by the millage, a rate giving the number of mills of tax per $1 of assessed value; the product of these is the amount of tax on a piece of property.

The problem with ad valorem taxes is that they are going up. Property tax revenue since 1966 has risen 60 percent.[24] This rise in ad valorem taxes can be attributed to two factors—the first being an increase in the price of real estate and the second, an increase in the millage being applied to assessed values.

In the 1930's an official committee was established to study the ad valorem tax problem. The forest taxation inquiry recorded its findings and recommendations in a report called the Fairchild report. Although this study was made some 40 years ago, its findings and recommendations are still used today to explain the problems of ad valorem taxation.

The first finding of the Fairchild report was related to the heavy tax burden caused by the high cost of local government. Because of the increasing demand for local services and the increasing cost of these services, ad valorem taxes would go up even if there were no population increases. But, the situation is being aggravated by the shifting of population in two directions. The first population shift is from rural to urban. With more people moving from rural areas to urban areas, rural counties have a decreasing tax base, and the tax rate is raised to finance local government services for the remaining population. The second population shift is from urban to surburban. Urban residents, attracted by rural settings, buy lots and move to the country. Other residents follow, and soon taxes rise so that schools, roads, sewage, and other services can be provided. Tax assessors note the high prices paid for homesites and raise their assessments on land. Revenues from timber sales flowing to farmers and other forest owners are severely cut or wiped out by the increased taxes. The land is sold to subdividers and speculators and lies idle until it is used.

The second finding of the Fairchild report concerned faulty administration and nonuniformity of the property tax. Tax assessors tend to discriminate for or against particular landowners or classes of property. In most instances where States have removed this bias, forest owners have found themselves worse off than before.

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[23] *Karlson* v. *United States* (82F. (2d) 330, 337 8th Circuit Court of Appeals).

[24] "State, Local Tax Loads: Why No Relief in Sight," U.S. News & World Reports, June 7, 1971, pp. 59–61.

The third finding is that:

Annual property taxes are a carrying charge that accumulates over time; the amount increases through the accrual of current interest or by the owner's opportunity rate of interest. The net effect is inducement of premature cutting and shortening of the rotation.[25]

A charge made by forest landowners against the ad valorem tax is that income from land may be deferred for many years while the ad valorem taxes must be paid every year. These complaints have resulted in the development of special methods of taxing forest property other than the ad valorem tax. These methods include exemption or rebate laws, modified property tax laws, and yield tax laws. Table 11 presents a classification of forest tax laws by State and type of law.

Exemption laws remove forest land and timber, or the timber alone, from ad valorem tax rolls for a period of years or, in some cases, indefinitely. Forest owners may need to comply with certain forest management requirements to qualify for a tax exemption. With respect to timber, the exemption may apply to all standing timber or it may apply to only immature timber, planted trees, trees of a particular species, or trees planted for a particular purpose such as windbreaks.

Rebate laws permit the landowner to apply for abatement of taxes levied. Small cash payments or reductions in other property taxes are usually provided by rebate laws as incentives for forest land owners.

Modified ad valorem tax laws are classified into three types:

1. The modified type may provide a fixed assessment or it may provide for forest land to be assessed at its value for growing timber and not at a higher value for some other use to which it may be adapted.

2. The modified rate type tax provides for a tax rate that differs from the millage rate applied to other real property.

3. The deferred payment type tax postpones a portion of the ad valorem tax each year until the timber is harvested.

The purpose of the yield tax is to delay payment of the property taxes on timber until the timber is harvested. Yield taxes are paid in lieu of ad valorem taxes. The forest land itself remains under the ad valorem tax.

[25] Leon A. Hargreaves and Richard W. Jones, "Forest Property Taxation," Georgia Forest Research Council Report No. 29, May 1972, p. 9.

The revenue tax, like the yield tax, is imposed when the timber is harvested. The purpose of the severance tax is to obtain additional revenue. Therefore, the severance tax is imposed in addition to the ad valorem tax.

## Ad Valorem Taxation as a Disincentive

Assessed values for forest land in recent years have tended to lag behind market values. However, the failure of net income attributable to land to keep pace with selling prices is resulting in an increased proportion of gross timber income being devoted to ad valorem taxes. With an increased portion of timber income being devoted to the ad valorem tax, private forest owners incentives to grow timber are greatly reduced. Therefore, the level of ad valorem taxes is inversely related to timber production on nonindustrial private lands.

Table 12 compares the deduced harvest per acre for 1970 by product and value for the South, North, Rocky Mountains, and Pacific Coast regions of the United States. A typical ad valorem tax is shown for each of the regions.

In the table, removals were divided into two divisions—pulpwood and sawtimber. These two divisions are further subdivided into softwood pulpwood, hardwood pulpwood, softwood sawtimber, and hardwood sawtimber. Each subdivision is further divided into cords or board feet per acre harvested, unit price, and value per acre.

The number of broad feet per acre of hardwood and softwood sawtimber that was harvested in 1970 was taken from the "Other Private" figures from "Forest Statistics for the United States, by State and Region, 1970"[26]. These figures were entered into their respective columns and then changed to units of cubic feet by using the conversion factor of 150 cubic feet/M fbm. The softwood and hardwood sawtimber figures in cubic feet were subtracted from the softwood and hardwood pulpwood removal figures for 1970.

The removal figures by product and species were multiplied by a unit price to give a value per acre for each product removed. Unit price figures were adapted from "The Demand and Price Situation for Forest Products—1970–1971",[27] by Dwight Hair and Alice H. Ulrich. Value per acre

[26] Forest Service, "1970 Forest Statistics."

[27] Dwight Hair and Alice H. Ulrich, "The Demand and Price Situation for Forest Products, 1970–71," U.S. Department of Agriculture, Forest Service, Miscellaneous publication No. 1195, May 1971, p. 40.

**TABLE 11.—A Digest of Forest Tax Laws by State and Type of Law—June 5, 1972**

| State | Exemption or rebate | Modified property tax | | | Yield tax | Total |
|---|---|---|---|---|---|---|
| | | Modified assessment | Modified rate | Deferred payment | | |
| Alabama | × | | | | × | 2 |
| Arkansas | | × | | | | 1 |
| California | × | × | | | | 2 |
| Colorado | × | | | | | 1 |
| Connecticut | | × | | | × | 2 |
| Delaware | × | × | | | | 2 |
| Florida | | × | | | | 1 |
| Hawaii | × | × | | | × | 3 |
| Idaho | × | | | | × | 2 |
| Indiana | | × | | | | 1 |
| Iowa | × | × | | | | 2 |
| Kansas | × | | | | | 1 |
| Louisiana | | | | | ×× | 2 |
| Maine | × | ×× | | | | 3 |
| Maryland | | × | | | | 1 |
| Massachusetts | | | | | × | 1 |
| Michigan | | | | | ×× | 2 |
| Minnesota | | | × | | × | 2 |
| Mississippi | | | | | × | 1 |
| Missouri | | | | | × | 1 |
| New Hampshire | × | | | | × | 2 |
| New Jersey | × | × | | | | 2 |
| New Mexico | | × | | | | 1 |
| New York | | | | | × | 1 |
| North Carolina | × | | | | | 1 |
| North Dakota | | | × | | | 1 |
| Ohio | | | × | | | 1 |
| Oregon | | ×× | | | ×× | 4 |
| Pennsylvania | | × | | | | 1 |
| Rhode Island | × | × | | | | 2 |
| Virginia | | × | | | | 1 |
| Washington | | × | | × | × | 3 |
| Wisconsin | | | × | | × | 2 |
| Total | 13 | 19 | 4 | 1 | 18 | 55 |

figures for the four species and product groups were added to get a total value per acre of all products removed. This process was repeated for each of the four regions and a total value per acre of removed products was obtained for each region.

The typical ad valorem tax per acre is a weighted average based on acres of nonindustrial timberland and typical ad valorem tax rates for states within regions. A comparison of these weighted per acre rates with the total value per acre of removed products indicates the percentage of timber income being taken by the ad valorem tax.

Considerable work in the formulation of a set of standards for the ad valorem taxation of forest lands has been done by Dr. Leon A. Hargreaves of the University of Georgia School of Forestry in cooperation with the Georgia Forest Research Council. This work resulted in nine criteria which were published in "The Property Tax on Forest Lands in Georgia," Georgia Forest Research Council Report No. 12. Six of these standards, somewhat modified, are as follows:

1. The rate of taxation on an acre of forest land should be a reasonable percentage of the cash income produced by that acre;

2. Forest taxes should provide counties with relatively stable flows of revenue;

3. Forest taxation policy should be consistent in order to permit the long-range planning that is so vital to effective management;

TABLE 12.—Deduced Harvest Per Acre for 1970 by Product and Value

| Region | Nonindustrial forest acreage (thousand acres) | Pulpwood | | | | | |
|---|---|---|---|---|---|---|---|
| | | Softwood | | | Hardwood | | |
| | | Cords per acre harvested | Unit price | Value per acre | Cords per acre harvested | Unit price | Value per acre |
| South | 139, 937 | 0. 120 | $6. 00 | $0. 72 | 0. 093 | $3 | $0. 28 |
| North | 128, 426 | . 013 | 4. 50 | . 06 | . 053 | 2 | . 11 |
| Rocky Mountain | 12, 429 | . 027 | 4. 50 | . 12 | 0 | 2 | 0 |
| Pacific Coast | 15, 440 | . 067 | 6. 00 | . 40 | . 013 | 3 | . 04 |

| Region | Sawtimber | | | | | | Total value per acre products removed | Typical ad valorem tax per acre | Percent taken by tax |
|---|---|---|---|---|---|---|---|---|---|
| | Softwood | | | Hardwood | | | | | |
| | Board feet per acre harvested | Unit price | Value per acre | Board feet per acre harvested | Unit price | Value per acre | | | |
| South | 71 | $0. 045 | $3. 19 | 45 | $0. 026 | $1. 17 | $5. 36 | $0. 74 | 14 |
| North | 10 | . 028 | . 28 | 45 | . 026 | 1. 17 | 1. 62 | 1. 09 | 67 |
| Rocky Mountain | 43 | . 039 | 1. 68 | 0 | . 025 | 0 | 1. 80 | . 57 | 32 |
| Pacific Coast | 178 | . 071 | 12. 64 | 7 | . 025 | . 17 | 13. 25 | 1. 38 | 10 |

4. Forest taxes should be responsive to sustained economic trends;

5. Forest taxes should encourage the most efficient use of our forest land resources; and

6. The taxation of forest property should be a simple procedure.[28]

## The Economics of Woodland Ownership

Certain economic factors are common to all classes of private woodland ownership. Two trends have been common to almost all classes of real estate in recent years. Land prices have been increasing and net income from the land itself has been declining. The extent of the price increase is vividly illustrated for agricultural land by figure 3, a reproduction of a 1969 cover of Farm Real Estate Market Developments, a publication of the Economic Research Service of the U.S. Department of Agriculture.

One of the big reasons that farm and forest land is increasing in price is that pressure for other uses such as sites for industrial plants is spilling over from urban areas. This is borne out by an article by Norman Sklarewitz in the November 29, 1969, issue of Wall Street Journal. This article in part reads as follows:

> * * * the corporate land rush is on all across the country. Many companies are buying land for immediate expansion of factories, even though signs of a business slowdown are cropping up. Others are buying with an eye toward future construction or expansion, perhaps as distant as 10 years from now. But a surprising number of companies are buying huge plots of land merely for speculation.
>
> The results: Prices are soaring, and available plots are becoming scarce in some parts of the nation.[29]

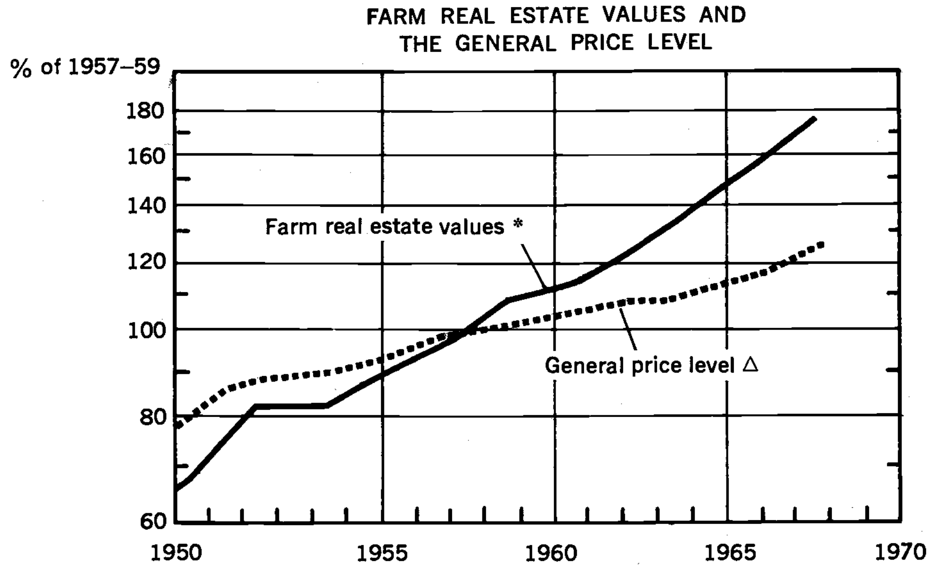
In land acquisitions by the forest products industry or by other classes of owners, the value of merchantable timber on a purchased tract was often equal to or more than the total cost, hence little or no capital was invested in the land itself. This was also true of individuals acquiring their lands by gift or inheritance. In contrast to that situation, current purchases often result in $50 to $150 per acre being permanently undepletable as the value of the bare land. This type of economic pressure is obvious with respect to new tracts but is often overlooked as it affects lands purchased or inherited many years ago. Even though land is on the books for a nominal figure, if it is in fact worth 50 to 100 times its book value, it still should provide a reasonable return on its true value.

Additional economic pressure is exerted by land use changes. Many tracts that were useful for timber growing and nothing else are now suited for drastically higher and better uses. Bare land values of $50 and $150 make it difficult to maintain a satisfactory rate of return. If land is worth $1,000 or

28 Hargreaves, Leon A., Jr., et al., "The Property Tax on Forest Lands in Georgia," Georgia Forest Research Council Report No. 12 (Macon: G.F.R.C., 1965).

29 Norman Sklarewitz, Wall Street Journal (Nov. 29, 1969).

FIGURE 3.—Farm Real Estate Trends 1950–1968




* Index of Farmland and Building Value per Acre.

△ Index of General Price Level, 1950—100.

U.S. farmland values have climbed 175 percent since 1950, averaging 5.4 percent per year compounded annually. The increase in the general price level (gross national product deflator) averaged 2.2 percent per year. Thus, the real average increase in farmland values was 3.2 percent per year.

Source: Economic Research Service U.S. Department of Agriculture

more per acre for farm, residential, or recreational use, a decent return from timber growing is impossible.

## Return From Productivity Improvements

The prices at which forest lands sell in the open market are not set by the return that can be obtained from the practice of intensive forest management. Prices are closely related to the actions of investors, speculators, and developers. Practically all of these categories regard appreciation in value as a major incentive to the purchase of forest land. In most cases, maximizing discounted cash flow points to a do-nothing policy with respect to timber growing. If industry had no stake in maintaining a favorable inventory of standing timber, it would also maximize on the basis of appreciation in sales price for the land.

The calculation of a rate of return for natural stands is extremely difficult because of the number of variables that must be considered. For this reason, in analyzing rate of return for forest operations, it is necessary to start with land from which the timber has recently been removed and a new cycle or rotation begun. The maximization of rate of return from the growing of timber means the use of an even-aged rotation and single species silviculture on most of the lands in the United States. Space does not permit the analysis of intensive operations for all of the major species in this country. Instead, one species from each region has been selected to illustrate the ranges of rate of return. These species are for the North—jack pine, for the South—loblolly pine, for the Rocky Mountains—western white pine, for the Pacific Coast—Douglas-fir. Table 13 shows the assumptions that must be made in order to forecast cost and revenues from growing timber as well as yields for the species just mentioned. Table 14 compares expected yields from both thinnings and harvest by various rotations for the four species. Figure 4 shows a form designed to calculate the present worth of an acre of land to be used for the growing of timber



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under the assumptions presented in the last two tables. A number of present worth figures based on discounted cash flow using several assumptions from each species have been calculated by computer and are shown in the appendix. The results of these calculations are tabulated in table 15. This table shows that an extremely low interest rate is required if the present worth is equated to the retail land price for forest land in the region. On the other hand, this table can also be used to approximate the internal rate of return from site preparation and planting, using the four species. It is probable that the internal rate of return is the proper yardstick for forest industry to use in selecting its forest management policy on land that it already owns. It is also obvious that industry would not buy any more forest land if rate of return based on cash flow were the only consideration in making the decision. However, the internal rate of return offered by site preparation and planting is competitive with other uses of capital. What is suggested is that if industry were relieved of the capital cost of owning land, considerably more forest development work might be done.

**TABLE 13.—Assumptions Used to Forecast Costs and Revenues**

| Item number and description | North | South | Rocky Mountain | Pacific Coast |
|---|---|---|---|---|
| 1. Length of rotation | 60 yr | 30 yr | 60 yr | 45 yr. |
| 2. Interest rate | Variable | Variable | Variable | Variable. |
| 3. Annual operating cost | $2 per acre | $2 per acre | $2 per acre | $2 per acre. |
| 4. Product prices: | | | | |
| Sawtimber | $39 | $60 | $28 | $71. |
| Pulpwood: | | | | |
| Harvest | $4.50 | $8 | $4.50 | $6. |
| Thinnings | $4 | $7 | $4 | $5. |
| 5. Utilization standards: | | | | |
| Sawtimber | 9.0 in. d.b.h. and up, top not less than 6 in. | Over 11.0 in. d.b.h. | 12.6 in. d.b.h. and up. | 12 in. d.b.h. and up. |
| Pulpwood | 5.0 in. d.b.h. to 9.0 in. d.b.h. to a 3 in. top dib. | 6.6 in. to 11.0 in. d.b.h.[1] | 0.6 in. to 12.6 in. d.b.h.[1] | 1.5 in. to 12.0 in. d.b.h. |
| 6. Future site preparation and planting. | $50 | $31 | $68 | $68. |
| 7. Species to be grown | Jack pine | Loblolly pine | Western white pine. | Douglas-fir. |
| 8. Tax policy | Ordinary taxes at 30 percent, capital gains at 50 percent | | | |
| 9. Site index | 55 | 80 | 60 | 160. |
| 10. Initial site preparation and planting. | $66 | $41 | $90 | $90. |

[1] Yield tables used include small amount of nonmerchantable material below usable sizes.

## The Economy of Scale

If industry cannot afford to practice intensive forestry, then the private nonindustrial owner is in a much poorer position.

As previously suggested in the quotation from Worrell, the nonindustrial woodland owner has suffered because his operation isn't large enough. This affects, for example, the cost of harvesting. Any time that an area has to be harvested, the equipment must be moved in, additional roads are put in place, and finally, the equipment must be moved out. Unless the amount of timber to be removed is sufficiently large, such fixed costs will make the operation uneconomic.

Site preparation and planting costs are even more sensitive to the size of the area that is to be treated. The equipment necessary to do such work is much larger than in the case of logging. Further, rehabilitation expenses are more closely related to such things as the distance that a piece of equipment can travel without making a turn. Again costs on a small tract are disproportionate to those for a larger tract.

For the nonindustrial owner, the situation is complicated by the fact that he cannot have his

**TABLE 14.—Comparison of Yields of Major Species**

| Age | Cords per acre | Board feet international per acre | |
|---|---|---|---|
| Yields per acre, fully stocked stands, western white pine, good site, site index 60 | | | |
| 20 | [1] 5.33 | [2] 0 | Typical stumpage price pulpwood, $4.50 per cord. |
| 40 | [1] 35.33 | [2] 0 | Do. |
| 60 | [1] 68.40 | [2] 5,000 | Typical stumpage price sawtimber, $28 per M fbm. |
| Yields per acre, fully stocked stands, loblolly, site index 80 | | | |
| 20 | [3] 19.5 | [4] 600 | Typical stumpage price pulpwood, $8 per cord. |
| 30 | [3] 20.3 | [4] 5,600 | Do. |
| 40 | [3] 14.0 | [4] 12,100 | Do. |
| 50 | [3] 8.9 | [4] 17,200 | Typical stumpage price sawtimber, $60 per M fbm. |
| 60 | [3] 6.3 | [4] 21,500 | Do. |
| Yields per acre, fully stocked stands, jack-pine, medium site, site index 53 | | | |
| 20 | [5] 7.93 | [6] 0 | Typical stumpage price pulpwood, $4.50 per cord. |
| 30 | [5] 15.37 | [6] 650 | Do. |
| 40 | [5] 20.60 | [6] 1,500 | Do. |
| 50 | [5] 23.17 | [6] 2,650 | Typical stumpage price sawtimber, $39 per M fbm. |
| 60 | [5] 23.57 | [6] 3,750 | Do. |
| Yields per acre, fully stocked stands, Douglas-fir, site class II, site index 160 | | | |
| 20 | [7] 19.87 | [8] 0 | Typical stumpage price pulpwood, $6 per cord. |
| 30 | [7] 45.20 | [8] 2,300 | Do. |
| 40 | [7] 52.13 | [8] 14,300 | Do. |
| 50 | [7] 41.33 | [8] 33,900 | Typical stumpage price sawtimber, $71 per M fbm. |
| 60 | [7] 26.67 | [8] 55,000 | Do. |

[1] Volume of trees between 0.6-in and 12.6-in d.b.h.
[2] Volume of trees 12.6-in d.b.h. and above.
[3] Volume of trees between 6.6-in to 11.0-in d.b.h.
[4] Volume of trees over 11.0-in d.b.h.
[5] Volume, inside bark, of trees between 5.0-in to 9.0-in d.b.h. to a 3-in top dib.
[6] Volume of trees 9.0-in d.b.h. and larger, to a variable top dib, not less than 6 in.
[7] Volume of trees between 1.5-in to 12.0-in d.b.h.
[8] Volume of trees 12.0-in d.b.h. and up.

own force to do logging, site preparation and planting. Worrell's comments on the situation are:

Even the small owner who is aware that his timberland is an economic asset and who is interested in doing something with it faces some serious handicaps. The first of these is lack of technical knowledge about timber growing. Few small owners have had any education or experience in managing forests. They do not know what cultural practices should be applied and even if told what is needed they do not know the techniques to follow. The practice of silviculture is based on a knowledge of ecology, tree physiology, and soils and is not learned by reading a leaflet or attending a demonstration. But the small owner would not need to be a silviculturist himself if he had the direct advice and assistance of one. Such advice is available today from consulting foresters, extension foresters, state service foresters, and others. Many owners are availing themselves of this advice and assistance and some are learning a little forestry themselves through extension programs and vocational-agriculture courses. Progress is being made in overcoming the small owner's lack of knowledge. But he will continue to be handicapped by the fact that he is not a forester himself and too small an operator to have one as a full-time employee.[30]

**TABLE 15.—Summary of Present Worth Calculations**

| Species | Length of rotation at maximum present worth | Present worth at 4 percent at maximum value | Approximate internal rate of return percent at maximum present worth rotation |
|---|---|---|---|
| Jack-Pine | 45 | −60 | 1+ |
| Loblolly Pine | 40 | 134 | 7+ |
| Western White Pine | 60+ | −54 | 2+ |
| Douglas-fir | 55 | 283 | 6+ |

## INDUSTRY-NONINDUSTRIAL CONFLICTS

### Background

Maintenance of adequate timber supplies is not only an important national goal, but it is also vital to the profitability of the forest products industry. Raw material costs are typically 30 to 40 percent of the total costs of first-stage manufacturing. Stumpage costs in the South and the Pacific coast have recently reached as much as 75 percent of delivered log costs. Thus, stumpage prices strongly influence profits and the ultimate cost to the consumer of manufactured forest products.

Early industry land purchases were made to obtain a backlog of timber. The value of the merchantable timber on many of these purchases was equal to, or more than, the total price involved. As intensive forestry measures came to be adopted by industry and standing timber inventories began to increase, it became apparent that a con-

[30] Worrell, p. 409.

FIGURE 4.—COMPUTATION OF PRESENT WORTH OF LAND AND NONMERCHANTABLE STOCKING PER ACRE AT BEGINNING OF FIRST FULL ROTATION

BASIC DATA

Site Index (A) ________ Rotation (B) ________ Interest Rate (C) ________% Annual Operating Cost per acre (D) $________

Pulpwood Price per Cord Not Thinnings (E) $________ Harvest (F) $________

Sawtimber price per thousand scribner (G) $________
Minimum ST dbh ☐ 12.5″ ☐ 11.0″

Initial Recoverable Cost Cap. (H) $________
Exp. (I) $________

Fut. recur. cap. site prep. and plt. cost (J) $________

Book value of bare land per acre (K) ________
Specimen (L)________

PRESENT WORTH OF INCOME

| | | |
|---|---|---|
| Harvest | | |
| Periodic factor ________ × value at harvest factor ________ = | $ | 1 |
| Present worth of thinnings | | 2 |
| Total present worth of income | | 3 |

PRESENT WORTH OF EXPENSE

| | | | | |
|---|---|---|---|---|
| Initial site preparation and planting (capitalized) (H) ________ × 100% = | | | $ | 4 |
| Initial site preparation and planting (expensed) (I) ________ × 47.2% = | | | | 5 |
| Future recurring site preparation and planting (1) ________ × periodic factor ________ = | | | | 6 |
| Operating cost 47.2% × capitalized annual expense factor ________ = | | | | 7 |
| | | | | 8 |
| Book value (K) | | | | 9 |
| Taxes (capital gain) Total present worth of income (line 3) ________ × 25% = | | $ | | 10 |
| credits 25% [PW of $1 ______ × Line 4 ______ = ______] | $ | | | 11 |
| 25% [PW of $1 ______ × Line 6 ______ = ______] | | | | 12 |
| Subtotal (line 11 plus line 12) | | (        ) | | 13 |
| Net taxes (line 10 less line 13) | | | | 14 |
| Total present worth of expense (sum of lines 4, 5, 6, 7, 8, 9, and 14) | | | (        ) | 15 |
| Total unadjusted PW of nonmerch. growing stock per acre (line 3 less line 15) | | | | 16 |
| PW of transportation adjustment per acre | | | | 17 |
| Adjustment for depletion tax adv. 25% [PW of $1 ______ × line 16 ______ = ______] | | | | 18 |
| Book value of bare land per acre (K) | | | | 19 |
| Total present worth of land and non-merch. stocking per acre (sum of lines 16, 17, 18, and 19) | | | | 20 |

trolled supply of wood also exerted a price-dampening effect. This effect is related to the high multiple that the inventory of standing, and generally usable, timber is of annual consumption. The decision of a private landowner to sell a particular block of timber this year or next year is usually based on short-term considerations. As a tract approaches optimum harvest age, regardless of the criteria used for establishing this age, the marginal return derived from the growth of another year diminishes. Thus, a price increase can easily exceed the marginal return from growth. In a situation where the inventory is adequate to support long-range demand, price elasticity with respect to stumpage is the result. If the supply with respect to long-range demand is short, then stumpage price inelasticity results. The latter effect has been vividly demonstrated in the South and West as a result of recent demands for stumpage suitable for sawtimber and plywood.

The level of stumpage prices, in turn, determines whether or not investments in the growing of timber yield an adequate rate of return. If all forest land were producing at a rate consistent with its potential, and the existing demand prevailed it is obvious that there would be price elasticity, and that the rate of return would be unsatisfactory. The inescapable conclusion is that there is a strong basic conflict between the national goal (and industry's as well) to increase the supply of timber and the timberland owner's desire to achieve a fair rate of return.

Similar problems occur with those forest products firms having woodlands as profit centers. If the objective of woodland ownership is recognized for what it is—a means of depressing stumpage prices—it becomes apparent that woodlands operations must show an unsatisfactory rate of return if the other centers are to operate at a profit. Thus, the more successfully the overall objective is achieved, the poorer the performance as a profit center becomes.

### Implications With Respect to Nonindustrial Holdings

The primary purpose of the discussion in this section was to present in greater detail some of the reasons why maximum production of timber cannot be achieved on nonindustrial holdings. These reasons may be summarized as follows:

1. Forest lands located near urban centers, on main highways, or which are suited for recreational use will develop increasingly higher values, thus making it uneconomic, and the owners unwilling, to use such lands for timber growing. Any program encouraging the practice of forestry on these lands would simply result in more volume becoming unavailable for manufacture, hence from a forestry standpoint the investment would be lost.

2. The harvesting of pulpwood or sawtimber using conventional short wood procedures will become increasingly uneconomic because of both high wage rates and the unavailability of labor willing to do this type of work. Such a trend increases the size of the marginal harvesting area, thus eliminating a greater acreage of nonindustrial forest land.

3. The scarcity of labor will force the adoption of mechanization in harvesting. Mechanized wood harvesting in turn will be feasible only in those stands containing large volumes per acre in adequate concentrations. Many nonindustrial ownerships thus could not support mechanized operations.

4. Changing conditions will soon make partially stocked woodlands economically marginal for harvesting, a condition which will inhibit the institution of improved practices by nonindustrial owners.

This points to several trends with respect to industry ownership of woodlands. The higher and better use lands will be separated from timber-growing activities. This may be accomplished either by direct sale or by transfer to a real estate development department or subsidiary, a course of action that has already been taken by several pulp and paper firms.

Although this trend is definitely recognizable, it will develop slowly. Where portions of tracts are only slightly more valuable for other uses, additional management costs brought about by such a move could outweigh the gains. Higher costs could result from reduced access or reduction of the access owned to an uneconomic size. Thus, a firm disposing of its woodlands on the basis of short-term factors could find itself in the same position as a small nonindustrial owner.

## FUTURE TRENDS IN FOREST INVENTORY, GROWTH, AND CUT ON NONINDUSTRIAL HOLDINGS

### Projection Methods

In a previous section, a technique for calculating gross growth was discussed and results displayed for the period 1952 to 1970. It may be reasonably expected that the compound rates of change developed in that section could be applied to the period 1970–90. This may be justified on the theory that with respect to forest inventory and growth, there is a certain momentum and that momentum has been defined by changes occurring between 1952 and 1970. The number of variables affecting timber supply and demand makes it virtually impossible to select a given set of values for the basis of all forecasts. It is preferable to test what might happen using different assumptions. Time and space do not permit using such a technique for all regions. Since it is widely thought that the South must furnish most of the softwood in the future, this region has been selected as the area in which to explore the possibilities.

In a normal forest, or in a forest in which there is reasonable uniformity of age classes, the relationship among inventory, cut, and length of rotation can be expressed by the equation: Rotation=2× (inventory, cut). This formula provides a means of calculating the average length of the rotation for nonindustrial private forest land in the South. Referring to the publication, 1970 Forest Statistics,[31] which has already been cited, it is found that the 1970 total volume for all species in the other private category for the South is 108,182,800,000 cu. ft. The corresponding figure for removals is 4,786,804,000 cu. ft. Dividing the last value into the former produces a ratio of 22.60. Twice this figure is 45.2 which becomes the indicated average rotation being used throughout the South as a whole.

The future status of inventory, growth, and drain can be predicted under the assumption that this rotation will be employed, that the species to be planted will be loblolly pine, and that the most intensive forestry possible will be practiced. A projection of inventories, cuts, and growth over a period equal to one rotation can assume that equal acreages will be cut over each year, that such acreages will immediately be planted, and that the uncut stands will grow at a rate equal to the growth previously calculated. Yields from plantations established on nonindustrial lands may be forecast using various rotation assumptions.

The computer model employed to make the forecasts to be presented was originally designed to predict the results of various operating plans on inventory, cut, and growth on lands under a single ownership. Obviously, no unified management policy exists for nonindustrial lands in the South as a whole. However, the testing of various managreement assumptions can help to pinpoint the results of inaction. Such testing also indicates whether or not there is any possibility of manipulating inventory, growth, and cut so as to synchronize peak availability with peak demand.

The use of averages weakens the model but is the only practical course in view of the lack of details on stand conditions. Inasmuch as the model being used will not cut planted stands until all natural stands are liquidated, it is not possible to include the contribution that existing planted stands might make. Separate projections have been made to evaluate this contribution. The questions to which answers are generally sought may be phrased as follows:

1. What contribution would nonindustrial lands make to demand if area regulation is instituted and areas cutover are immediately replanted?

2. What happens if the present rate of removals is continued but all areas cut are restocked as cut?

3. What happens under a regulation system as proposed in 1. if the present level of replantings (based on acreage planted during the period 1966 through 1970) is continued?

4. What effect would liquidation of all present natural stands in 20 years have on future inventory, cut, and growth if all areas cut are regenerated?

Logical assumptions related to each of the foregoing questions are tabulated in table 16. An annotated reproduction of the forecast designed to answer question 1 appears in figure 5. This projection in full size and those developed to provide answers for the other questions appear in the appendix.

Harvests by product are shown graphically by 10-year period for each projection in figure 6. Each graph shows the current level of cut and the potential for nonindustrial private lands in the South as previously cited in addition to the year-by-year yields.

The cutting schemes, thus far presented, all indicate that there will be a period beginning in about 1988 during which the softwood sawtimber would be grossly inadequate. Existing plantations can make a significant contribution toward overcoming this deficit if properly manipulated. For purposes of contrast, two treatments may be explored. Suppose, for example, that existing plantations could be cutover using a 30-year regulatory period, that equal areas would be treated, and that the projection would begin in 1970. Results that would be obtained are shown in table 17. In contrast, it could be assumed that no plantations would be cut in until 1988 and that the regulatory period would begin in that year. These results are shown in table 18.

[31] Forest Service, "1970 Forest Statistics."

**TABLE 16.—Assumptions Related to Projections**

| Projection number and property status | Acreage (thousand acres) | Assumptions | Regulatory period (years) | Rotation period (years) | Regeneration |
|---|---|---|---|---|---|
| 1. Natural stands | 131,878 | Average volume per acre by product assumed to be distributed uniformly over entire acreage. Growth rates developed based on 1952–70 figures are assumed to apply for 20 years then reduced by ⅓ for the remainder of period. | 45 | 45 | All areas cutover are site prepared and planted. |
| 2. Natural stands | 131,878 | Average volume per acre by product assumed to be unequally distributed over entire acreage. Pine sawtimber volume per acre ranges from 100 to 3,386 fbm. | 45 | 45 | Do. |
| 3. Natural stands | 131,878 | Same as No. 1 above | 45 | 45 | 16,000 acres planted per year.[1] |
| 4. Natural stands | 131,878 | do | 20 | 40 | All areas cutover are site prepared and planted. |
| 5. Existing plantations | 8,059 | Volumes per acre based on yields for fully stocked stands of loblolly pine. | 30 [2] | 30 | Do. |
| 6. Existing plantations | 8,059 | Same as No. 5 above | 30 [3] | 30 | Do. |

[1] Based on the average acreage planted per year for 5-year period of 195,000 acres. It is assumed that plantation areas must be site prepared and planted after harvest (1/45 of 8,059,000=179,000) therefore the remaining 16,000 acres would be applicable to natural stands.
[2] First cut in 1970.
[3] First cut in 1988.

## Major Conclusions

A study of the graphs and the projection results leads to the following conclusions:

1. Current demands on nonindustrial private woodlands cannot be sustained until newly planted areas reach sawtimber size.
2. A reduction in current cutting would alleviate the situation in the critical 1988–98 period.
3. Institution of intensive forestry on all private land could produce yields by the year 2000 that are many times current harvests.
4. Manipulation of existing stands so as to maximize growth and increase cuts during the critical period is feasible.

# A SUGGESTED APPROACH FOR IMPROVING THE OUTPUT FROM NONINDUSTRIAL WOODLANDS

## The Situation in Brief

The problem created by the large proportion of forest lands owned by nonindustrial private owners and the character of the optimum solution can be summarized in seven statements as follows:

1. The Nation cannot continue to develop in an orderly way without reasonable utilization of the potential fiber-growing capacity of nonindustrial woodlands;
2. There is insufficient incentive for the owner of nonindustrial woodlands to induce him to use the potential of his woodlands for growing timber to the extent that the Nation requires;
3. The ownership pattern of nonindustrial woodlands makes them uneconomic for intensive forest management;
4. The required solution must transfer the control of forest management practices on these ownerships in blocks of economic size to an entity having an incentive to institute intensive forest management;
5. Payments to the owner in return for transfer of control must represent a reasonable return on the actual value of the property transferred;
6. This transfer of forest management responsibility must be made with a minimum loss of other ownership privileges; and
7. The improvement of production from nonindustrial holdings is a national goal unrelated to any desire to improve the financial well-being of the owner of the land.

**FIGURE 5.—Annotated Reproduction of Projection No. 1**

P R O J E C T E D   I N V E N T O R Y   A N A L Y S I S

| YEAR | ACRES CUT | PINE PULPWOOD (CORDS) INV. | CUT | GR. | PINE SAWTIMBER(MBF) INV. | CUT | GR. | HDWD PULPWOOD (CORDS) INV. | CUT | GR. | HDWD SAWTIMBER(MBF) INV. | CUT | GR. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1970 | 2930 | 276943. | 6159. | 10315. | 154824. | 3439. | 7478. | 502455. | 11163. | 12894. | 152055. | 3376. | 4255. |
| 1971 | 2930 | 281106. | 6387. | 11341. | 158863. | 3609. | 7561. | 504186. | 11456. | 12601. | 152932. | 3474. | 4284. |
| 1972 | 2930 | 286060. | 6651. | 12077. | 162815. | 3785. | 7754. | 505332. | 11749. | 12308. | 153741. | 3574. | 4308. |
| 1973 | 2930 | 290487. | 6914. | 10814. | 166784. | 3970. | 7930. | 505891. | 12042. | 13217. | 154475. | 3677. | 4325. |
| 1974 | 2930 | 294387. | 7178. | 11722. | 170744. | 4163. | 8205. | 507066. | 12364. | 12895. | 155123. | 3782. | 4337. |
| 1975 | 2930 | 298931. | 7471. | 11429. | 174786. | 4368. | 8343. | 507597. | 12686. | 12572. | 155678. | 3891. | 4457. |
| 1976 | 2930 | 302889. | 7764. | 11136. | 178762. | 4582. | 8575. | 507483. | 13009. | 13364. | 156245. | 4005. | 4454. |
| 1977 | 2930 | 306261. | 8057. | 11928. | 182754. | 4806. | 8675. | 507838. | 13360. | 13012. | 156694. | 4122. | 4445. |
| 1978 | 2930 | 310132. | 8379. | 11605. | 186621. | 5042. | 8862. | 507489. | 13712. | 12660. | 157016. | 4242. | 4431. |
| 1979 | 2930 | 313358. | 8702. | 12309. | 190441. | 5288. | 9026. | 506438. | 14064. | 12309. | 157206. | 4365. | 4410. |
| 1980 | 2930 | 316966. | 9053. | 17817. | 194180. | 5546. | 9267. | 504683. | 14415. | 12954. | 157252. | 4491. | 4384. |
| 1981 | 2930 | 325730. | 9405. | 24000. | 197900. | 5818. | 9381. | 503222. | 14796. | 12573. | 157144. | 4620. | 4449. |
| 1982 | 2930 | 340325. | 9786. | 29186. | 201463. | 6103. | 9566. | 500999. | 15177. | 12192. | 156973. | 4755. | 4406. |
| 1983 | 2930 | 359725. | 10167. | 35574. | 204926. | 6402. | 9721. | 498014. | 15558. | 12720. | 156625. | 4893. | 4361. |
| 1984 | 2930 | 385132. | 10577. | 40730. | 208246. | 6715. | 9847. | 495176. | 15968. | 12309. | 156094. | 5033. | 4396. |
| 1985 | 2930 | 415285. | 10987. | 47030. | 211378. | 7043. | 10029. | 491517. | 16378. | 12749. | 155456. | 5180. | 4334. |
| 1986 | 2930 | 451329. | 11427. | 52158. | 214364. | 7389. | 10176. | 487888. | 16818. | 12310. | 154611. | 5329. | 4349. |
| 1987 | 2930 | 492060. | 11866. | 58370. | 217151. | 7752. | 10287. | 483380. | 17257. | 11870. | 153631. | 5464. | 4273. |
| 1988 | 2930 | 538563. | 12335. | 63468. | 219687. | 8133. | 10364. | 477993. | 17697. | 12193. | 152419. | 5643. | 4267. |
| 1989 | 2930 | 589696. | 12804. | 69592. | 221917. | 8532. | 10478. | 472489. | 18166. | 11724. | 151044. | 5807. | 4176. |
| 1990 | 2930 | 646485. | 13302. | 70090. | 223864. | 8951. | 13716. | 466048. | 18634. | 11959. | 149613. | 5974. | 4150. |
| 1991 | 2930 | 703273. | 13829. | 69563. | 228629. | 9390. | 15234. | 459372. | 19132. | 11461. | 147590. | 6147. | 4112. |
| 1992 | 2930 | 759007. | 14357. | 69973. | 234473. | 9850. | 16770. | 451700. | 19631. | 10962. | 145555. | 6325. | 4062. |
| 1993 | 2930 | 814623. | 14913. | 70325. | 241393. | 10334. | 18264. | 443032. | 20129. | 11080. | 143292. | 6510. | 3939. |
| 1994 | 2930 | 870035. | 15499. | 70618. | 249323. | 10840. | 19709. | 433983. | 20656. | 10553. | 140721. | 6697. | 3669. |
| 1995 | 2930 | 925154. | 16114. | 70003. | 258191. | 11371. | 21162. | 423880. | 21183. | 10582. | 137893. | 6891. | 3787. |
| 1996 | 2930 | 979043. | 16730. | 70208. | 267983. | 11928. | 22560. | 413279. | 21740. | 10025. | 134789. | 7090. | 3693. |
| 1997 | 2930 | 1032522. | 17374. | 70355. | 278616. | 12511. | 23958. | 401564. | 22297. | 9967. | 131392. | 7295. | 3588. |
| 1998 | 2930 | 1085503. | 18048. | 70443. | 290063. | 13123. | 25300. | 389234. | 22883. | 9381. | 127684. | 7506. | 3471. |
| 1999 | 2930 | 1137898. | 18752. | 70473. | 302240. | 13765. | 26625. | 375733. | 23469. | 9235. | 123649. | 7723. | 3342. |
| 2000 | 2930 | 1189619. | 19484. | 68393. | 315101. | 14439. | 28290. | 361499. | 24084. | 8620. | 119268. | 7946. | 3242. |
| 2001 | 2930 | 1238528. | 20246. | 65961. | 328952. | 15145. | 29928. | 346036. | 24679. | 8385. | 114564. | 8177. | 3067. |
| 2002 | 2930 | 1284244. | 21037. | 63764. | 343735. | 15886. | 31531. | 329720. | 25344. | 7761. | 109474. | 8414. | 2920. |
| 2003 | 2930 | 1326971. | 21857. | 61506. | 359380. | 16665. | 33055. | 312117. | 25965. | 7419. | 103980. | 8658. | 2774. |
| 2004 | 2930 | 1366622. | 22707. | 58901. | 375769. | 17483. | 34505. | 293547. | 26663. | 7038. | 98096. | 8910. | 2580. |
| 2005 | 2930 | 1402816. | 23586. | 56528. | 392792. | 18338. | 35936. | 273923. | 27366. | 6335. | 91767. | 9167. | 2402. |
| 2006 | 2930 | 1435758. | 24494. | 54331. | 410389. | 19238. | 37275. | 252892. | 28069. | 5867. | 85001. | 9434. | 2182. |
| 2007 | 2930 | 1465594. | 25461. | 51518. | 428427. | 20181. | 38547. | 230690. | 28801. | 5339. | 77749. | 9707. | 1971. |
| 2008 | 2930 | 1491652. | 26457. | 48940. | 446792. | 21172. | 39726. | 207228. | 29563. | 4578. | 70014. | 9988. | 1743. |
| 2009 | 2930 | 1514135. | 27483. | 46450. | 465346. | 22209. | 40825. | 182242. | 30325. | 3963. | 61768. | 10276. | 1497. |
| 2010 | 2930 | 1533102. | 28567. | 44019. | 483962. | 23296. | 41476. | 155880. | 31116. | 3289. | 52987. | 10577. | 1233. |
| 2011 | 2930 | 1548554. | 29680. | 41324. | 502142. | 24439. | 42018. | 128053. | 31936. | 2469. | 43643. | 10884. | 952. |
| 2012 | 2930 | 1560197. | 30852. | 38746. | 519722. | 25637. | 42453. | 98585. | 32757. | 1707. | 33711. | 11201. | 653. |
| 2013 | 2930 | 1568090. | 32054. | 36138. | 536537. | 26894. | 42775. | 67535. | 33607. | 887. | 23163. | 11526. | 337. |
| 2014 | 2958 | 1572175. | 33632. | 33402. | 552419. | 28482. | 42959. | 34815. | 34815. | 0. | 11973. | 11973. | 0. |
| 2015 | 2930 | 1571944. | 33402. | 33402. | 566896. | 42959. | 42959. | 0. | 0. | 0. | 0. | 0. | 0. |
| 2016 | 2930 | 1571944. | 33402. | 33402. | 566896. | 42959. | 42959. | 0. | 0. | 0. | 0. | 0. | 0. |
| 2017 | 2930 | 1571944. | 33402. | 33402. | 566896. | 42959. | 42959. | 0. | 0. | 0. | 0. | 0. | 0. |
| 2018 | 2930 | 1571944. | 33402. | 33402. | 566896. | 42959. | 42959. | 0. | 0. | 0. | 0. | 0. | 0. |
| 2019 | 2930 | 1571944. | 33402. | 33402. | 566896. | 42959. | 42959. | 0. | 0. | 0. | 0. | 0. | 0. |
| 2020 | 2930 | 1571944. | 33402. | 33402. | 566896. | 42959. | 42959. | 0. | 0. | 0. | 0. | 0. | 0. |

Initial pine pulpwood inventory in thousand cords.

Initial pine sawtimber inventory in million board feet, International Rule.

Initial hardwood pulpwood inventory in thousand cords.

Initial hardwood sawtimber inventory in million board feet, International Rule.

Thousand acres cut by year.

Estimated 11,427 M pine pulpwood cords cut in 1986.

Predicted hardwood pulpwood cut in 1988 is 17,697,000 cords.

Estimated pine pulpwood inventory in year 2000 is 1,189,619,000 cords.

Hardwood sawtimber inventory in 1999 is 123,649,000 MBF, International.

Estimated pine sawtimber inventory in year 2020 is 566,896,000 MBF, International.

Predicted pine sawtimber cut and growth in year 2020 is 42,959,000 MBF, International.

## The Plan in Brief

The major objective to be accomplished is the assembly of small holdings into operating units on which it would be economically feasible to practice intensive forestry. A solution is suggested by a statement appearing in timber program issue paper, "Opportunities for Expanding Timber Production on Nonindustrial Private Forest Lands." This statement is as follows:

*Industrial leasing* is an established practice. It is most efficient with large tracts of land. A public incentive supplement that reduced the cost of the lease to the industrial lessor could expand the use of this practice for smaller tracts. This approach would be less expensive of Federal funds and personnel ceilings than a Federal loan program. The Federal payments per-acre would be less. The industry would provide the management and technical assistance to grow and harvest the timber crops. Constraining the timber crop to saw-timber production could diminish industrial interest in such leases, since pulp and paper companies interested in pulpwood production have been the principal lessors of nonindustrial private lands. But, many companies are integrating their operations with lumber and plywood production. It is possible that a lease providing for a mix of sawtimber and pulpwood production would remain attractive.[32]

The best potential lessees from a productivity standpoint would no doubt be firms already in the forest products field. However, any plan developed should permit involvement by State agencies, conservation groups, hunting clubs, consulting forestry firms, individuals, or cooperatives. To implement the basic idea, it is contemplated that such entities would be licensed by the Federal Government to participate in the program. Licensing would be based on the capability to assemble small tracts into larger operating units and the financial and management capability to conduct intensive forestry operations. Once a lessee had assembled

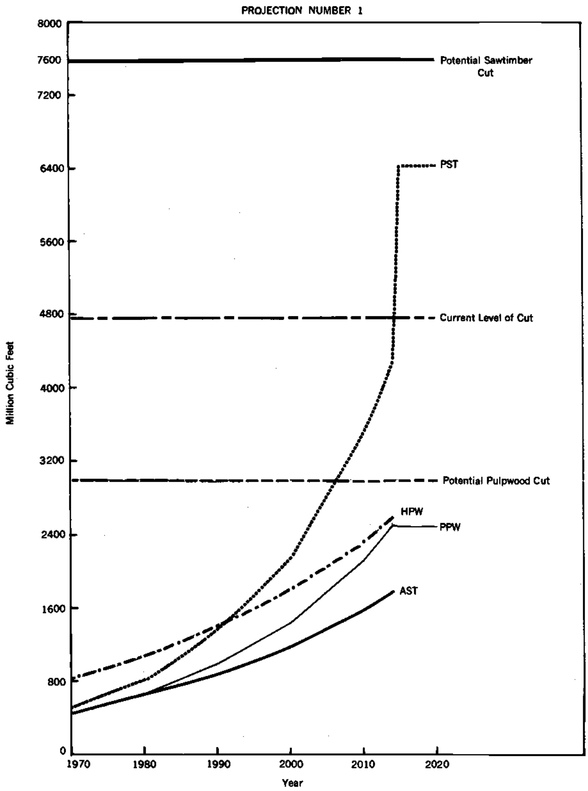
[32] U.S. Department of Agriculture, timber program issue paper.

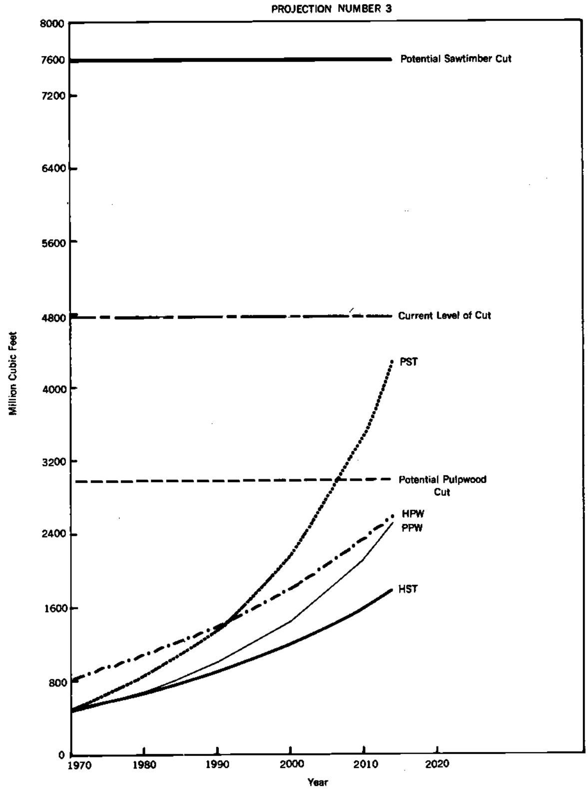
## TABLE 17.—Projection No. 5, Projected Inventory Analysis

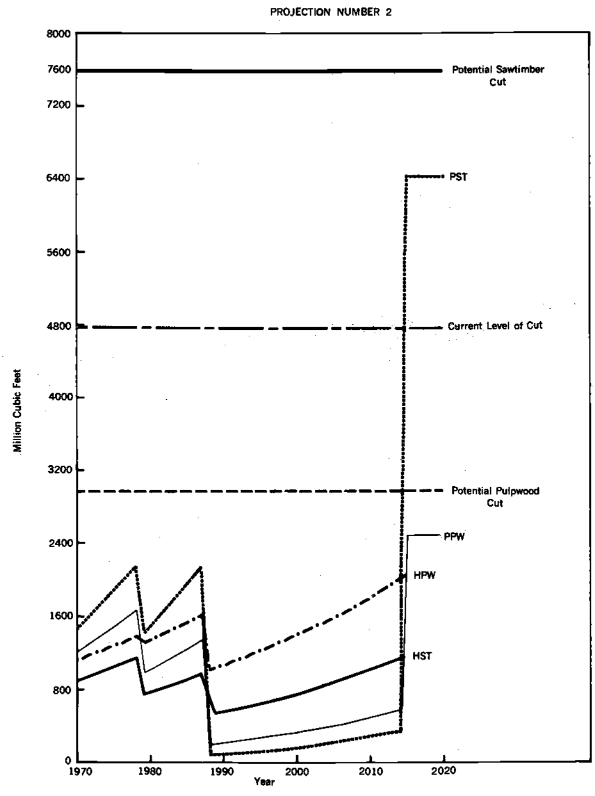
| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1970 | 237 | 46,608 | 4,716 | 9,125 | 2,223 | 815 | 316 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1971 | 237 | 51,017 | 4,642 | 9,692 | 1,723 | 733 | 306 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1972 | 237 | 56,067 | 4,607 | 9,956 | 1,297 | 595 | 349 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1973 | 237 | 61,416 | 4,640 | 10,039 | 1,051 | 484 | 415 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1974 | 268 | 66,816 | 5,285 | 10,013 | 983 | 591 | 392 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1975 | 268 | 71,543 | 5,263 | 9,902 | 783 | 477 | 439 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1976 | 268 | 76,183 | 5,257 | 9,582 | 745 | 445 | 602 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1977 | 268 | 80,508 | 5,252 | 8,894 | 902 | 425 | 856 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1978 | 268 | 84,149 | 5,253 | 7,038 | 1,333 | 430 | 1,647 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1979 | 268 | 85,933 | 5,269 | 5,438 | 2,550 | 510 | 1,923 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1980 | 268 | 86,103 | 5,279 | 4,987 | 3,963 | 560 | 1,849 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1981 | 268 | 85,810 | 5,301 | 4,739 | 5,252 | 672 | 1,748 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1982 | 268 | 85,248 | 5,306 | 4,625 | 6,327 | 696 | 1,703 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1983 | 268 | 84,567 | 5,333 | 4,528 | 7,334 | 832 | 1,663 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1984 | 268 | 83,763 | 5,333 | 4,431 | 8,166 | 967 | 1,630 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1985 | 268 | 82,861 | 5,360 | 4,461 | 8,829 | 1,103 | 1,599 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1986 | 268 | 81,963 | 5,365 | 4,342 | 9,325 | 1,128 | 1,628 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1987 | 268 | 80,940 | 5,386 | 4,323 | 9,825 | 1,238 | 1,573 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1988 | 268 | 79,877 | 5,413 | 4,347 | 10,159 | 1,374 | 1,508 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 268 | 78,811 | 5,438 | 4,402 | 10,294 | 1,501 | 1,461 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 268 | 77,775 | 5,440 | 3,923 | 10,254 | 1,510 | 1,629 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 268 | 76,258 | 5,279 | 3,837 | 10,373 | 1,682 | 1,527 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 268 | 74,815 | 5,253 | 3,841 | 10,218 | 1,706 | 1,492 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 268 | 73,403 | 5,199 | 3,864 | 10,004 | 1,756 | 1,453 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 268 | 72,068 | 5,199 | 3,896 | 9,702 | 1,756 | 1,412 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 268 | 70,764 | 5,225 | 3,917 | 9,358 | 1,732 | 1,370 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 268 | 69,456 | 5,277 | 3,928 | 8,995 | 1,682 | 1,335 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 268 | 68,106 | 5,297 | 3,958 | 8,649 | 1,663 | 1,293 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 268 | 66,767 | 5,329 | 4,013 | 8,279 | 1,629 | 1,247 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 268 | 65,451 | 5,382 | 4,070 | 7,897 | 1,572 | 1,200 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 268 | 64,139 | 5,436 | 4,015 | 7,524 | 1,514 | 1,175 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 268 | 62,717 | 5,395 | 4,055 | 7,186 | 1,558 | 1,131 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 268 | 61,377 | 5,430 | 4,053 | 6,759 | 1,483 | 1,096 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2003 | 287 | 60,001 | 5,811 | 4,045 | 6,371 | 1,542 | 1,052 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 268 | 58,235 | 5,417 | 4,038 | 5,881 | 1,392 | 1,017 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2005 | 268 | 56,856 | 5,405 | 4,031 | 5,506 | 1,331 | 983 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 268 | 55,483 | 5,398 | 4,024 | 5,157 | 1,297 | 948 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 268 | 54,109 | 5,389 | 4,018 | 4,808 | 1,252 | 914 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 268 | 52,738 | 5,378 | 4,011 | 4,469 | 1,194 | 879 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 268 | 51,371 | 5,371 | 4,004 | 4,155 | 1,159 | 845 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010 | 268 | 50,004 | 5,362 | 3,997 | 3,841 | 1,113 | 811 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2011 | 268 | 48,640 | 5,350 | 3,990 | 3,539 | 1,056 | 776 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012 | 268 | 47,280 | 5,344 | 3,984 | 3,259 | 1,022 | 742 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 268 | 45,920 | 5,337 | 3,979 | 2,979 | 973 | 708 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 268 | 44,562 | 5,335 | 3,979 | 2,713 | 919 | 673 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 268 | 43,209 | 5,333 | 3,980 | 2,468 | 884 | 639 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 268 | 41,856 | 5,330 | 3,976 | 2,222 | 834 | 604 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 268 | 40,503 | 5,323 | 3,970 | 1,993 | 781 | 570 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 268 | 39,150 | 5,316 | 3,963 | 1,782 | 747 | 535 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 268 | 37,796 | 5,306 | 3,956 | 1,570 | 694 | 501 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 268 | 36,447 | 5,296 | 3,949 | 1,378 | 643 | 467 | 0 | 0 | 0 | 0 | 0 | |

what, for convenience of reference, may be designated as a leasing block, the individual landowners in that leasing block would be eligible for the payment of ground rent by the Federal Government for the period between the execution of the lease and the time that the first commercial thining becomes feasible. The lessee would be required to enter into a timber purchase contract for all of the timber existing on each ownership within a leasing block for a period at least equal to the sum of the required regulatory period and one rotation. It is probable that the purchase of the timber by the lessee would be encouraged on a deferred basis. When such an arrangement was made, the Federal Government would also guarantee payment by the lessee of the deferred payments. The lessee would be required to rehabilitate completely all of the nonstocked potentially productive woodland or cutover woodland existing within a leasing block immediately after the execution of the long-term lease. Inspections by representatives of the Federal Government would

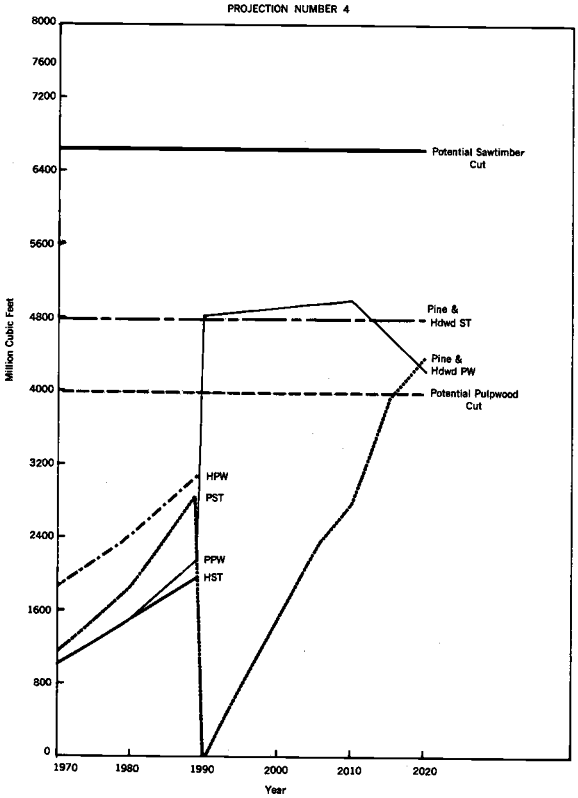
## FIGURE 6.—Graphic Illustration of Projection

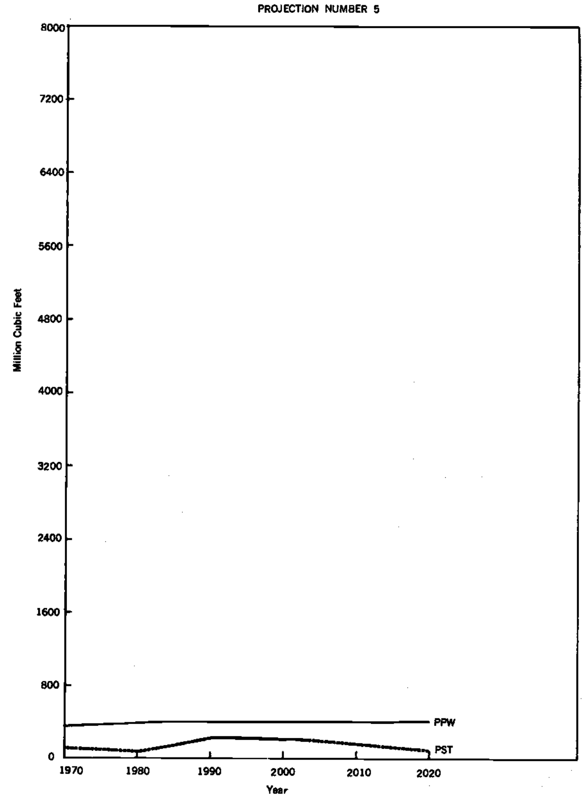


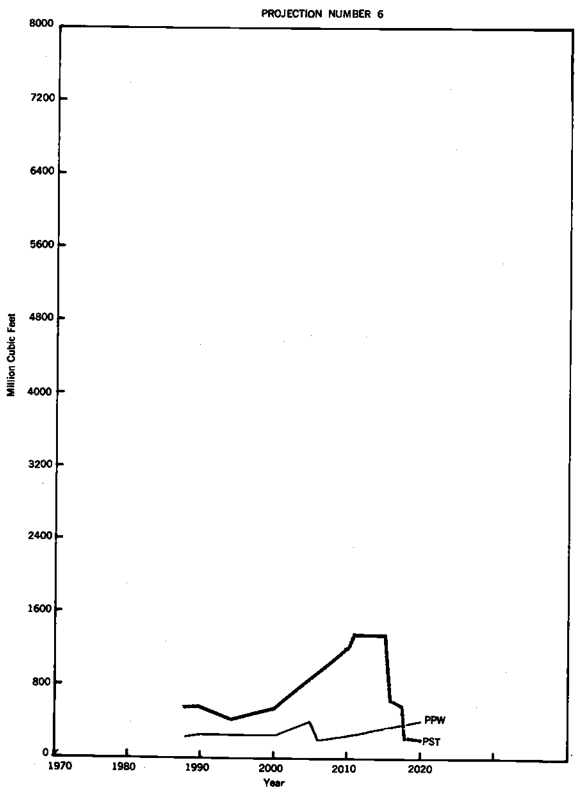



## FIGURE 6—(Cont'd)



## TABLE 18.—Projection No. 6, Projected Inventory Analysis

| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1988 | 270 | 150,105 | 3,269 | −3,561 | 47,578 | 3,760 | 3,433 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1989 | 270 | 143,275 | 3,363 | −3,614 | 47,250 | 3,763 | 3,530 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1990 | 270 | 136,296 | 3,457 | −3,598 | 47,017 | 3,799 | 3,561 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 270 | 129,231 | 3,520 | −3,328 | 46,779 | 3,367 | 3,615 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 270 | 122,383 | 3,723 | −3,026 | 47,027 | 3,128 | 3,754 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 270 | 115,633 | 3,798 | −2,797 | 47,653 | 3,024 | 3,902 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 270 | 109,037 | 3,818 | −2,549 | 48,531 | 2,989 | 4,056 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 270 | 102,669 | 3,805 | −2,304 | 49,598 | 3,011 | 4,218 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 270 | 96,559 | 3,734 | −2,069 | 50,805 | 3,116 | 4,389 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 270 | 90,755 | 3,736 | −1,861 | 52,078 | 3,185 | 4,562 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 270 | 85,157 | 3,609 | −1,249 | 53,456 | 3,398 | 4,770 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 270 | 80,298 | 3,567 | −692 | 54,828 | 3,547 | 4,977 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 270 | 76,038 | 3,472 | −113 | 56,258 | 3,788 | 5,183 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 270 | 72,451 | 3,342 | 600 | 57,653 | 4,087 | 5,379 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 270 | 69,709 | 3,218 | 1,260 | 58,945 | 4,410 | 5,584 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2003 | 270 | 67,751 | 3,176 | 1,949 | 60,120 | 4,688 | 5,800 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 270 | 66,525 | 3,188 | 2,589 | 61,231 | 4,959 | 6,024 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2005 | 270 | 65,925 | 3,083 | 3,245 | 62,296 | 5,371 | 6,261 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 270 | 66,088 | 2,980 | 3,872 | 63,186 | 5,817 | 6,513 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 270 | 66,980 | 3,071 | 4,519 | 63,882 | 6,231 | 6,028 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 270 | 68,428 | 3,072 | 4,674 | 63,679 | 6,744 | 5,174 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 270 | 70,030 | 3,144 | 4,761 | 62,109 | 7,335 | 3,880 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010 | 270 | 71,646 | 3,297 | 4,881 | 58,654 | 8,071 | 1,599 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2011 | 270 | 73,230 | 3,531 | 4,977 | 52,182 | 8,847 | 957 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012 | 270 | 74,677 | 3,869 | 5,070 | 44,293 | 8,847 | 1,093 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 270 | 75,878 | 4,280 | 5,109 | 36,539 | 8,847 | 1,230 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 270 | 76,707 | 4,774 | 5,154 | 28,923 | 8,847 | 1,366 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 275 | 77,087 | 5,411 | 5,180 | 21,443 | 9,010 | 1,503 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 268 | 76,855 | 2,697 | 5,340 | 13,935 | 4,299 | 1,501 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 268 | 79,498 | 3,154 | 5,476 | 11,137 | 3,808 | 1,500 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 268 | 81,821 | 5,436 | 5,477 | 8,828 | 1,489 | 1,501 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 268 | 81,862 | 5,436 | 5,477 | 8,840 | 1,490 | 1,502 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 268 | 81,902 | 5,436 | 5,477 | 8,851 | 1,491 | 1,503 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2021 | 268 | 81,943 | 5,437 | 5,477 | 8,862 | 1,492 | 1,504 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2022 | 268 | 81,983 | 5,437 | 5,477 | 8,873 | 1,493 | 1,505 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2023 | 268 | 82,024 | 5,437 | 5,478 | 8,885 | 1,494 | 1,506 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2024 | 268 | 82,065 | 5,437 | 5,478 | 8,896 | 1,496 | 1,507 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2025 | 268 | 82,105 | 5,437 | 5,488 | 8,907 | 1,497 | 1,508 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2026 | 268 | 82,156 | 5,438 | 5,484 | 8,919 | 1,498 | 1,509 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2027 | 268 | 82,202 | 5,438 | 5,480 | 8,930 | 1,499 | 1,510 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2028 | 268 | 82,244 | 5,438 | 5,477 | 8,941 | 1,500 | 1,511 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2029 | 268 | 82,283 | 5,438 | 5,473 | 8,952 | 1,501 | 1,512 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2030 | 268 | 82,318 | 5,438 | 5,470 | 8,964 | 1,502 | 1,513 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2031 | 268 | 82,349 | 5,439 | 5,465 | 8,975 | 1,503 | 1,514 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2032 | 268 | 82,376 | 5,439 | 5,462 | 8,986 | 1,504 | 1,515 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2033 | 268 | 82,399 | 5,439 | 5,458 | 8,997 | 1,505 | 1,516 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2034 | 268 | 82,418 | 5,439 | 5,455 | 9,009 | 1,506 | 1,517 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2035 | 268 | 82,433 | 5,439 | 5,441 | 9,020 | 1,507 | 1,523 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2036 | 268 | 82,435 | 5,440 | 5,441 | 9,037 | 1,508 | 1,519 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2037 | 268 | 82,437 | 5,440 | 5,442 | 9,048 | 1,509 | 1,519 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2038 | 268 | 82,439 | 5,440 | 5,442 | 9,059 | 1,510 | 1,519 | 0 | 0 | 0 | 0 | 0 | 0 |

be made periodically to insure that rehabilitation was being properly carried out.

### Conditions for Governmental Support

Improvements in woodland productivity should be made in blocks large enough so that harvest operations are economically feasible. For planning purposes, it is necessary to have a definition of the size of such an area. Any such definition is somewhat arbitrary but, for the purposes of planning, the term potential leasing block may be used and its size set as any area 2 miles square. Such an area does not have to conform to any land subdivision, such as sections of the public land survey. Such blocks should have at least 50 percent of its area in woodland or in land that should be converted to timber growing. Any lessee participating in the plan must acquire long-term rights to at least half of the woodland in any block not counting fee ownership that the lessee itself might hold within the area. No more than 20 percent of the leased area should be owned by a single owner. No land for which a change to a higher and better use is probable before minimum economic harvest age of planted trees would be eligible for leasing. There would be no restrictions with respect to the total amount of land that could be held by a single owner in all leasing blocks as long as a 20-percent maximum in any one leasing block was observed and no lessor owned contiguous land in adjoining blocks.

## Determination of Eligibility

Eligibility requirements can be illustrated by studying land ownership maps in some sample areas. These areas were selected because of the availability of ownership maps for the particular sections involved. Figure 7 is a reproduction of an ownership map in an area in which there is high ownership by nonindustrial owners. Classification of the land use occurring in the sample leasing block shows that 1995± acres are in woodland and 565± acres are in other uses. Thus, from the standpoint of the required 50-percent dedication to forestry purposes, this potential leasing block qualifies. Study of the land ownership map shows that there are 23 owners represented in the potential leasing block. Acreages owned are shown by owners in table 19. Since no owner owns more than 20 percent of the total area, this block could qualify for inclusion in the program.

It is also desirable to examine a sample area

**FIGURE 7.—Example of High Nonindustrial Ownership Itawamba County, Mississippi**

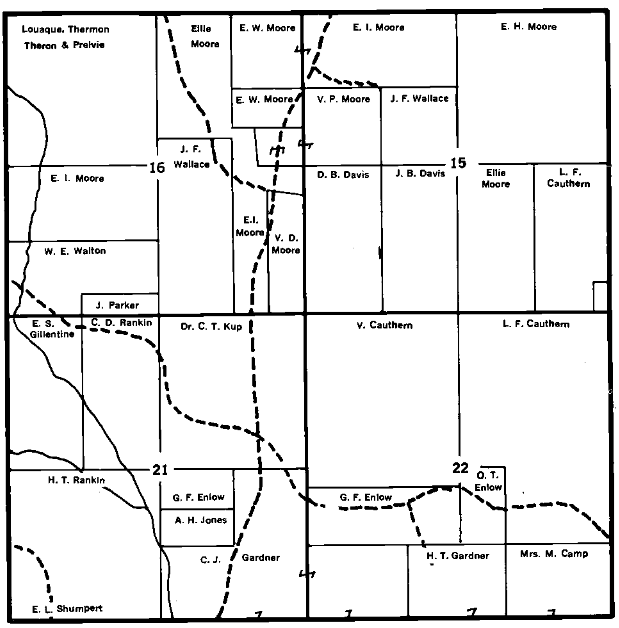



**TABLE 19.—Acreage by Owners Represented in Potential Leasing Block**

| Owner | Acres |
|---|---|
| Camp, Mrs. M | 55 |
| Cauthen, L. F | 290 |
| Cauthen, V | 180 |
| Davis, D. B | 80 |
| Davis, J. B | 80 |
| Enlow, G. B | 60 |
| Enlow, G. F | 20 |
| Enlow, O. T | 25 |
| Gardner, C. J | 120 |
| Gardner, H. T | 55 |
| Gillentine, E. S | 80 |
| Jones, A. H | 20 |
| Kup, Dr. C. T | 160 |
| Loaque, Thermon, Theron, Prelvie | 160 |
| Moore, E. H | 160 |
| Moore, E. L | 355 |
| Moore, E. W | 60 |
| Moore, V. P | 70 |
| Parker, J | 10 |
| Rankin, C. O | 80 |
| Rankin, H. T | 160 |
| Wallace, J. F | 130 |
| Walton, W. E | 70 |
| Not listed | 80 |
| Total | 2, 560 |

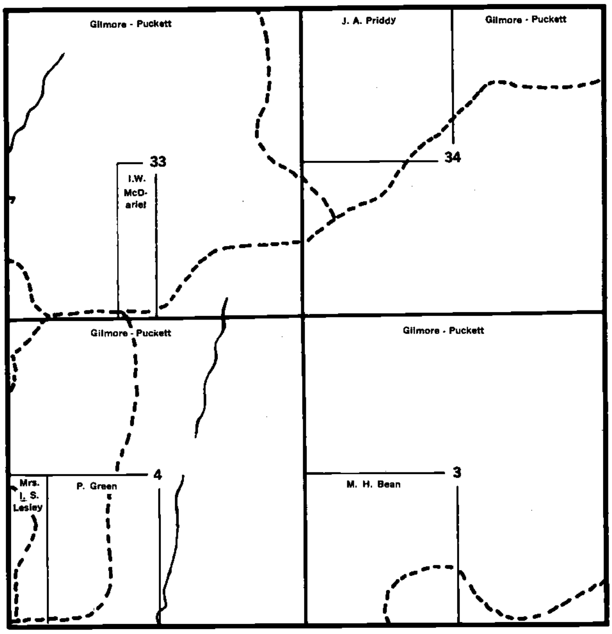
which could not qualify under the proposed plan. Figure 8 presents a second reproduced map which qualifies on the basis of the proportion of land devoted to timber growing. Inasmuch as a single company owns more than 50 percent of the area in the block, it could not qualify for inclusion in the plan.

The instrument by which the leasing entity acquires rights to the property should be a standard form lease. This is necessary in order to reduce the administrative costs of obtaining and administering the leases. Such a lease can be patterned after agreements that have been used by forest products firms in acquiring rights to larger ownership. Table 20 summarizes the most important features that should be a part of such an agreement.

## Lessee Responsibility

The overall responsibility of the lessee is to institute intensive forest management on the land contained in an individual leasing block. However, there is no requirement that the production of this single leasing block be maximized. Rather, it is contemplated that this leasing block will be part of a much larger area which is under the control

FIGURE 8.—Example of High Ownership by Industry Itawamba County, Mississippi




of the lessee. This means that the output of all the lands controlled will be maximized rather than the output of any one block. Further, the period of maximization would be much longer than in the case of the individual owners. It should be emphasized that any peculiar financial requirements of the landowner have now been eliminated, and the property will be managed completely independently of his aims.

Nevertheless, there must be a requirement that the lands contained in a leasing block are managed with the ultimate aim of maximizing production from those lands. To this end, each lessee will be required to submit a forestry plan as each new leasing block is established.

Such a plan must have as one of its features the immediate regeneration or rehabilitation of all lands which do not at that time have a satisfactory stand of reproduction or a stand of merchantable timber. The lessee must routinely provide for prompt restocking after any part of the land is cutover. It must be continuously protected from wildfire and from disease and insects.

The lessee must negotiate a purchase of all merchantable timber existing on the property at the time of the execution of the lease. The lessee also must pay the present worth of the premerchantable timber on the property. These agreements preferably should be made to extend over a time which approximates the regulatory period. The lessee will be required to assume the ground rent payment after the regulatory period. Further, there must be some requirement for landowner participation in the proceeds of timber sales after the end of the regulatory period.

TABLE 20.—Suggested Provisions for Incentive Leases and Governmental Participation

Lessor—Lessee relations

1. Lessor sells all trees of merchantable species to lessee at inception of lease.
2. Lessee to pay Lessor 10 percent of fair market value of all stumpage removed from property after 15 years from inception of lease.
3. Lessee must practice intensive forestry.
4. Cutover areas must be immediately regenerated by Lessee at his expense.
5. Standard arbitration procedures.
6. Lessee must keep books and records (available for inspection at reasonable times) and furnish report to Lessor each year.
7. (a) Lessee must pay all cost of restocking, severance taxes, and an amount equal to ½ ad valorem taxes.
   (b) Lessee may contest in own or Lessor's name taxes considered illegally or improperly assessed.
8. In event of damage to timber or equipment and right of action exists against 3d party, Lessee may bring suit in own or Lessor's name.
9. (a) Lessor has right to exploration for and development of minerals.
   (b) Lessor must reimburse lessee for Loss or damage due to exploration and development of minerals.
10. (a) Lessor warrants title to surface of land to Lessee except for preexisting commitments as may be defined.
    (b) Lessee to furnish title insurance policy.
11. Title to timber passes to Lessee at severance.
12. Provisions of agreement must inure to successors. Agreement may not be assigned by either party without written consent of the other. Consent cannot be arbitrarily withheld.
13. Lessee to be given first opportunity to buy lands in event Lessor desires to sell. If Lessee fails to exercise option, Lessor not permitted to sell to a 3d party for any less price or more favorable terms. Sale to a 3d party subject to this agreement.
14. Granting of easements and distribution of awards from this source and from condemnations to be divided on equitable basis between parties. If unable to agree, arbitration may be invoked.
15. Lessee to save Lessor harmless from liability to 3d persons.
16. Lessor retains rights of access, recreational rights hunting and fishing rights so long as exercise of such rights does not interfere with Lessee's operations.
17. After the first 15 years of the lease, the Lessee must assume responsibility for the annual lease payments.

**TABLE 20.—Suggested Provisions for Incentive Leases and Governmental Participation—Continued**

| Governmental obligations |
|---|
| 1. To pay annually for the first 15 years of the lease to the Lessor an amount equal to 10 percent of the bare land value at the inception of the lease. |
| 2. To guarantee payment of all sumsdue Lessor by Lessee in connection with the lease. |
| 3. To police the practice of forestry on the lands involved. |

### Retained Ownership Rights

It is sociably desirable that each landowner retain as many of the ownership rights as possible. He should also retain some of the responsibilities. Rights to be retained should be related to the use of the property for recreation so long as it does not interfere with management operations. He should have access for observation purposes. This right of access should help protect the property as well. Ownership responsibilities should include the payment of at least one-half of the ad valorem tax due each year.

### Costs of Program Under Alternative Levels

The amount of acreage which should be converted is dependent upon the timing and removal level required. The series of projections previously presented shows that national long-range needs could be more than met by intensifying efforts in the South alone. Opportunities for the program would not be as great in the West because of the large amounts of forest land owned by the Federal Government in this region. In 1970, 70,702,000 acres or 54 percent of the 129,253,000 acres of forest land in the Pacific Coast and Rocky Mountains regions, was in national forest holdings and only 27,869,000 or 21 percent was in other private lands. By contrast in the South, 5 percent was in national forest and 72 percent in other private lands.

The potential for the program would be greater in the North Central States and the East than in the West because of better ownership patterns and larger quantities of nonindustrial privately owned land.

Small forest holdings, particularly those of less than 500 acres each, make up the bulk of nonindustrial private holdings in the North. Formerly a relatively high percentage of the land was owned by farmers. This is much less the case now than four decades ago. During this period farming has become highly mechanized; the farms have become larger in size and are more intensively managed. The modern farmer does not have the time personally to engage in harvesting and selling forest products from his land except for the few who operate sugar bushes. Increasingly the farmers have bought up land from their neighbors who found farming unprofitable. Such farmers tend to use the hill lands for pasturing dry milk stock or permit them to grow up to forest. Eventually they tend to sell off the forested tracts to city people who buy the land for summer recreation. Purchasers will often buy out an entire farm property, but usually the barn has already fallen down and the farm equipment has been sold off before the city owner takes over the job of modernizing the farmhouse and using the property as primarily a vacation home. A considerable number of such properties are owned by city dwellers who make no attempt to maintain a home on the property but simply drive back and forth to use their woodland for daytime recreation.

Most such nonresident owners are interested in trees or they wouldn't have purchased the land in the first place. Many of them plant trees on the open land or at least on part of it. Some may rent out a portion of their property for pasture or hay, but generally they tend to allow it to go to timber. Those that maintain a vacation home on the property tend generally to be interested in developing the land and its resources including the timber resource. They are handicapped in harvesting the timber because of the small size of their holding and the fragmented nature of logging in the North.

The timber growing potential represented by nonindustrial holdings in the North, Rocky Mountains, and the Pacific Coast should not be neglected, but it is obvious that the priority for a program such as has been described is less than in the South.

One projection already presented assumed that forest conditions were distributed in the South ranging from a maximum of 3,386 fbm, International, to 100 fbm per acre. It was further assumed that approximately the same cubic volume of wood, irrespective of product, could be removed from the heaviest stocked areas. However, only one forty-fifth of the total area could be planted in each year. Inasmuch as this plan resulted in an availability greater than most projections of need, a reduction in intensity can be made. The effects on inventory, growth, and cut of applying the foregoing assumptions are shown in table 21.

Table 22 presents the results that would be obtained if only one-ninetieth of the total acreage is replanted each year. Under the conservation reserve program of the soil bank in late 1950's, $8 per acre was a common payment. A figure of $10 per acre would be required to approximate that payment today. Costs may be forecast using the following assumptions;

1. 1,465,000 acres will be put under lease each year and continued for 15 years at a payment rate of $10 per acre per year.

2. Forest industry will purchase additional stumpage in the pattern previously forecast.

Cost by years and cumulative costs are shown in table 23. In view of the fact that leasing rates for industrial agreements are generally much less than $10 per acre, these costs should represent the upper level of total expected cost.

**TABLE 21.—Projected Inventory Analysis**

| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1970 | 2,930 | 276,680 | 16,788 | 10,169 | 154,824 | 9,920 | 7,109 | 502,454 | 15,382 | 12,777 | 152,108 | 6,243 | 4,249 |
| 1971 | 2,826 | 270,060 | 16,814 | 9,753 | 152,013 | 10,037 | 6,937 | 499,850 | 15,232 | 12,645 | 150,113 | 6,197 | 4,141 |
| 1972 | 2,725 | 263,000 | 16,840 | 9,569 | 148,913 | 10,153 | 6,782 | 497,263 | 15,069 | 12,264 | 148,058 | 6,150 | 4,117 |
| 1973 | 2,627 | 255,729 | 16,865 | 9,092 | 145,542 | 10,268 | 6,676 | 494,458 | 14,895 | 12,049 | 146,025 | 6,099 | 4,082 |
| 1974 | 2,533 | 247,956 | 16,895 | 8,849 | 141,950 | 10,387 | 6,463 | 491,612 | 14,742 | 12,724 | 144,007 | 6,051 | 3,964 |
| 1975 | 2,442 | 239,910 | 16,923 | 8,317 | 138,025 | 10,505 | 6,233 | 489,594 | 14,578 | 12,460 | 141,921 | 6,002 | 3,922 |
| 1976 | 2,353 | 231,305 | 16,941 | 8,025 | 133,753 | 10,619 | 6,080 | 487,476 | 14,423 | 12,348 | 139,840 | 5,950 | 3,902 |
| 1977 | 2,268 | 222,389 | 16,964 | 7,711 | 129,214 | 10,736 | 5,826 | 485,401 | 14,265 | 11,985 | 137,793 | 5,901 | 3,854 |
| 1978 | 2,186 | 213,136 | 16,985 | 7,903 | 124,304 | 10,855 | 5,541 | 483,120 | 14,099 | 12,461 | 135,745 | 5,851 | 3,753 |
| 1979 | 2,107 | 204,054 | 17,003 | 7,548 | 118,990 | 10,975 | 5,336 | 481,482 | 13,948 | 12,367 | 133,647 | 5,804 | 3,697 |
| 1980 | 2,332 | 194,599 | 16,111 | 13,063 | 113,351 | 10,895 | 5,031 | 479,901 | 15,272 | 11,980 | 131,540 | 5,667 | 3,667 |
| 1981 | 2,864 | 191,552 | 14,234 | 17,878 | 107,487 | 10,593 | 4,716 | 476,609 | 18,215 | 11,747 | 129,539 | 5,438 | 3,614 |
| 1982 | 2,762 | 195,197 | 14,251 | 22,719 | 101,609 | 10,716 | 4,473 | 470,141 | 18,035 | 12,069 | 127,715 | 5,396 | 3,581 |
| 1983 | 2,663 | 203,664 | 14,273 | 27,632 | 95,366 | 10,838 | 4,121 | 464,175 | 17,842 | 11,616 | 125,899 | 5,355 | 3,525 |
| 1984 | 2,568 | 217,023 | 14,303 | 32,031 | 88,649 | 10,962 | 3,835 | 457,949 | 17,642 | 11,325 | 124,070 | 5,313 | 3,405 |
| 1985 | 2,476 | 234,751 | 14,336 | 36,521 | 81,522 | 11,087 | 3,438 | 451,633 | 17,455 | 10,879 | 122,163 | 5,271 | 3,360 |
| 1986 | 2,387 | 256,937 | 14,369 | 41,205 | 73,873 | 11,211 | 3,101 | 445,057 | 17,258 | 11,338 | 120,252 | 5,229 | 3,311 |
| 1987 | 2,301 | 283,773 | 14,381 | 45,324 | 65,763 | 11,337 | 2,654 | 439,138 | 17,073 | 10,901 | 118,333 | 5,188 | 3,250 |
| 1988 | 2,219 | 314,716 | 14,401 | 48,959 | 57,080 | 11,467 | 2,260 | 432,966 | 16,886 | 10,531 | 116,395 | 5,148 | 3,195 |
| 1989 | 2,139 | 349,275 | 14,416 | 52,715 | 47,873 | 11,595 | 1,758 | 426,611 | 16,705 | 10,895 | 114,443 | 5,105 | 3,137 |
| 1990 | 2,061 | 387,573 | 14,427 | 51,330 | 38,036 | 11,720 | 4,467 | 420,800 | 16,508 | 10,492 | 112,475 | 5,061 | 3,076 |
| 1991 | 4,407 | 424,477 | 10,906 | 51,007 | 30,782 | 6,800 | 5,521 | 414,784 | 25,676 | 9,841 | 110,489 | 7,156 | 3,028 |
| 1992 | 6,584 | 464,577 | 7,505 | 51,051 | 29,504 | 1,896 | 6,823 | 398,949 | 34,697 | 9,676 | 106,361 | 9,250 | 2,833 |
| 1993 | 6,395 | 508,123 | 7,546 | 51,750 | 34,431 | 1,931 | 8,072 | 373,928 | 34,596 | 8,781 | 99,944 | 9,247 | 2,634 |
| 1994 | 6,208 | 552,327 | 7,635 | 51,787 | 40,571 | 1,967 | 9,263 | 348,112 | 34,454 | 7,912 | 93,331 | 9,237 | 2,430 |
| 1995 | 6,029 | 596,479 | 7,717 | 51,497 | 47,867 | 2,007 | 10,350 | 321,570 | 34,305 | 7,572 | 86,524 | 9,230 | 2,221 |
| 1996 | 5,854 | 640,259 | 7,785 | 51,541 | 56,209 | 2,043 | 11,437 | 294,838 | 34,187 | 6,694 | 79,515 | 9,220 | 2,053 |
| 1997 | 5,686 | 684,015 | 7,846 | 51,552 | 65,604 | 2,081 | 12,478 | 267,345 | 34,059 | 6,231 | 72,348 | 9,217 | 1,830 |
| 1998 | 5,521 | 727,721 | 7,895 | 51,927 | 76,001 | 2,120 | 13,474 | 239,517 | 33,954 | 5,348 | 64,961 | 9,209 | 1,604 |
| 1999 | 5,358 | 771,754 | 7,983 | 51,881 | 87,356 | 2,159 | 14,421 | 210,911 | 33,808 | 4,490 | 57,357 | 9,194 | 1,403 |
| 2000 | 5,203 | 815,652 | 8,064 | 49,271 | 99,619 | 2,200 | 16,053 | 181,593 | 33,663 | 3,886 | 49,566 | 9,188 | 1,166 |
| 2001 | 5,050 | 856,858 | 8,130 | 47,145 | 113,472 | 2,242 | 18,110 | 151,816 | 33,532 | 3,028 | 41,543 | 9,175 | 944 |
| 2002 | 4,904 | 895,873 | 8,189 | 45,598 | 129,340 | 2,285 | 19,730 | 121,313 | 33,396 | 2,323 | 33,312 | 9,170 | 697 |
| 2003 | 4,758 | 933,282 | 8,278 | 44,913 | 146,785 | 2,326 | 21,279 | 90,240 | 33,258 | 1,467 | 24,838 | 9,154 | 456 |
| 2004 | 4,619 | 969,197 | 8,360 | 42,837 | 165,738 | 2,369 | 22,767 | 58,449 | 33,118 | 671 | 16,140 | 9,145 | 201 |
| 2005 | 3,533 | 1,003,674 | 6,642 | 41,973 | 186,135 | 1,900 | 24,218 | 26,002 | 26,002 | 0 | 7,196 | 7,196 | 0 |
| 2006 | 2,930 | 1,039,005 | 48,345 | 43,400 | 208,453 | 27,832 | 23,812 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 2,930 | 1,034,060 | 48,407 | 45,017 | 204,434 | 27,764 | 23,352 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 2,930 | 1,030,670 | 48,530 | 46,933 | 200,022 | 27,632 | 22,843 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 2,930 | 1,029,073 | 48,712 | 48,960 | 195,233 | 27,437 | 22,284 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010 | 2,930 | 1,029,321 | 48,950 | 51,064 | 190,080 | 27,181 | 21,716 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2011 | 2,930 | 1,031,435 | 49,243 | 51,112 | 184,615 | 26,866 | 22,205 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012 | 2,930 | 1,033,305 | 49,589 | 51,107 | 179,954 | 26,494 | 22,182 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 2,930 | 1,034,823 | 50,371 | 51,375 | 175,642 | 25,713 | 22,144 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 2,930 | 1,035,827 | 51,064 | 51,706 | 172,074 | 25,058 | 22,094 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 2,930 | 1,036,469 | 51,482 | 52,048 | 169,110 | 24,672 | 22,032 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 2,930 | 1,037,035 | 51,528 | 52,367 | 160,470 | 24,630 | 21,957 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 2,930 | 1,037,873 | 51,646 | 52,843 | 163,797 | 24,522 | 21,869 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 2,930 | 1,039,070 | 51,833 | 53,385 | 161,145 | 24,350 | 21,771 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 2,930 | 1,040,623 | 52,301 | 53,957 | 158,566 | 23,886 | 21,663 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 2,930 | 1,042,279 | 52,694 | 54,573 | 156,343 | 23,475 | 21,544 | 0 | 0 | 0 | 0 | 0 | 0 |

**TABLE 22.—Projected Inventory Analysis**

| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1970 | 2,930 | 276,680 | 16,788 | 10,169 | 154,824 | 9,920 | 7,109 | 502,454 | 15,382 | 12,777 | 152,108 | 6,243 | 4,249 |
| 1971 | 2,826 | 270,060 | 16,814 | 9,753 | 152,013 | 10,037 | 6,937 | 499,850 | 15,232 | 12,645 | 150,113 | 6,197 | 4,141 |
| 1972 | 2,725 | 263,000 | 16,840 | 9,569 | 148,913 | 10,153 | 6,782 | 497,263 | 15,069 | 12,264 | 148,058 | 6,150 | 4,117 |
| 1973 | 2,627 | 255,729 | 16,865 | 9,092 | 145,542 | 10,268 | 6,676 | 494,458 | 14,895 | 12,049 | 146,025 | 6,099 | 4,082 |
| 1974 | 2,533 | 247,956 | 16,895 | 8,849 | 141,950 | 10,387 | 6,463 | 491,612 | 14,742 | 12,724 | 144,007 | 6,051 | 3,964 |
| 1975 | 2,442 | 239,910 | 16,923 | 8,317 | 138,025 | 10,505 | 6,233 | 489,594 | 14,578 | 12,460 | 141,921 | 6,002 | 3,922 |
| 1976 | 2,353 | 231,305 | 16,941 | 8,025 | 133,753 | 10,619 | 6,080 | 487,476 | 14,423 | 12,348 | 139,840 | 5,950 | 3,902 |
| 1977 | 2,268 | 222,389 | 16,964 | 7,711 | 129,214 | 10,736 | 5,826 | 485,401 | 14,265 | 11,985 | 137,793 | 5,901 | 3,854 |
| 1978 | 2,186 | 213,136 | 16,985 | 7,903 | 124,304 | 10,855 | 5,541 | 483,120 | 14,099 | 12,461 | 135,745 | 5,851 | 3,753 |
| 1979 | 2,107 | 204,054 | 17,003 | 7,548 | 118,990 | 10,975 | 5,336 | 481,482 | 13,948 | 12,367 | 133,647 | 5,804 | 3,697 |
| 1980 | 2,332 | 194,599 | 16,111 | 10,133 | 113,351 | 10,895 | 5,031 | 479,901 | 15,272 | 11,980 | 131,540 | 5,667 | 3,667 |
| 1981 | 2,864 | 188,622 | 14,234 | 12,373 | 107,487 | 10,593 | 4,716 | 476,609 | 18,215 | 11,747 | 129,539 | 5,438 | 3,614 |
| 1982 | 2,762 | 186,761 | 14,251 | 14,830 | 101,609 | 10,716 | 4,473 | 470,141 | 18,035 | 12,069 | 127,715 | 5,396 | 3,581 |
| 1983 | 2,663 | 187,339 | 14,273 | 17,398 | 95,366 | 10,838 | 4,121 | 464,175 | 17,842 | 11,616 | 125,899 | 5,355 | 3,525 |
| 1984 | 2,568 | 190,464 | 14,303 | 19,788 | 88,649 | 10,962 | 3,835 | 457,949 | 17,642 | 11,325 | 124,070 | 5,313 | 3,405 |
| 1985 | 2,476 | 195,949 | 14,336 | 22,294 | 81,522 | 11,087 | 3,438 | 451,633 | 17,455 | 10,879 | 122,163 | 5,271 | 3,360 |
| 1986 | 2,387 | 203,908 | 14,369 | 25,320 | 73,873 | 11,211 | 3,101 | 445,057 | 17,258 | 11,338 | 120,252 | 5,229 | 3,311 |
| 1987 | 2,301 | 214,859 | 14,381 | 27,795 | 65,763 | 11,337 | 2,654 | 439,138 | 17,073 | 10,901 | 118,333 | 5,188 | 3,250 |
| 1988 | 2,219 | 228,273 | 14,401 | 30,098 | 57,080 | 11,467 | 2,260 | 432,966 | 16,886 | 10,531 | 116,395 | 5,148 | 3,195 |
| 1989 | 2,139 | 243,970 | 14,416 | 32,523 | 47,873 | 11,595 | 1,758 | 426,611 | 16,705 | 10,895 | 114,443 | 5,105 | 3,137 |
| 1990 | 2,061 | 262,077 | 14,427 | 32,144 | 38,036 | 11,720 | 2,884 | 420,800 | 16,508 | 10,492 | 112,475 | 5,061 | 3,076 |
| 1991 | 4,407 | 279,794 | 10,906 | 31,742 | 29,200 | 6,800 | 3,309 | 414,784 | 25,676 | 9,841 | 110,489 | 7,156 | 3,028 |
| 1992 | 6,584 | 300,629 | 7,505 | 31,625 | 25,709 | 1,896 | 4,032 | 398,949 | 34,697 | 9,676 | 106,361 | 9,250 | 2,833 |
| 1993 | 6,395 | 324,749 | 7,546 | 32,143 | 27,845 | 1,931 | 4,748 | 373,928 | 34,596 | 8,781 | 99,944 | 9,247 | 2,634 |
| 1994 | 6,208 | 349,346 | 7,635 | 31,979 | 30,662 | 1,967 | 5,453 | 348,112 | 34,454 | 7,912 | 93,331 | 9,237 | 2,430 |
| 1995 | 6,029 | 373,689 | 7,717 | 31,677 | 34,147 | 2,007 | 6,097 | 321,570 | 34,305 | 7,572 | 86,524 | 9,230 | 2,221 |
| 1996 | 5,854 | 397,650 | 7,785 | 31,531 | 38,238 | 2,043 | 6,788 | 294,838 | 34,187 | 6,694 | 79,515 | 9,220 | 2,053 |
| 1997 | 5,686 | 421,396 | 7,846 | 31,393 | 42,983 | 2,081 | 7,472 | 267,345 | 34,059 | 6,231 | 72,348 | 9,217 | 1,830 |
| 1998 | 5,521 | 444,943 | 7,895 | 31,598 | 48,374 | 2,120 | 8,149 | 239,517 | 33,954 | 5,348 | 64,961 | 9,209 | 1,604 |
| 1999 | 5,358 | 468,646 | 7,983 | 31,423 | 54,403 | 2,159 | 8,816 | 210,911 | 33,808 | 4,490 | 57,357 | 9,194 | 1,403 |
| 2000 | 5,203 | 492,086 | 8,064 | 30,232 | 61,061 | 2,200 | 9,678 | 181,593 | 33,663 | 3,886 | 49,566 | 9,188 | 1,166 |
| 2001 | 5,050 | 514,254 | 8,130 | 28,903 | 68,539 | 2,242 | 10,534 | 151,816 | 33,532 | 3,028 | 41,543 | 9,175 | 944 |
| 2002 | 4,904 | 535,027 | 8,189 | 27,859 | 76,831 | 2,285 | 11,382 | 121,313 | 33,396 | 2,323 | 33,312 | 9,170 | 697 |
| 2003 | 4,758 | 554,697 | 8,278 | 26,647 | 85,928 | 2,326 | 12,223 | 90,240 | 33,258 | 1,467 | 24,838 | 9,154 | 456 |
| 2004 | 4,619 | 573,066 | 8,360 | 25,298 | 95,825 | 2,369 | 13,059 | 58,449 | 33,118 | 671 | 16,140 | 9,145 | 201 |
| 2005 | 3,533 | 590,005 | 6,642 | 24,172 | 106,514 | 1,900 | 13,916 | 26,002 | 26,002 | 0 | 7,196 | 7,196 | 0 |
| 2006 | 2,930 | 607,535 | 49,224 | 25,051 | 118,530 | 26,887 | 12,971 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 2,930 | 583,362 | 51,128 | 26,077 | 104,614 | 24,998 | 12,027 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 2,930 | 558,311 | 53,033 | 26,956 | 91,643 | 23,113 | 11,085 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 2,930 | 532,234 | 54,791 | 27,835 | 79,615 | 21,227 | 10,142 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010 | 2,930 | 505,278 | 56,695 | 28,860 | 68,529 | 19,340 | 9,198 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2011 | 2,930 | 477,443 | 58,600 | 29,739 | 58,387 | 17,454 | 8,255 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012 | 2,930 | 448,582 | 59,332 | 29,593 | 49,188 | 15,769 | 7,513 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 2,930 | 418,843 | 59,039 | 29,446 | 40,933 | 14,285 | 6,771 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 2,930 | 389,250 | 58,746 | 29,300 | 33,419 | 12,801 | 6,029 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 2,930 | 359,804 | 58,453 | 29,153 | 26,648 | 11,320 | 5,290 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 2,930 | 330,504 | 58,307 | 29,153 | 20,618 | 9,838 | 4,548 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 2,930 | 301,350 | 58,160 | 29,007 | 15,328 | 8,356 | 3,807 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 2,930 | 272,197 | 57,867 | 28,860 | 10,779 | 6,872 | 3,064 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 2,930 | 243,189 | 57,574 | 28,714 | 6,971 | 5,389 | 2,324 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 2,930 | 214,329 | 57,428 | 28,714 | 3,907 | 3,907 | 1,582 | 0 | 0 | 0 | 0 | 0 | 0 |

## Potential Nonindustrial Lessees

It should be emphasized that nonindustrial lessees would be eligible to participate in the program. A State forestry agency, for example, in a State having little acreage in State forests could take advantage of this program as a means of establishing demonstration timber growing areas. State parks could be given the protection of forested buffer areas. Intensive forestry could be practiced in the buffer areas without reducing the recreational use of interior lands.

The acquisition of leases or fee title for intensive game management is a growing practice among hunting clubs, private landowners and State agencies. If only 25 percent of the land included were devoted to intensive forestry, that 25 percent could qualify for the suggested program.

These considerations lead to the conclusion that the program could bring significant areas into full production for timber production that would otherwise contribute little to the wood needs of the Nation.



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**TABLE 23.—Costs by Years and Cumulative Costs**

[In thousands]

| Year | Cumulative acres leased | Cumulative dollars |
|---|---|---|
| 1970 | 1,465 | $14,650 |
| 1971 | 2,930 | 29,300 |
| 1972 | 4,395 | 43,950 |
| 1973 | 5,860 | 58,600 |
| 1974 | 7,325 | 73,250 |
| 1975 | 8,790 | 87,900 |
| 1976 | 10,255 | 102,550 |
| 1977 | 11,720 | 117,200 |
| 1978 | 13,185 | 131,850 |
| 1979 | 14,650 | 146,500 |
| 1980 | 16,115 | 161,150 |
| 1981 | 17,580 | 175,800 |
| 1982 | 19,045 | 190,450 |
| 1983 | 20,510 | 205,100 |
| 1984 | 21,975 | 219,750 |

## A Hypothetical Case Study

Assume that a private landowner in the South owned 300 acres on which the following conditions applied:

| Items | *Amount* |
|---|---|
| Value of currently standing timber | $150 per acre. |
| Predicted volume increase (next 10 yr) | 6 percent compound. |
| Predicted annual unit rate increase in 1973 dollars | 2 percent. |
| Conversion cost | $50 per acre. |
| Present land value | $100 per acre. |
| Land value 10 yr from now | $125 per acre. |
| Annual operating costs including ad valorem taxes | $2 per acre per year. |
| Marginal ordinary income tax bracket | 50 percent. |
| Tax basis in land | $12,500. |
| Tax basis in timber | $12,500. |

Assume further that the land lies in a qualified leasing block. Company A offers to include this 300 acres in its operations and to pay for the timber over the next 10 years in equal annual installments based on present value but paying 4 percent on unpaid balance. The landowner could sell the land, sell the land and timber 10 years from now, or enter into the lease agreement.

If the landowner sells the land, his net after taxes would be $75,000 − (25 percent × 50,000) = $62,500.

If he sells the land and timber 10 years hence, his yields would be as follows:

| Item: | *Amount* |
|---|---|
| Timber ($\$150 \times (1.08)^{10}$) | $323.85 |
| Land | 125.00 |
| Total per acre | 448.85 |
| Total for 300 acres | 134,655 |
| Tax basis | 25,000 |
| Taxable | 109,655 |
| Tax: | |
| $50,000 at 25 percent | 12,500 |
| $59,655 at 35 percent | 20,879 |
| | 33,379 |
| Net proceeds | 101,276 |
| Present worth at 4 percent | 68,422 |
| Less operating costs effective at 50 percent ($1.00×8.111×300) | 2,433 |
| Total | 65,989 |

If he enters into the lease, his results would be as follows:

| Item: | *Amount* |
|---|---|
| After tax yields: Rentals $5 per acre per year for 10 years at 4 per cent 8.111×5×300 | $12,166 |
| Timber: | |
| After tax: Timber basis 12,500/45,000=27.8 per cent. | |
| Annual tax: (4,500—1251)×0.25=812; 4,500—812=3,688×8.111 | 29,913 |
| Present worth of interest annualized (5.548—4,500)-1,048; 524.00×8.111 | 4,250 |
| Sale of land assumed 10 years hence to make examples parallel: | |
| Gross proceeds: $125×300 | 37,500 |
| Taxable: $37,500—$12,500 | 25,000 |
| Tax | 6,250 |
| Net proceeds | 31,250 |
| Present worth at 4 per cent ($31,250×0.6756) | 21,112 |
| | 67,441 |
| Less ½ ad valorem tax costs effective at 50 per cent (0.25×8.111×300) | 608 |
| Total | 66,833 |

From these calculations it appears that the best course for the landowner is to enter into the lease since an after tax present worth of $66,833 would be realized in comparison with $62,500 for immediate sale and $65,989 for deferred sale.

The forest industry would obtain control of 300 acres of land for a capital investment of $15,000 (for conversion) plus an annual commitment of $5,548 for the timber value. Volume growth would at least equal the interest rate paid to the landowner. The $15,000 investment under the lease is in contrast to capital investment of $75,000 if the land and timber were purchased.

The Government would spend $3,000 per year but would recover a total of $2,312 per year from a landowner in the 50 percent bracket for the first 10 years. This would be offset by a tax loss of some $272 from the forest industry paying the interest to the landowner.

The exact effects of any lease would be dependent on a number of variables including, but not limited to, land and timber characteristics, owner's financial and tax status, and the leasing firm's financial and tax status. However, the single example presented indicates that there are likely to be a significant number of cases where advantages would accrue to the landowner and leasing firm at a relatively low net cost to the Government.

## SUMMARY AND CONCLUSIONS

This study has analyzed the current status of inventory, cut, and growth for nonindustrial private woodlands. It has summarized the mechanics of existing and proposed assistance programs. It has examined the results that have been achieved. Financial returns from timber growing in all sections of the Nation have been evaluated using only one set of assumptions but which reflect current thought. A plan has been presented for consolidating all forms of assistance into one program.

The following conclusions are reached:

1. There is insufficient inventory on nonindustrial private holdings to sustain present removals;
2. The period during which removals become inadequate can be varied by manipulation of the timing and extent of cutting;
3. The present level of assistance has no significant effect on the intensity of forest practice;
4. Increased planting now will have no significant effect on supply until after 2000;
5. An increased supply during projected deficit periods can be achieved only by placing management policy in the hands of entities whose overriding objective is to maximize long-range wood availability; and
6. Government subsidized leases from private owners by forest industry or other groups interested in timber production offer the most efficient way to change management motivation.

## APPENDIX

### A Summary of State Laws Regulating Cutting Practices

| State and administrative agency | Title of act and reference | Method of establishing practices | Forest practice rules | Violations and penalties | Special features |
|---|---|---|---|---|---|
| California—Division of Forestry. | Forest Practice Act of 1945 as amended codified in division 4, ch. 8. Public Resources Code. Specific rules filed in California Administrative Code, title 14, division 2. | Preliminary rules made by district forest practice committees consisting of forest-land owners and the environmentally minded public. Rules are submitted to the State board of forestry for approval. State board of forestry in emergencies may adopt temporary rules. Alternate plans submitted by timber owners or timber operators are acceptable. | State is divided into four districts with separate rules for each. Summary of the rules: Redwood—Leave 40 to 80 seed trees, depending upon age, on each 10 acre-block. Mixed conifer—18- to 22-in diameter limit depending on type and age class. On small timber, leave 100 to 300 trees of the largest class. Lodgepole pine—leave 5 percent of the stand uncut on each 40-acre block. Keep logging damage to a minimum. Take fire prevention measures. Forest-land owners and timber operators must register with the State. | Failure by the owner to notify State forester of proposed timber operations is a misdemeanor. Misdemeanor to operate without a permit. Noncompliance results in the revocation of operating permit. State forester may take steps to correct violations in the forest practice rules. Any expenses involved up to $100 per acre are placed as a lien against the property. | District forest practice committees determine the practices that are submitted to the State board of forestry for approval. Committee membership consists of forest-land owners and members of the public concerned with the environmental aspects of timber operations. Changes in forest practice rules are initiated by district committees. |
| Florida—Forest Service and Commission of Agriculture. | Seed Tree Law, 1943 (ch. 21940. Law of 1943). | By State legislature in basic act. | Leave from 3 to 8 seed trees per acre marked in accordance with the rules and practice of good forestry. | Cutting or destroying seed trees is a misdemeanor punishable by $55 maximum fine. | Law applies to those landowners who request to have seed trees marked. Title to marked seed trees passes to the State. |

| State and administrative agency | Title of act and reference | Method of establishing practices | Forest practice rules | Violations and penalties | Special features |
|---|---|---|---|---|---|
| Idaho—Cooperative Board of Forestry. | Cooperative Sustained Yield Districts Law, 1937 (ch. 140, Sessions Law 1937). | By State legislature in basic act. | Ponderosa pine—16-in diameter limit in mature stands; leave 200 pole sized trees in immature stands; or 4 16-in seed trees per acre where no advanced reproduction exists.<br>White pine—12-in diameter limit in mature stands; leave 300 pole sized trees in immature stands; or 10 12-in seed trees per acre where no advanced reproduction exists.<br>Owner must file intent to cut. | $50 fine for each acre upon which seed trees are not left. | Uncut young growth trees not taxed. Act applies to forest areas over 5 acres in size. |
| Louisiana—State Forester. | Turpentine Seed Tree Law, 1922. (ch. 4, Laws of 1922). | By legislature in basic acts. | Leave uncut and unbled 2 seed trees per acre, not less than 10-in in diameter of the species being cut. | Maximum $100 or 3-mo imprisonment for violations. | Law applies to trees worked for naval stores. |
| Maryland—Department of Forests and Parks. | Forest Conservancy Districts Act-1943 (ch. 722 acts of 1943). | General framework rules by State legislature. District rules by district forestry boards made up of forest owners and operators. Rules subjected to local public discussions before final adoption. | General framework rules Leave conditions favorable for regrowth. Leave young growth undisturbed as far as possible. Leave seed trees of suitable size and species to obtain restocking. Maintain adequate growing stock after partial cutting. | Violation is a misdemeanor punishable by $10 to $500 fine or maximum 6 mo imprisonment. | Act applies to woodlands 3 or more acres in size. District forestry boards determine iocal practices. |
| Massachusetts—Division of Forestry. | Forest Cutting Practices Act of 1943 as amended (ch. 539 of the acts of 1943). | Tentative rules developed by State forestry committee representing woodland owners and the general public. Rules subjected to local public hearings. Rules are submitted to commissioner of conservation for final approval. Practices may be amended by petition of 25 or more owners or operators. | Leave from 4 to 25 seed trees of desirable species depending upon diameter of seed trees Coniferous seed trees should be left surrounded with young trees for protection Clearcutting permitted if area has 1,000 or more seedlings per acre or if stand is injured beyond recovery by fire, insects or disease. Keep logging damage to residual trees to a minimum. No cutting of seed trees allowed until ground is stocked with 1,000 or more seedlings per acre. Timber operators must obtain license. | Failure to give notice of intent to cut or noncompliance with written plan is punishable by a $25 maximum fine for each acre on which violation occurred. Failure to obtain operator's license punishable by maximum fine of $25 for each violation. | Compulsory advice type law; forester makes written cutting plan. Forest land owners have voice in making rules through State forestry committee and local hearings. Act does not apply to cuttings of less than 25,000 or 50 cords on 1 land parcel. |
| Mississippi—Forestry Commission. | Forest Harvesting Act 1944 (ch. 420 laws of 1944). | By State legislature in basic act. Alternate plans acceptable. | Naval stores: Work no trees less than 10 in in diameter unless 100 4-in or 4 10-in trees remain uncut per acre.<br>Wood products: Pine sites—leave at least 4 10-in pine seed trees per acre. Hardwood sites—leave at least 6 10-in hardwood seed trees per acre. Mixed sites—leave at least 4 10-in pines and 2 10-in hardwoods per acre as seed trees. | Violation judged on basis of 40-acre tract; punishable by maximum $50 fine. | Enforcement aided by local law enforcement officers. |
| Missouri—Conservation Commission. | State Forestry Act 1945 (ch. 254 laws of 1945). | Conservation Commission sets up broad rules of forest practice to be followed by those who wish to have lands classified as "forest crop lands." District forester prepares management and cutting plan for each property. Owner may submit own plan of operation. | General forest practice rules:<br>1. Provide for adequate restocking of trees of desirable species and condition.<br>2. Reserve growing stock to keep land reasonably productive.<br>3. Use reasonable effort to prevent and suppress fires.<br>4. Control grazing to maintain adequate stocking. District forester prepares management and specific cutting plan for each property. | Violation a misdemeanor. Noncompliance on classified lands makes owner liable for all back taxes at normal property rate plus penalty plus reimbursement to State for taxes paid to county. | Has tax reduction feature for good practices. Harvested material subject to graduated yield tax. Land assessed at $1 per acre for maximum of 25 yr. |

| State and administrative agency | Title of act and reference | Method of establishing practices | Forest practice rules | Violations and penalties | Special features |
|---|---|---|---|---|---|
| Nevada—Department of Conservation and Natural Resources. | Act to Preserve Young Forest Trees, 1903, as amended (laws of 1903). | By State legislature in basic act and amendments. | Cut no white, yellow, or sugar pine, or fir, tamarack, spruce, or flat leaved cedar that is less than 1 ft in diameter 2 ft above the ground. | Violation is a misdemeanor punishable by $500 fine or 6 mo imprisonment. | Act forbids the selling of lumber cut from trees less than 1 ft in diameter. |
| | Nevada Forest Practice Act of 1955 as amended by Senate bill No. 168 (ch. 626, Nevada Revised Statutes). | By State legislature in basic act and amendments. | Timber owners must have logging permits or timberland conversion permits. Application for permit must be accompanied by a performance bond and a logging plan or a timberland conversion plan. Timber owners and/or timber operators must sow grass on skid trails, landings, and on unmaintained logging roads. In areas of old-growth timber, all trees 18-in d.b.h. or less are to be left uncut with at least 10 well located seed trees 18-in d.b.h. or larger to be left per acre. In areas of young growth and prior-cut timber harvested for sawlogs and veneer logs, the same rules apply as in old-growth stands of timber. No tractor logging is allowed on slopes of 30 percent or steeper or on saturated soils. This does not apply in timberland conversion operations. State board of forestry and fire controls makes rules concerning skid trails, felling techniques, stump heights, etc.; to protect reserve timber. | State forester fire-warden reduces performance bond proportionately equal to number of acres adequately seeded or reforested out of the total acreage covered in permit. In timberland conversion bond is reduced proportionately equal to the number of acres adequately stabilized or rehabilitated out of the total acreage covered in the permit. | Performance bonds must be sent with application for logging permits or timberland conversion permits. Timber owners or operators must sow grass on skid trails, landings, and unmaintained logging roads. No tractor logging on slopes of 30 percent or steeper or on saturated soils. |
| New Hampshire—Department of Resources and Economic Development. | Act Relating to Forest Conservation and Taxation (Revised Statues Annotated of New Hampshire, ch. 79, 148, 149, and 224). | By State legislature in basic act. | Owners must apply for permit to cut and file a notice of intent to cut. Owners must submit report of all timber cut during tax year. Timber operators must apply to Water Supply and Pollution Control Commission before altering any land near a body of water. No more than 50 percent of merchantable timber can be cut within 200 ft of a public body of water, navigable stream, or public highway without permission from State forester or county forester in area. | Failure to apply for permit to cut is a misdemeanor with a fine not to exceed $50. Misdemeanor with fine of $100 if owner fails to make a report of cut for the year. Violations of logging near a body of water without written permission can result in fines of up to $1,000 per day. Failure to report amount cut by timber owner can result in a doubling of taxes on the amount of timber removed from owner's land. | Laws are a combination of forest tax laws and laws governing cutting practices. Law includes a yield tax of 10 percent. |
| New Mexico—Department of State Forestry. | Act for the Protection of Public and Private Forest Lands (New Mexico Statutes, annotated, Constitution of New Mexico-article XV, sec. 62—1-2). | By State legislature in basic act. | Lumber products—leave all trees under 12-in diameter and at least 2 17-in seed trees per acre. Ties, mine timbers, etc.—leave all trees under 5 in diameter and at least 4 17-in seed trees per acre. On spruce type areas, or on mixed spruce and fir type areas, if an adequate stand of young growth is not present, leave uncut at least 5 percent of the coniferous trees, many of which should be of seed bearing size. Keep logging damage to a minimum. Take all precautions to prevent and suppress fire. | Violation is a misdemeanor punishable by $200 fine or 6 mo imprisonment. | Minimum cutting diameter in same stands varies with type of product cut. |

| State and administrative agency | Title of act and reference | Method of establishing practices | Forest practice rules | Violations and penalties | Special features |
|---|---|---|---|---|---|
| New York—State Department of Environmental Conservation. | New York Forest Practice Act, 1946 (sec. 60-d. Conservation Law 1946. Recoded 1966). | Tentative rules developed by district forest practice boards. Rules submitted to State forest practice board which develops uniform standards. These must be approved by the State conservation commissioner. | Owners who become cooperators must agree to manage their lands based on a plan approved by district director. Owners who become cooperators must take precautionary measures against fire, eliminate grazing by domestic animals, rehabilitate idle lands, and enhance value of immature forest stands through improvement practices. Owners must advise district director of any timber sale on his woodland. On high and medium quality sites, individual tree selection is recommended. On low quality sites, clear cutting is recommended. In uneven-aged stands, the selection system of cutting will be applied. High quality hardwoods under 16 in d.b.h. and softwood species under 12 in d. b. h. will not be cut. In even-aged stands, cutting recommendations vary with species, age class, and stand conditions. Logging roads, skid trails, log decks, and yards must be located so as to minimize damage to site, stand, and other values. Roads must be stabilized after cutting. | Compliance is voluntary. Noncompliance after signing cooperative agreement results in discontinuing of management services by State forester. | Management and market services extended to owners signing cooperative agreement to comply with act. |
| Oregon—State Board of Forestry. | Oregon Forest Practices Act, 1971 (chap. 527 or 527.610 to 527.730). | Rules developed by regional forest practice committees. Rules recommended to board of forestry for approval. State board of forestry designates types of operations for which notifications of commencement of operations will be submitted. | Eastern, Northwestern, and Southwestern Regions: Landings, skid trails, and fire trails must be located and property drained to minimize the risk of pollution to streams. Roads must be located, designed, and constructed so as to minimize damage to water quality of streams and to minimize alteration of natural features. Residual trees must be of sufficient vigor and of acceptable species to assure continuous growth and harvesting. Logging methods and types of equipment must be adapted to slope landscape and soil properties. All waste material associated with harvesting must be left in such a manner as to prevent it from entering streams. Skidding and cable yarding should be avoided. When logging along streams, enough timber should be left along streams to provide up to 75 percent of the original shade over the stream. Eastern and Southwestern Regions only: When stocking of acceptable species is reduced below 25 percent, 100 seedlings and/or saplings must be established per acre. Northwestern Region only: When stocking of acceptable species is reduced below 25 percent, 150 seedlings and/or saplings must be established per acre. Operators, timber owners, or land owners must notify State forester of commencement of operations. | Failure to notify State forester of commencement of operations is a misdemeanor. | Failure to comply with order to repair damage caused by violations of rules can result with the State forester making the repairs and the cost is placed as a lien against the property of the violator. |

## A Summary of State Laws Regulating Cutting Practices—Continued

| State and administrative agency | Title of act and reference | Method of establishing practices | Forest practice rules | Violations and penalties | Special features |
|---|---|---|---|---|---|
| Vermont—Board of Forests and Parks. | Conservation and Management of Forest Land Law, 1945 (chap. 301, Laws of 1945, amended by laws of 1951). | Practices prescribed by the State board of forests and parks. | Partial cutting: 1. Spruce fir—leave 400 thrifty trees 3 to 8 in d.b.h. or a proportionate mixture of these trees over 9 in d.b.h. up to 350 3 to 8 in and 15 over 9 in d.b.h. per acre. 2. Northern hardwoods—leave over 300 hardwoods, 2–6 in d.b.h. or 30 trees over 12 in or 120 trees 6 to 11 in, or a graduation of these sizes on basis of 4 trees 11 in d.b.h. equal 1 tree 12 in and over. Clearcutting—allowed where 1,000 young trees 2 or more feet high per acre are present or where stand is over mature and owner will assure artificial regeneration. | No penalties involved for noncompliance. | Prescribed practices may be changed, when appropriate, by State Board of Forests and Parks. Practices are advisory in character and not mandatory. |
| Virginia—Division of Forestry, Department of Conservation and Economic Development. | Virginia Seed Tree Law (title 10, article 6 (Virginia Code) as amended 1972, secs. 10–75 through 10–83.01). | By State legislature in basic act. | Applies where tulip poplar, or loblolly, shortleaf, pond, or white pine constitute 10 percent or more of a stand of trees 6 in or more in diameter at stump height. Leave 8 14-in loblolly, shortleaf, pond or white pines per acre. Leave 2 14-in tulip poplars per acre. If 14-in seed trees or greater are not available, 2 trees of the next largest diameter class must be left. Seed trees must be left uncut for 3 yr. | Violations of rules are misdemeanors and punishable by fines of $10 for each seed tree cut with total not exceeding $80. | Timber owners who fail to carry out terms of a State-approved management plan are liable to suit by the State of Virginia for money required to regenerate the area. |
| Washington—Division of Forestry, Department of Natural Resources. | Forest Practices Act, 1945 (chap. 193, Laws of 1945. Amended by chap. 218, Laws of 1947, chap. 44, laws of 1953). | By State legislature in basic act. Alternate plans acceptable. | State divided into east and west side of Cascade Mountains. Eastside of Cascade Mountains: Ponderosa pine—16-in diameter limit with a minimum of 4 16-in seed trees per acre. Where stand does not permit leaving of at least minimum number of seed trees, leave 4 trees of other commercial species per acre. Lodgepole pine—leave 5 percent of each 40-acre block uncut. Westside of Cascade Mountains leave 5 percent of each 160-acre block well stocked with conifers not less than 16-in d.b.h. Operators must register. | Misdemeanor to operate without permit. Permit revokable for noncompliance or failure to post bond. Bond forfeited if natural reproduction fails to restock area within 5 yr. | Requires posting of $24 bond for each acre cut in violation. If natural reproduction fails to restock area in 5 yr, bond is forfeited and used by State to replant area. |

## A Digest of State Sponsored Forest Incentive Programs

| State | Program | Authority | Purpose of program | Specific forestry assistance | Landowner regulations |
|---|---|---|---|---|---|
| Connecticut | Forest classification program. | Public Act No. 697 | The purpose of this program is to encourage the reforestation of land valuable for timber production by lowering the tax rate on classified forest land. | Forest lands are taxed at the local rate, but not exceeding 10 mills of the value established. The land is revalued in 50 yr and taxed at the local rate, but not exceeding 10 mills on the value established. After this period, the land is revalued and taxed at the local rate. | The tract must be 25 acres or larger and suitable for the production of timber. The land must be worth not more than $100 per acre exclusive of timber. Partially stocked stands must be planted with enough trees to have a stocking of 700 trees per acre. Proper forest conditions must be maintained by the owner. |
| Hawaii | Tree farm program | Tree farm law | The purpose of this program is to improve the quality and enlarge the amount of timber growing on privately owned woodlands by subjecting the woodlands to good forestry management practices. | Property classified as tree farm property is exempt from real property taxes. | The property must be 30 acres or larger to be classified as a tree farm. Each year after the application for the tree farm is approved, the applicant must establish trees of a designated species or apply good forestry practices on areas already adequately stocked with commercial species on not less than 1/40 of the acreage in the entire tree farm or 5 acres, whichever is larger, until the entire acreage is under good forestry practices. |

| State | Program | Authority | Purpose of program | Specific forestry assistance | Landowner regulations |
|---|---|---|---|---|---|
| Indiana | Forest classification program. | Forest Classification Act, 1921. Amended 1945, 1947, and 1967. | This program is aimed at encouraging timber production and protecting watersheds. | Forest classified as forest plantations or native forests are assessed at $1 per acre. | The area must be 10 acres or larger and must be recently surveyed to be classified. Dwellings cannot be situated on the land. No land classified under the act is to be grazed by domestic animals. Land classified under this act must be marked with posters The State forester or his agent will inspect the land every 5 yr and make recommendations. |
| Massachusetts | Classification and taxation of forest lands and forest products. | Classified forest tax law, 1943. Amended 1969. | The purpose of this program is to improve the quantity and quality of a continuous forest crop. | Landowners who have classified land are entitled to a tax exemption. | Classified land must be 10 acres or larger. Landowners must submit a management plan for approval. Landowners are to notify the State forester when cutting is to be done. |
| Michigau | Farm woodlot incentive program. | Farm Woodlot Act, 1917. Amended 1960. | This program is aimed at encouraging private forestry and the care and management of private forests. | Private forest reservations are assessed at $1 per acre if the owner complies with all the standards set by the act. | Forest reservations must be 40 acres or less. Newly established forests must contain at least 1,200 trees per acre. In 10 yr the forest must contain 500 trees per acre; and in 25 yr, the forest must contain 250 trees per acre. If a stand of young growth has not emerged in 2 yr after a cutting, the area must be restocked to meet stocking levels of 1,200 trees per acre. |
| Michigan | Commercial forest establishment program. | Commercial Forest Act, 1925. Amended through 1970. | The purpose of this act is to encourage reforestation and proper forest management on lands valuable for the purpose of growing timber. | Lands approved as commercial forests are exempt from the general ad valorem taxes, but are subject to a specific tax of 15 cents per acre. | Owners of commercial forest must make applications to the Department of Natural Resources for a permit to act before cutting operation can begin. Harvesting of forest products on commercial forests is limited to the areas species, and classes of products identified in the cutting permits issued by the Department. This land may not contain buildings or improvements other than those used exclusively for forest management or logging operations. Landowners must open the land to the public for hunting and fishing purposes. This land is not to be used for any commercial purpose other than the production of forest products. |
| New York | Program granting a tax relief to qualifying owners. | Fisher forest tax law | The purpose of this program is to promote continuity of woodland ownership and establish a more stable forest economy. | Eligible lands are not assessed at a higher valuation than similar lands without substantial forest growth in the same town. The assessment is never to exceed the valuation fixed at the time the application is filed. The land is assessed at a lower rate so long as the forest growth remains uncut or is under the direction of the Conservation Department. These obligations and benefits will devolve upon all successors or assigns. | Landowners must notify the tax assessor within 30 days of their intention to cut. Landowners must pay a 6 percent tax on the value of the stumpage cut before the timber is removed from the land. Landowners can make improvement cuttings upon approval of the Conservation Department. Landowners must harvest mature timber in accordance with the recommendations of the Conservation Department. |

| State | Program | Authority | Purpose of program | Specific forestry assistance | Landowner regulations |
|---|---|---|---|---|---|
| North Dakota | Woodland tax program. | Native woodland tax law. | The purpose of this program is to encourage the establishment of forest cover on privately owned woodlands and to encourage the use of good management practices on the lands. | Landowners are entitled to a lower real property tax as determined by the county in which the native woodland is located. | Landowners must practice good forest management practices on the land. Native woodlands must not be cleared, grazed, cut, or burned. The tract must be 10 acres or larger. |
| Oregon | A deferred tax program. | The forest fee and yield tax law. | The purpose of this program is to promote the establishment of new crops on cutover or denuded land, to encourage thinnings and improvement cuttings, and to discourage premature harvesting of forest crops. | Land classified under this act is exempt from ad valorem taxes and a yield tax is placed on the timber when it is harvested. | Landowners must pay an annual forest fee of 10 cents per acre in Western Oregon and an annual fee of 5 cents per acre in eastern Oregon. |
| Virginia | New reforestation of timberlands program. | Reforestation of Timberlands Act 1970. | The purpose of this program is to protect and preserve the forest resources of the state of Virginia by means of reforestation and continuous growth of timber on lands that are suitable for that purpose. | To prepare the land and plant trees, the landowner may rent state equipment, use his own equipment, or hire the work done by contractors. Landowners are eligible to receive 50 percent of the costs incurred but not to exceed $20 per acre, or the landowner is eligible to receive a loan free of interest, up to 75 percent of the costs incurred, not to exceed $30 per acre, for preparing and planting the area. The loan is supported by a lien on the property. | The number of acres must not exceed 500 in any 1 year. Site preparation and planting must be done in accordance with the recommendations of the Division of Forestry. If a crop of timber has been harvested under the direction of the State forester within 30 yr after planting, the landowner is released from his lien by repaying the loan. Landowners must notify the State forester before any timber is cut from the lands under this law. |

## Present Worth of Future Rotations

### Western White Pine

Present worth of future rotations—Site index 60: Pulpwood prices—Thinnings, 4.00; harvest, 4.50; sawtimber 28.00; costs—Annual, 2.00; site prep and plant—Initial, 90.00; recurring, 68.00; tax rates—Capital gains, 0.30; ordinary income, 0.50.

*Rotation interest rate*

| | 0. 010 | 0. 040 | 0. 020 | 0. 030 |
|---|---|---|---|---|
| 20 | −324. 947 | −137. 933 | −199. 155 | −158. 017 |
| 25 | −210. 629 | −116. 894 | −147. 341 | −126. 836 |
| 30 | −114. 426 | −101. 427 | −105. 542 | −102. 794 |
| 35 | −23. 401 | −88. 420 | −67. 380 | −81. 690 |
| 40 | 45. 768 | −79. 927 | −39. 637 | −67. 104 |
| 45 | 148. 531 | −68. 637 | 0. 170 | −46. 937 |
| 50 | 232. 254 | −61. 210 | 30. 723 | −32. 516 |
| 55 | 298. 823 | −56. 736 | 53. 353 | −22. 756 |
| 60 | 351. 687 | −54. 305 | 69. 884 | −16. 418 |

### Loblolly Pine

Present worth of future rotations—Site index 80: Pulpwood prices—thinnings, 7.00; harvest, 8.00; sawtimber, 60.00; costs—annual, 2.00; site prep and plant—initial, 41.00; recurring, 31.00; tax rates—capital gains, 0.30; ordinary income, 0.50.

*Rotation interest rate*

| | 0. 040 | 0. 050 | 0. 060 | 0. 070 |
|---|---|---|---|---|
| 20 | 46. 001 | 20. 401 | 3. 837 | −7. 574 |
| 25 | 97. 170 | 54. 520 | 27. 310 | 8. 866 |
| 30 | 118. 209 | 66. 099 | 33. 421 | 11. 703 |
| 35 | 132. 787 | 72. 662 | 35. 684 | 11. 644 |
| 40 | 134. 090 | 70. 273 | 31. 850 | 7. 457 |
| 45 | 124. 739 | 61. 406 | 24. 118 | 1. 015 |
| 50 | 113. 083 | 51. 650 | 16. 318 | −5. 040 |
| 55 | 99. 958 | 41. 629 | 8. 867 | −10. 468 |
| 60 | 88. 114 | 32. 917 | 2. 648 | −14. 809 |

JACK-PINE

Present worth of future rotations—Site index 55: Pulpwood prices—thinnings, 4.00; harvest, 4.50; sawtimber, 39.00; costs—annual, 2.00; site prep and plant—initial, 66.00; recurring, 50.00; tax rates—capital gains, 0.30; ordinary income, 0.50.

*Rotation interest rate*

| | 0. 010 | 0. 040 |
|---|---|---|
| 20 | −208. 003 | −97. 301 |
| 25 | −127. 806 | −83. 358 |
| 30 | −61. 282 | −73. 463 |
| 35 | −1. 059 | −65. 760 |
| 40 | 36. 078 | −62. 220 |
| 45 | 63. 447 | −60. 471 |
| 50 | 79. 381 | −60. 332 |
| 55 | 88. 478 | −61. 009 |
| 60 | 93. 503 | −62. 073 |

DOUGLAS-FIR

Present worth of future rotations—site index 160: pulpwood prices—thinnings, 5.00; harvest, 6.00; sawtimber, 71.00; costs—annual, 2.00; site prep and plant—initial, 90.00; recurring, 68.00; tax rates—capital gains, 0.30; ordinary income, 0.50.

*Rotation interest rate*

| | 0. 040 | 0. 060 |
|---|---|---|
| 20 | −81. 781 | −88. 307 |
| 25 | −23. 355 | −60. 005 |
| 30 | 18. 286 | −42. 644 |
| 35 | 121. 370 | . 188 |
| 40 | 180. 637 | 19. 461 |
| 45 | 241. 886 | 36. 581 |
| 50 | 271. 275 | 39. 578 |
| 55 | 282. 950 | 35. 769 |
| 60 | 280. 350 | 27. 610 |

## Projection No. 1.—Projected Inventory Analysis

| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1970 | 2,930 | 276,943 | 6,153 | 10,315 | 154,824 | 3,439 | 7,478 | 502,455 | 11,163 | 12,894 | 152,055 | 3,378 | 4,255 |
| 1971 | 2,930 | 281,106 | 6,387 | 11,341 | 158,863 | 3,609 | 7,561 | 504,186 | 11,456 | 12,601 | 152,932 | 3,474 | 4,284 |
| 1972 | 2,930 | 286,060 | 6,651 | 11,077 | 162,815 | 3,785 | 7,754 | 505,332 | 11,749 | 12,308 | 153,741 | 3,574 | 4,308 |
| 1973 | 2,930 | 290,487 | 6,914 | 10,814 | 166,784 | 3,970 | 7,930 | 505,891 | 12,042 | 13,217 | 154,475 | 3,677 | 4,325 |
| 1974 | 2,930 | 294,387 | 7,178 | 11,722 | 170,744 | 4,163 | 8,205 | 507,066 | 12,364 | 12,895 | 155,123 | 3,782 | 4,337 |
| 1975 | 2,930 | 298,931 | 7,471 | 11,429 | 174,786 | 4,368 | 8,343 | 507,597 | 12,686 | 12,572 | 155,678 | 3,891 | 4,451 |
| 1976 | 2,930 | 302,889 | 7,764 | 11,136 | 178,762 | 4,582 | 8,575 | 507,483 | 13,009 | 13,364 | 156,245 | 4,005 | 4,454 |
| 1977 | 2,930 | 306,261 | 8,057 | 11,928 | 182,754 | 4,808 | 8,675 | 507,838 | 13,360 | 13,012 | 156,694 | 4,122 | 4,445 |
| 1978 | 2,930 | 310,132 | 8,379 | 11,605 | 186,621 | 5,042 | 8,862 | 507,489 | 13,712 | 12,660 | 157,018 | 4,242 | 4,431 |
| 1979 | 2,930 | 313,358 | 8,702 | 12,309 | 190,441 | 5,288 | 9,026 | 506,438 | 14,064 | 12,309 | 157,206 | 4,365 | 4,410 |
| 1980 | 2,930 | 316,966 | 9,053 | 17,817 | 194,180 | 5,546 | 9,267 | 504,683 | 14,415 | 12,954 | 157,252 | 4,491 | 4,384 |
| 1981 | 2,930 | 325,730 | 9,405 | 24,000 | 197,900 | 5,818 | 9,381 | 503,222 | 14,796 | 12,573 | 157,144 | 4,620 | 4,449 |
| 1982 | 2,930 | 340,325 | 9,786 | 29,186 | 201,463 | 6,103 | 9,566 | 500,999 | 15,177 | 12,192 | 156,973 | 4,755 | 4,408 |
| 1983 | 2,930 | 359,725 | 10,167 | 35,574 | 204,926 | 6,402 | 9,721 | 498,014 | 15,558 | 12,720 | 156,625 | 4,893 | 4,361 |
| 1984 | 2,930 | 385,132 | 10,577 | 40,730 | 208,246 | 6,715 | 9,847 | 495,176 | 15,968 | 12,309 | 156,094 | 5,033 | 4,396 |
| 1985 | 2,930 | 415,285 | 10,987 | 47,030 | 211,378 | 7,043 | 10,029 | 491,517 | 16,378 | 12,749 | 155,456 | 5,180 | 4,334 |
| 1986 | 2,930 | 451,329 | 11,427 | 52,185 | 214,364 | 7,389 | 10,176 | 487,888 | 16,818 | 12,310 | 154,611 | 5,329 | 4,349 |
| 1987 | 2,930 | 492,060 | 11,866 | 58,370 | 217,151 | 7,752 | 10,287 | 483,380 | 17,257 | 11,870 | 153,631 | 5,484 | 4,273 |
| 1988 | 2,930 | 538,563 | 12,335 | 63,468 | 219,687 | 8,133 | 10,364 | 477,993 | 17,697 | 12,193 | 152,419 | 5,643 | 4,267 |
| 1989 | 2,930 | 589,696 | 12,804 | 69,592 | 221,917 | 8,532 | 10,478 | 472,489 | 18,166 | 11,724 | 151,044 | 5,807 | 4,176 |
| 1990 | 2,930 | 646,485 | 13,302 | 70,090 | 223,864 | 8,951 | 13,716 | 466,048 | 18,634 | 11,959 | 149,413 | 5,974 | 4,150 |
| 1991 | 2,930 | 703,273 | 13,829 | 69,563 | 228,629 | 9,390 | 15,234 | 459,372 | 19,132 | 11,461 | 147,590 | 6,147 | 4,112 |
| 1992 | 2,930 | 759,007 | 14,357 | 69,973 | 234,473 | 9,850 | 16,770 | 451,700 | 19,631 | 10,962 | 145,555 | 6,325 | 4,062 |
| 1993 | 2,930 | 814,623 | 14,913 | 70,325 | 241,393 | 10,334 | 18,264 | 443,032 | 20,129 | 11,080 | 143,292 | 6,510 | 3,939 |
| 1994 | 2,930 | 870,035 | 15,499 | 70,618 | 249,323 | 10,840 | 19,709 | 433,983 | 20,656 | 10,553 | 140,721 | 6,697 | 3,869 |
| 1995 | 2,930 | 925,154 | 16,114 | 70,003 | 258,191 | 11,371 | 21,162 | 423,880 | 21,183 | 10,582 | 137,893 | 6,891 | 3,787 |
| 1996 | 2,930 | 979,043 | 16,730 | 70,208 | 267,983 | 11,928 | 22,560 | 413,279 | 21,740 | 10,025 | 134,789 | 7,090 | 3,693 |
| 1997 | 2,930 | 1,032,522 | 17,374 | 70,355 | 278,616 | 12,511 | 23,958 | 401,564 | 22,297 | 9,967 | 131,392 | 7,295 | 3,588 |
| 1998 | 2,930 | 1,085,503 | 18,048 | 70,443 | 290,063 | 13,123 | 25,300 | 389,234 | 22,883 | 9,381 | 127,684 | 7,506 | 3,471 |
| 1999 | 2,930 | 1,137,898 | 18,752 | 70,473 | 302,240 | 13,765 | 26,625 | 375,733 | 23,469 | 9,235 | 123,649 | 7,723 | 3,342 |
| 2000 | 2,930 | 1,189,619 | 19,484 | 68,393 | 315,101 | 14,439 | 28,290 | 361,499 | 24,084 | 8,620 | 119,268 | 7,946 | 3,242 |
| 2001 | 2,930 | 1,238,528 | 20,246 | 65,961 | 328,952 | 15,145 | 29,928 | 346,034 | 24,699 | 8,385 | 114,564 | 8,177 | 3,087 |
| 2002 | 2,930 | 1,284,244 | 21,037 | 63,764 | 343,735 | 15,886 | 31,531 | 329,720 | 25,344 | 7,741 | 109,474 | 8,414 | 2,920 |
| 2003 | 2,930 | 1,326,971 | 21,857 | 61,508 | 359,380 | 16,665 | 33,055 | 312,117 | 25,989 | 7,419 | 103,980 | 8,658 | 2,774 |
| 2004 | 2,930 | 1,366,622 | 22,707 | 58,901 | 375,769 | 17,483 | 34,505 | 293,547 | 26,663 | 7,038 | 98,096 | 8,910 | 2,580 |
| 2005 | 2,930 | 1,402,816 | 23,586 | 56,528 | 392,792 | 18,338 | 35,936 | 273,923 | 27,366 | 6,335 | 91,767 | 9,167 | 2,402 |
| 2006 | 2,930 | 1,435,758 | 24,494 | 54,331 | 410,389 | 19,238 | 37,275 | 252,892 | 28,069 | 5,867 | 85,001 | 9,434 | 2,182 |
| 2007 | 2,930 | 1,465,594 | 25,461 | 51,518 | 428,427 | 20,181 | 38,547 | 230,690 | 28,801 | 5,339 | 77,749 | 9,707 | 1,971 |
| 2008 | 2,930 | 1,491,652 | 26,457 | 48,940 | 446,792 | 21,172 | 39,726 | 207,228 | 29,563 | 4,578 | 70,014 | 9,988 | 1,747 |
| 2009 | 2,930 | 1,514,135 | 27,483 | 46,450 | 465,346 | 22,209 | 40,825 | 182,242 | 30,325 | 3,963 | 61,768 | 10,278 | 1,493 |
| 2010 | 2,930 | 1,533,102 | 28,567 | 44,019 | 483,962 | 23,296 | 41,476 | 155,880 | 31,116 | 3,289 | 52,987 | 10,577 | 1,233 |
| 2011 | 2,930 | 1,548,554 | 29,680 | 41,324 | 502,142 | 24,439 | 42,018 | 128,053 | 31,936 | 2,469 | 43,643 | 10,884 | 952 |
| 2012 | 2,930 | 1,560,197 | 30,852 | 38,746 | 519,722 | 25,637 | 42,453 | 98,585 | 32,757 | 1,707 | 33,711 | 11,201 | 653 |
| 2013 | 2,930 | 1,568,090 | 32,054 | 36,138 | 536,537 | 26,894 | 42,775 | 67,535 | 33,607 | 887 | 23,163 | 11,526 | 330 |
| 2014 | 2,958 | 1,572,175 | 33,632 | 33,402 | 552,419 | 28,482 | 42,959 | 34,815 | 34,815 | 0 | 11,973 | 11,973 | 7 |
| 2015 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |

## Projection No. 2—Projected Inventory Analysis

| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1970 | 2,930 | 276,680 | 16,788 | 10,169 | 154,824 | 9,920 | 7,109 | 502,454 | 15,382 | 12,777 | 152,108 | 6,243 | 4,249 |
| 1971 | 2,930 | 270,060 | 17,433 | 9,729 | 152,013 | 10,407 | 6,919 | 499,850 | 15,792 | 12,631 | 150,113 | 6,425 | 4,135 |
| 1972 | 2,930 | 262,357 | 18,107 | 9,495 | 148,525 | 10,917 | 6,726 | 496,688 | 16,202 | 12,220 | 147,823 | 6,613 | 4,097 |
| 1973 | 2,930 | 253,745 | 18,810 | 8,939 | 144,334 | 11,453 | 6,559 | 492,706 | 16,613 | 11,957 | 145,307 | 6,803 | 4,041 |
| 1974 | 2,930 | 243,874 | 19,543 | 8,587 | 139,440 | 12,015 | 6,260 | 488,050 | 17,052 | 12,572 | 142,545 | 6,999 | 3,895 |
| 1975 | 2,930 | 232,918 | 20,304 | 7,913 | 133,685 | 12,604 | 5,917 | 483,571 | 17,492 | 12,221 | 139,440 | 7,201 | 3,815 |
| 1976 | 2,930 | 220,527 | 21,096 | 7,445 | 126,997 | 13,223 | 5,621 | 478,300 | 17,960 | 12,016 | 136,054 | 7,409 | 3,751 |
| 1977 | 2,930 | 206,876 | 21,916 | 6,917 | 119,396 | 13,870 | 5,191 | 472,355 | 18,429 | 11,547 | 132,396 | 7,623 | 3,649 |
| 1978 | 2,930 | 191,877 | 22,766 | 6,859 | 110,717 | 14,550 | 4,696 | 465,473 | 18,898 | 11,869 | 128,421 | 7,843 | 3,482 |
| 1979 | 2,930 | 175,971 | 13,498 | 6,594 | 100,863 | 9,858 | 4,502 | 453,444 | 17,700 | 11,664 | 124,060 | 5,259 | 3,436 |
| 1980 | 2,930 | 169,067 | 14,005 | 12,132 | 95,506 | 10,331 | 4,183 | 452,408 | 18,166 | 11,196 | 122,235 | 5,405 | 3,402 |
| 1981 | 2,930 | 167,194 | 14,562 | 17,143 | 89,358 | 10,838 | 3,816 | 445,439 | 18,634 | 10,903 | 120,232 | 5,564 | 3,341 |
| 1982 | 2,930 | 169,775 | 15,118 | 22,300 | 82,337 | 11,368 | 3,497 | 437,707 | 19,132 | 11,196 | 118,010 | 5,725 | 3,288 |
| 1983 | 2,930 | 176,956 | 15,704 | 27,691 | 74,467 | 11,925 | 3,046 | 429,770 | 19,631 | 10,698 | 115,573 | 5,892 | 3,212 |
| 1984 | 2,930 | 188,943 | 16,320 | 32,731 | 65,588 | 12,508 | 2,630 | 420,838 | 20,129 | 10,288 | 112,893 | 6,062 | 3,060 |
| 1985 | 2,930 | 205,354 | 16,964 | 38,005 | 55,711 | 13,120 | 2,077 | 410,997 | 20,656 | 9,760 | 109,891 | 6,237 | 2,975 |
| 1986 | 2,930 | 226,394 | 17,638 | 43,689 | 44,667 | 13,762 | 1,546 | 400,101 | 21,183 | 10,054 | 106,628 | 6,419 | 2,878 |
| 1987 | 2,930 | 252,445 | 18,312 | 48,875 | 32,452 | 14,436 | 873 | 388,971 | 21,740 | 9,497 | 103,087 | 6,607 | 2,770 |
| 1988 | 2,930 | 283,008 | 2,932 | 54,323 | 18,889 | 751 | 914 | 376,728 | 13,978 | 9,144 | 99,250 | 3,685 | 2,743 |
| 1989 | 2,930 | 334,400 | 2,988 | 60,066 | 19,052 | 732 | 879 | 371,895 | 14,298 | 9,526 | 98,308 | 3,779 | 2,711 |
| 1990 | 2,930 | 391,477 | 3,105 | 60,241 | 19,198 | 767 | 4,078 | 367,122 | 14,679 | 9,145 | 97,239 | 3,888 | 2,673 |
| 1991 | 2,930 | 448,613 | 3,223 | 60,124 | 22,510 | 805 | 5,526 | 361,588 | 15,060 | 8,764 | 96,025 | 3,999 | 2,696 |
| 1992 | 2,930 | 505,515 | 3,340 | 60,300 | 27,230 | 843 | 7,032 | 355,292 | 15,441 | 9,028 | 94,722 | 4,116 | 2,644 |
| 1993 | 2,930 | 562,475 | 3,457 | 61,091 | 33,419 | 884 | 8,538 | 348,880 | 15,851 | 8,618 | 93,249 | 4,236 | 2,585 |
| 1994 | 2,930 | 620,110 | 3,603 | 61,238 | 41,072 | 928 | 10,035 | 341,646 | 16,261 | 8,207 | 91,598 | 4,359 | 2,521 |
| 1995 | 2,930 | 677,744 | 3,750 | 61,091 | 50,179 | 975 | 11,471 | 333,593 | 16,671 | 8,354 | 89,759 | 4,485 | 2,450 |
| 1996 | 2,930 | 735,086 | 3,896 | 61,238 | 60,675 | 1,022 | 12,956 | 325,276 | 17,111 | 7,915 | 87,724 | 4,614 | 2,427 |
| 1997 | 2,930 | 792,427 | 4,043 | 61,384 | 72,609 | 1,072 | 14,439 | 316,080 | 17,550 | 7,974 | 85,536 | 4,749 | 2,342 |
| 1998 | 2,930 | 849,769 | 4,189 | 62,000 | 85,976 | 1,125 | 15,919 | 306,503 | 18,019 | 7,505 | 83,129 | 4,887 | 2,251 |
| 1999 | 2,930 | 907,579 | 4,365 | 62,117 | 100,771 | 1,180 | 17,390 | 295,989 | 18,488 | 7,036 | 80,494 | 5,027 | 2,198 |
| 2000 | 2,930 | 965,331 | 4,541 | 60,183 | 116,980 | 1,239 | 19,259 | 284,537 | 18,957 | 6,978 | 77,665 | 5,174 | 2,093 |
| 2001 | 2,930 | 1,020,974 | 4,717 | 57,957 | 136,000 | 1,300 | 21,122 | 272,558 | 19,455 | 6,480 | 74,584 | 5,323 | 2,020 |
| 2002 | 2,930 | 1,074,214 | 4,893 | 56,375 | 154,822 | 1,365 | 22,980 | 259,583 | 19,953 | 6,333 | 71,280 | 5,479 | 1,900 |
| 2003 | 2,930 | 1,125,696 | 5,098 | 54,412 | 176,437 | 1,432 | 24,829 | 245,964 | 20,480 | 5,806 | 67,701 | 5,637 | 1,806 |
| 2004 | 2,930 | 1,175,009 | 5,303 | 52,155 | 199,834 | 1,503 | 26,675 | 231,289 | 21,008 | 5,572 | 63,870 | 5,801 | 1,671 |
| 2005 | 2,930 | 1,221,862 | 5,508 | 50,192 | 225,006 | 1,576 | 28,518 | 215,854 | 21,564 | 5,015 | 59,741 | 5,968 | 1,557 |
| 2006 | 2,930 | 1,266,547 | 5,713 | 48,464 | 251,948 | 1,652 | 30,376 | 199,304 | 22,121 | 4,693 | 55,330 | 6,141 | 1,431 |
| 2007 | 2,930 | 1,309,298 | 5,947 | 46,179 | 280,672 | 1,734 | 32,201 | 181,877 | 22,707 | 4,107 | 50,620 | 6,320 | 1,293 |
| 2008 | 2,930 | 1,349,529 | 6,182 | 44,186 | 311,139 | 1,819 | 34,021 | 163,277 | 23,293 | 3,697 | 45,594 | 6,504 | 1,126 |
| 2009 | 2,930 | 1,387,533 | 6,416 | 42,341 | 343,340 | 1,907 | 35,849 | 143,681 | 23,908 | 3,082 | 40,216 | 6,692 | 968 |
| 2010 | 2,930 | 1,423,457 | 6,680 | 40,612 | 377,282 | 2,001 | 37,282 | 122,854 | 24,524 | 2,584 | 34,493 | 6,885 | 798 |
| 2011 | 2,930 | 1,457,389 | 6,944 | 38,590 | 412,564 | 2,097 | 38,720 | 100,915 | 25,168 | 1,939 | 28,406 | 7,084 | 716 |
| 2012 | 2,930 | 1,489,036 | 7,207 | 36,920 | 449,187 | 2,200 | 40,144 | 77,686 | 25,813 | 1,354 | 21,939 | 7,289 | 423 |
| 2013 | 2,930 | 1,518,749 | 7,500 | 35,162 | 487,131 | 2,308 | 41,560 | 53,227 | 26,487 | 709 | 15,073 | 7,500 | 218 |
| 2014 | 2,958 | 1,546,411 | 7,868 | 33,401 | 526,383 | 2,446 | 42,959 | 27,450 | 27,450 | 0 | 7,791 | 7,791 | 0 |
| 2015 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 2,930 | 1,571,944 | 33,402 | 33,402 | 566,896 | 42,959 | 42,959 | 0 | 0 | 0 | 0 | 0 | 0 |

## Projection No. 3.—Projected Inventory Analysis

| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1970 | 2,930 | 276,943 | 6,153 | 10,315 | 154,824 | 3,439 | 7,478 | 502,455 | 11,163 | 12,894 | 152,055 | 3,378 | 4,255 |
| 1971 | 2,930 | 281,106 | 6,387 | 11,341 | 158,863 | 3,609 | 7,561 | 504,186 | 11,456 | 12,601 | 152,932 | 3,474 | 4,284 |
| 1972 | 2,930 | 286,060 | 6,651 | 11,077 | 162,815 | 3,785 | 7,754 | 505,332 | 11,749 | 12,308 | 153,741 | 3,574 | 4,308 |
| 1973 | 2,930 | 290,487 | 6,914 | 10,814 | 166,784 | 3,970 | 7,930 | 505,891 | 12,042 | 13,217 | 154,475 | 3,677 | 4,325 |
| 1974 | 2,930 | 294,387 | 7,178 | 11,722 | 170,744 | 4,163 | 8,205 | 507,066 | 12,364 | 12,895 | 155,123 | 3,782 | 4,337 |
| 1975 | 2,930 | 298,931 | 7,471 | 11,429 | 174,786 | 4,368 | 8,343 | 507,597 | 12,686 | 12,572 | 155,678 | 3,891 | 4,457 |
| 1976 | 2,930 | 302,889 | 7,764 | 11,136 | 178,762 | 4,582 | 8,575 | 507,483 | 13,009 | 13,364 | 156,245 | 4,005 | 4,454 |
| 1977 | 2,930 | 306,261 | 8,057 | 11,928 | 182,754 | 4,803 | 8,675 | 507,838 | 13,360 | 13,012 | 156,694 | 4,122 | 4,445 |
| 1978 | 2,930 | 310,132 | 8,379 | 11,605 | 186,621 | 5,042 | 8,862 | 507,489 | 13,712 | 12,660 | 157,018 | 4,242 | 4,431 |
| 1979 | 2,930 | 313,358 | 8,702 | 12,309 | 190,441 | 5,288 | 9,026 | 506,438 | 14,064 | 12,309 | 157,206 | 4,365 | 4,410 |
| 1980 | 2,930 | 316,966 | 9,053 | 11,989 | 194,180 | 5,546 | 9,267 | 504,683 | 14,415 | 12,954 | 157,252 | 4,491 | 4,384 |
| 1981 | 29,30 | 319,902 | 9,405 | 12,635 | 197,900 | 5,818 | 9,381 | 503,222 | 14,796 | 12,573 | 157,144 | 4,620 | 4,449 |
| 1982 | 2,930 | 323,132 | 9,786 | 12,285 | 201,463 | 6,103 | 9,566 | 500,999 | 15,177 | 12,192 | 156,973 | 4,755 | 4,408 |
| 1983 | 2,930 | 325,631 | 10,167 | 12,844 | 204,926 | 6,402 | 9,721 | 498,014 | 15,558 | 12,720 | 156,625 | 4,893 | 4,361 |
| 1984 | 2,930 | 328,309 | 10,577 | 12,465 | 208,246 | 6,715 | 9,847 | 495,176 | 15,968 | 12,309 | 156,094 | 5,033 | 4,396 |
| 1985 | 2,930 | 330,197 | 10,987 | 12,936 | 211,378 | 7,043 | 10,029 | 491,517 | 16,378 | 12,749 | 155,456 | 5,180 | 4,334 |
| 1986 | 2,930 | 332,146 | 11,427 | 12,527 | 214,364 | 7,389 | 10,176 | 487,888 | 16,818 | 12,310 | 154,611 | 5,329 | 4,349 |
| 1987 | 2,930 | 333,247 | 11,866 | 12,911 | 217,151 | 7,752 | 10,287 | 483,380 | 17,257 | 11,870 | 153,631 | 5,484 | 4,273 |
| 1988 | 2,930 | 334,292 | 12,335 | 12,473 | 219,687 | 8,133 | 10,364 | 477,993 | 17,697 | 12,193 | 152,419 | 5,643 | 4,267 |
| 1989 | 2,930 | 334,430 | 12,804 | 12,769 | 221,917 | 8,532 | 10,478 | 472,489 | 18,166 | 11,724 | 151,044 | 5,807 | 4,176 |
| 1990 | 2,930 | 334,395 | 13,302 | 12,976 | 223,864 | 8,951 | 10,569 | 466,048 | 18,634 | 11,959 | 149,413 | 5,974 | 4,150 |
| 1991 | 2,930 | 334,069 | 13,829 | 12,448 | 225,482 | 9,390 | 10,610 | 459,372 | 19,132 | 11,461 | 147,590 | 6,147 | 4,112 |
| 1992 | 2,930 | 332,688 | 14,357 | 12,567 | 226,701 | 9,850 | 10,673 | 451,700 | 19,631 | 10,962 | 145,555 | 6,325 | 4,062 |
| 1993 | 2,930 | 330,899 | 14,913 | 12,628 | 227,525 | 10,334 | 10,691 | 443,032 | 20,129 | 11,080 | 143,292 | 6,510 | 3,939 |
| 1994 | 2,930 | 328,614 | 15,499 | 12,630 | 227,882 | 10,840 | 10,661 | 433,983 | 20,656 | 10,553 | 140,721 | 6,697 | 3,869 |
| 1995 | 2,939 | 325,745 | 16,114 | 12,014 | 227,702 | 11,371 | 10,640 | 423,880 | 21,183 | 10,582 | 137,893 | 6,891 | 3,787 |
| 1996 | 2,930 | 321,645 | 16,730 | 11,928 | 226,971 | 11,928 | 10,566 | 413,279 | 21,740 | 10,025 | 134,789 | 7,090 | 3,693 |
| 1997 | 2,930 | 316,843 | 17,374 | 11,784 | 225,610 | 12,511 | 10,490 | 401,564 | 22,297 | 9,967 | 131,392 | 7,295 | 3,588 |
| 1998 | 2,930 | 311,253 | 18,048 | 11,581 | 223,589 | 13,123 | 10,354 | 389,234 | 22,883 | 9,381 | 127,684 | 7,506 | 3,471 |
| 1999 | 2,930 | 304,785 | 18,752 | 11,319 | 220,820 | 13,765 | 10,205 | 375,733 | 23,469 | 9,235 | 123,649 | 7,723 | 3,342 |
| 2000 | 2,930 | 297,352 | 19,484 | 10,987 | 217,260 | 14,439 | 9,993 | 361,499 | 24,084 | 8,620 | 119,268 | 7,946 | 3,242 |
| 2001 | 2,930 | 288,856 | 20,246 | 10,595 | 212,814 | 15,145 | 9,754 | 346,034 | 24,699 | 8,385 | 114,564 | 8,177 | 3,087 |
| 2002 | 2,930 | 279,205 | 21,037 | 10,147 | 207,424 | 15,856 | 9,481 | 329,720 | 25,344 | 7,741 | 109,474 | 8,414 | 2,920 |
| 2003 | 2,930 | 268,315 | 21,857 | 9,639 | 201,018 | 16,665 | 9,131 | 312,117 | 25,989 | 7,419 | 103,980 | 8,658 | 2,774 |
| 2004 | 2,930 | 256,097 | 22,707 | 9,071 | 193,484 | 17,483 | 8,705 | 293,547 | 26,663 | 7,038 | 98,096 | 8,910 | 2,580 |
| 2005 | 2,930 | 242,461 | 23,586 | 8,447 | 184,706 | 18,338 | 8,256 | 273,923 | 27,366 | 6,335 | 91,767 | 9,167 | 2,402 |
| 2006 | 2,930 | 227,322 | 24,494 | 7,998 | 174,623 | 19,238 | 7,718 | 252,892 | 28,069 | 5,867 | 85,001 | 9,434 | 2,182 |
| 2007 | 2,930 | 210,826 | 25,461 | 7,226 | 163,104 | 20,181 | 7,114 | 230,690 | 28,801 | 5,339 | 77,749 | 9,707 | 1,971 |
| 2008 | 2,930 | 192,590 | 26,457 | 6,396 | 150,036 | 21,172 | 6,416 | 207,228 | 29,563 | 4,578 | 70,014 | 9,988 | 1,743 |
| 2009 | 2,930 | 172,529 | 27,483 | 5,654 | 135,280 | 22,209 | 5,638 | 182,242 | 30,325 | 3,963 | 61,768 | 10,278 | 1,497 |
| 2010 | 2,930 | 150,700 | 28,567 | 4,680 | 118,710 | 23,296 | 4,783 | 155,880 | 31,116 | 3,289 | 52,987 | 10,577 | 1,233 |
| 2011 | 2,930 | 126,813 | 29,680 | 3,733 | 100,197 | 24,439 | 3,816 | 128,053 | 31,936 | 2,469 | 43,643 | 10,884 | 952 |
| 2012 | 2,930 | 100,866 | 30,852 | 2,612 | 79,574 | 25,637 | 2,743 | 98,585 | 32,757 | 1,707 | 33,711 | 11,201 | 653 |
| 2013 | 2,930 | 72,625 | 32,054 | 1,462 | 56,680 | 26,894 | 1,557 | 67,535 | 33,607 | 887 | 23,163 | 11,526 | 337 |
| 2014 | 2,958 | 42,034 | 33,632 | 182 | 31,343 | 26,482 | 234 | 34,815 | 34,815 | 0 | 11,973 | 11,973 | 0 |

## Projection No. 4.—Projected Inventory Analysis

| Year | Thousand acres cut | Pine pulpwood (thousand cords) | | | Pine sawtimber (million board feet) | | | Hardwood pulpwood (thousand cords) | | | Hardwood sawtimber (million board feet) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth | Inventory | Cut | Growth |
| 1970 | 6,593 | 276,943 | 13,845 | 10,022 | 154,824 | 7,740 | 7,266 | 502,455 | 25,119 | 12,528 | 152,055 | 7,601 | 4,134 |
| 1971 | 6,593 | 273,121 | 14,372 | 10,682 | 154,351 | 8,122 | 7,121 | 489,864 | 25,778 | 11,869 | 148,588 | 7,819 | 4,035 |
| 1972 | 6,593 | 269,430 | 14,966 | 10,088 | 153,350 | 8,518 | 7,062 | 475,954 | 26,437 | 11,209 | 144,804 | 8,043 | 3,923 |
| 1973 | 6,593 | 264,553 | 15,559 | 9,495 | 151,894 | 8,933 | 6,963 | 460,726 | 27,097 | 11,605 | 140,684 | 8,274 | 3,798 |
| 1974 | 6,593 | 258,489 | 16,152 | 9,891 | 149,924 | 9,368 | 6,923 | 445,235 | 27,822 | 10,880 | 136,208 | 8,511 | 3,659 |
| 1975 | 6,593 | 252,228 | 16,812 | 9,231 | 147,479 | 9,830 | 6,739 | 428,293 | 28,547 | 10,155 | 131,356 | 8,755 | 3,600 |
| 1976 | 6,593 | 244,647 | 17,471 | 8,572 | 144,388 | 10,311 | 6,600 | 404,900 | 29,272 | 10,287 | 126,201 | 9,012 | 3,429 |
| 1977 | 6,593 | 235,749 | 18,130 | 8,705 | 140,678 | 10,819 | 6,330 | 390,915 | 30,064 | 9,496 | 120,617 | 9,276 | 3,244 |
| 1978 | 6,593 | 226,323 | 18,855 | 7,979 | 136,189 | 11,346 | 6,093 | 370,347 | 30,855 | 8,704 | 114,586 | 9,546 | 3,046 |
| 1979 | 6,593 | 215,446 | 19,581 | 7,913 | 130,936 | 11,900 | 5,803 | 348,196 | 31,646 | 7,913 | 108,086 | 9,823 | 2,835 |
| 1970 | 6,593 | 203,779 | 20,372 | 20,308 | 124,839 | 12,480 | 5,520 | 324,464 | 32,437 | 7,716 | 101,098 | 10,107 | 2,611 |
| 1981 | 6,593 | 203,715 | 21,163 | 32,571 | 117,879 | 13,093 | 5,117 | 299,742 | 33,294 | 6,859 | 93,602 | 10,397 | 2,427 |
| 1982 | 6,593 | 215,123 | 22,020 | 44,241 | 109,903 | 13,733 | 4,709 | 273,307 | 34,151 | 6,001 | 85,632 | 10,700 | 2,169 |
| 1983 | 6,593 | 237,344 | 22,877 | 56,966 | 100,879 | 14,405 | 4,234 | 245,157 | 35,008 | 5,540 | 77,102 | 11,010 | 1,899 |
| 1984 | 6,593 | 271,432 | 23,800 | 68,569 | 90,708 | 15,111 | 3,694 | 215,689 | 35,931 | 4,617 | 67,991 | 11,326 | 1,649 |
| 1985 | 6,593 | 316,201 | 24,723 | 81,096 | 79,291 | 15,849 | 3,114 | 184,374 | 36,854 | 3,958 | 58,313 | 11,656 | 1,345 |
| 1986 | 6,593 | 372,574 | 25,712 | 92,634 | 66,555 | 16,627 | 2,454 | 151,478 | 37,843 | 2,969 | 48,003 | 11,992 | 1,049 |
| 1987 | 6,593 | 439,496 | 26,701 | 104,963 | 52,382 | 17,445 | 1,716 | 116,604 | 38,832 | 1,980 | 37,059 | 12,342 | 713 |
| 1988 | 6,593 | 517,758 | 27,756 | 116,435 | 36,654 | 18,302 | 899 | 79,752 | 39,821 | 1,057 | 25,430 | 12,698 | 370 |
| 1989 | 6,611 | 606,436 | 28,890 | 128,563 | 19,251 | 19,251 | 0 | 40,988 | 40,988 | 0 | 13,103 | 13,103 | 0 |
| 1990 | 3,296 | 706,110 | 64,272 | 128,893 | 0 | 0 | 3,560 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1991 | 3,296 | 770,731 | 64,601 | 129,222 | 3,560 | 3,559 | 7,120 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1992 | 3,296 | 835,352 | 64,601 | 129,222 | 7,122 | 3,560 | 8,792 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1993 | 3,296 | 899,973 | 64,601 | 129,222 | 12,354 | 5,230 | 10,464 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1994 | 3,296 | 964,595 | 64,601 | 129,552 | 17,587 | 5,231 | 12,129 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1995 | 3,296 | 1,029,546 | 64,931 | 129,882 | 24,485 | 6,895 | 13,794 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1996 | 3,296 | 1,094,497 | 64,931 | 130,212 | 30,383 | 6,896 | 15,465 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1997 | 3,296 | 1,159,777 | 65,260 | 130,541 | 39,952 | 8,566 | 17,137 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1998 | 3,296 | 1,225,058 | 65,261 | 130,871 | 48,523 | 8,568 | 18,805 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1999 | 3,296 | 1,290,669 | 65,590 | 131,202 | 58,760 | 10,234 | 20,473 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2000 | 3,296 | 1,356,281 | 65,590 | 124,642 | 69,000 | 10,236 | 22,142 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2001 | 3,296 | 1,415,333 | 65,590 | 118,377 | 80,906 | 11,901 | 23,810 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2002 | 3,296 | 1,468,120 | 65,591 | 112,442 | 92,814 | 11,904 | 25,475 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2003 | 3,296 | 1,514,972 | 65,920 | 106,180 | 106,385 | 13,566 | 27,140 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2004 | 3,296 | 1,555,232 | 65,920 | 100,243 | 119,959 | 13,569 | 28,808 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2005 | 3,296 | 1,589,555 | 66,249 | 93,981 | 135,197 | 15,234 | 30,476 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2006 | 3,296 | 1,617,286 | 66,250 | 88,044 | 150,440 | 15,238 | 32,148 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2007 | 3,296 | 1,639,081 | 66,579 | 81,782 | 167,350 | 16,905 | 33,820 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2008 | 3,296 | 1,654,284 | 66,580 | 75,846 | 184,265 | 16,909 | 35,488 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2009 | 3,296 | 1,663,550 | 66,908 | 69,574 | 202,844 | 18,572 | 37,159 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2010 | 3,296 | 1,666,215 | 66,902 | 67,234 | 221,430 | 18,579 | 35,739 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2011 | 3,296 | 1,666,547 | 64,931 | 65,253 | 238,590 | 20,695 | 36,181 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2012 | 3,296 | 1,666,869 | 64,923 | 62,617 | 254,076 | 20,702 | 36,639 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2013 | 3,296 | 1,664,563 | 62,624 | 59,981 | 270,013 | 22,818 | 37,091 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2014 | 3,296 | 1,661,920 | 62,616 | 57,673 | 284,286 | 22,825 | 37,546 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2015 | 3,296 | 1,656,976 | 60,646 | 55,693 | 299,006 | 24,940 | 38,001 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016 | 3,296 | 1,652,023 | 60,638 | 53,387 | 312,066 | 24,949 | 38,456 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2017 | 3,296 | 1,644,771 | 58,668 | 51,077 | 325,573 | 27,060 | 38,907 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2018 | 3,296 | 1,637,180 | 58,659 | 48,440 | 337,421 | 27,069 | 39,359 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2019 | 3,296 | 1,626,961 | 56,361 | 45,803 | 349,712 | 29,182 | 39,814 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2020 | 3,296 | 1,616,403 | 56,352 | 45,791 | 360,344 | 29,192 | 39,820 | 0 | 0 | 0 | 0 | 0 | 0 |

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# appendix J

BY I. I. HOLLAND

# Foreign Trade in Timber Products

## INTRODUCTION

One of the major recommendations of a task force on softwood lumber and plywood, appointed by the Cabinet Committee on Economic Policy in March of 1969, was that a special panel reporting to the President study the range of problems involved in reaching the Nation's housing goals not constrained by inadequate supplies of softwood lumber and plywood. The central question is how to increase the Nation's supply of timber to meet growing housing and other needs while protecting and enhancing the quality of the environment. The future wood products import-export position of the Nation will bear, to some degree, on the important forest and industry management decisions which are deemed necessary if the United States is to meet expanded demands for timber products, at the same time, protect and enhance the environment.

Evaluation of the potential for trade in timber products in estimating timber trends and requirements in the United States have generally been given incidental attention. Traditionally, requirements studies have been cast primarily in domestic terms. Exports have not figured importantly, perhaps with some justification in past studies, and imports have received incidental attention as possible supplemental sources of supply. There are good reasons for this.

Difficult as it is to handle projection problems dealing with the domestic scene, it is much more difficult to visualize the factors which will influence the development of foreign markets for U.S. wood exports or sources of supply for U.S. wood imports. Nevertheless, there is reason to believe that a more deliberate attempt to better estimate future import and export possibilities is warranted even though the validity of the results may not be any easier to justify than in earlier studies.



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## Some Changes Which Suggest Increasing Importance of Timber Products Trade and the Need for Reassessment of the U.S. Position

Since 1950, the timber products trade position of the United States has changed considerably. Imports of industrial wood in 1971 were 1.8 times imports in 1950, due mainly to increased imports of softwood lumber and newsprint from Canada. Exports of industrial wood in 1971 were 8.4 times exports in 1950, due almost entirely to exports of softwood logs to Japan and pulp products to Japan and northwestern Europe. On balance, however, the United States is still a net importer of industrial wood products, especially softwood products (table 1).

There are several other reasons for increasing world trade in wood products. Demands for wood products, particularly lumber, pulp and paper, and wood-based panel products, continue to expand in the industrialized nations of the world and to a somewhat less degree in the developing nations. Thus, demands have been for the higher value products, those with higher ratios of value to weight; i.e., products better able to bear transportation costs. Use of low-value products such as fuelwood and wood used in the round form has declined.

While the U.S. forest economy has been primarily domestically oriented, other wood surplus nations have looked to expanded world trade. Canada, the world's single most important exporter of wood products, has aggressively promoted trade in wood with the United States, particularly exports, as well as with Europe and many other nations. The Soviet Union is still Europe's most important supplier of softwood lumber, and with continued development of the forest industries in northern European U.S.S.R. and the eastern Siberian provinces, the Soviet Union promises to become a more important exporter of lumber and pulp, especially to Japan and the Pacific basin countries.

Japan, also an important wood-deficit nation, has become an aggressive trader in wood, importing from North America, the Soviet Union, and Southeast Asia.

Northwest Europe, at one time a net exporter of wood products, has, like the United States, become a net importer, particularly of softwood lumber and pulp and paper. Northern Europe, however, remains a surplus wood area and an aggressive trader in wood, particularly with the rest of Europe. Despite northern Europe's close proximity to northwestern European markets, indications are that Canada and the United States can become important suppliers of chemical pulps and kraft papers, due to rising wood-growing and wood-processing costs in Scandinavia relative to costs in Canada and the southeastern region of the United States.

## Principal Study Objectives

The principal objectives of this paper are to examine the major trends in world wood trade and to evaluate their impacts on the future U.S. timber demand-supply situation. An important question is whether we can logically expect U.S. trade in wood to be more or less important in determining the domestic production needed to meet demands (particularly for housing) in the future than it is today.

Reaching the primary objective necessarily involves review of a number of interrelated study elements. The beginning point is a review of the present U.S. wood trade position. Included in this review will be an examination of the most recent Forest Service projections of timber products imports and exports under a set of price assumptions. The intent is to evaluate the reasonableness of these projections after the review of external factors influencing the future U.S. wood trade position.

The external factors which will most likely affect, in one way or another, the magnitude and direction of U.S. trade in forest products involve the potential wood consumption and trade of the world's more important wood-using and/or wood-trading nations or regions. Foremost of these is Canada, the single most important source of softwood products in the past and the largest potential supplier in the future.

According to recent FAO studies (9), northwestern Europe will probably be the most important market for wood products in the world outside the United States. How large this market will be and what products the United States might supply in competition with Canada, the Scandinavian countries, and the U.S.S.R. are questions needing some answers in this study.

The future United States wood trade position will also be linked to Japan with respect to both imports and exports of timber products. Thus, it becomes necessary to examine and evaluate potential demands for wood products in Japan, and her potential sources of wood raw materials with which to meet domestic requirements and world trade commitments.

Other potential market areas needing brief examination include mainland China, the rest of Asia and Oceania, Africa, and Latin America.

Although relatively little is known about them, the tropical forests of the world may, under the right conditions, represent a source of wood at some future time. Whether these conditions are apt to prevail in the relatively near future is in need of review. A similar examination of the potential of fast-growing plantations in Latin America, Africa, and New Zealand to contribute significantly to world supplies is also in order.

The products to be covered in this world overview are softwood and hardwood lumber, softwood and hardwood plywood and veneer, pulp and paper products, pulpwood (including chips), and softwood and hardwood logs.

## THE PRESENT POSITION OF THE UNITED STATES IN WORLD WOOD TRADE

According to the FAO (7), the United States was the world's leading importer of forest products in 1969, the value of such products totaling almost $2.2 billion, or about 19 percent of the total value of world imports. Table 2 shows in both commercial units and cubic feet roundwood equivalent (table 2a) the composition of U.S. trade in wood products for 1971 (preliminary). As in more recent years, imports ran heavily to lumber, especially softwood lumber, and to newsprint. Other imported products included woodpulps, pulpwood, hardwood plywood and veneer, building boards, and sawlogs.

The same wood products also entered the export trade. The most important export items were softwood sawlogs, woodpulp, softwood lumber, paperboard, and pulpwood.

Several items show a net export surplus amounting in total to 642 million ft$^3$ roundwood equivalent. Of these, softwood logs and paperboard were the most important. A somewhat closer look at recent developments in the most important traded items is provided below.

### Softwood and Hardwood Sawlogs

Saw logs, mostly softwood, are imported into the United States primarily from Canada in relatively small amounts (tables 3 and 4). Hardwood saw logs come primarily from Latin America, Asia, Africa, as well as from Canada. Future increases in softwood or hardwood log imports are not likely because of increasing restrictions on the export of wood in an unprocessed form from most exporting regions. The trend is to greater export of processed wood products.

Saw log exports (over 97 percent softwoods in 1971), on the other hand, have increased rapidly in recent years, particularly since about 1960 (tables 5 and 6). In 1971, saw-log exports amounted to about 2.3 billion fbm, roughly 30 percent of the roundwood equivalent of all forest products exports. Whereas Canada was the principal destination in 1950, Japan has taken over 80 percent of the volume in recent years (table 8).

The export of logs to Canada is a long-established practice involving, for the most part, timber near the border which moves to Canadian lumber and plywood mills under favorable transportation costs. There is no reason to believe that this practice will soon be discontinued, particularly in view of the interrelationships between United States and Canadian processing facilities.

Much more interest and controversy have been generated in recent years concerning the rapid rise in log exports to Japan, and their present and future impact on the availability of raw material for processing on the west coast to meet domestic requirements of lumber and plywood.

Of the 2.2 billion fbm of softwood log exports in 1971, about 1.4 billion fbm originated in Washington, about 0.5 billion fbm in Oregon, and 0.1 billion fbm in northern California; Alaska contributed only a small volume, about 43 million fbm (mostly spruce). Only about 20 percent of total softwood volume exports in 1971 was Douglas-fir, and 80 percent other softwood species, mostly hemlock, true firs, and Port Orford cedar. Excluding Douglas-fir, log exports have involved mostly those species which do not enter the U.S. lumber or veneer markets in large volumes.

The rapid increase in export of softwood logs to Japan has been based on continued rapid economic development in that country, and the demand for housing together with Japan's inability to meet her wood requirements from the domestic timber resource. Supplies of coniferous logs of large size in acceptable species have been available in Oregon, Washington, and to a lesser extent, in northern California. Timber owners have been quite willing to sell to Japan at relatively high export prices, that material which brings lower prices on the log markets of the region.

Logs exported to Japan come from several sources: Lands managed by the Forst Service, Bureau of Land Management, and Bureau of Indian Affairs; State forest lands in Washington; lands owned by forest industry, and a variety of private lands of nonindustrial owners. The Morse amendment to the Foreign Assistance Act of 1968 (as extended) limits exports of logs from all Federal lands in the West to 350 million fbm annually. Although the Morse amendment has reduced the competition between exporters and domestic buyers of Federal timber, its main effect has been to concentrate the demand for export logs on non-Federal timberlands.

Although the arguments for and against continued export of softwood logs from non-Federal lands lie outside the scope of this paper, several facets of the argument are worth noting because they bear on the future softwood log export and/or forest management situation. The main argument against continued exporting of softwood logs is that this raw material is lost to domestic processors and hence to domestic building materials supplies. However, despite a more than tenfold increase in softwood log exports between 1960 and 1971, softwood lumber production in the exporting region (western Washington, western Oregon, and northern California), has remained about the same (*15*). Quite likely the fact that log exports involve primarily those species which are not so important for domestic lumber production has a good deal to do with this situation.

Another argument is that softwood logs exported to Japan come back to the United States in the form of lumber and other wood products which then compete with domestically produced products. There is no evidence to indicate that this is so; exported softwood logs to Japan are used almost exclusively to satisfy domestic needs. There may be some confusion here on what Japan does with imported softwood logs in contrast with what she does with tropical hardwood logs imported into the country; the latter do form the basis for Japan's declining export trade in hardwood products, mainly plywood and veneer. Furthermore, there is very little evidence to suggest that if log exports to Japan were restricted, trade in softwood lumber produced in the United States would increase. It is more likely that Japan would turn to Canada for imports in the form of rough-sawn timber squares or other semiprocessed products and to the U.S.S.R. for logs. Actually the effect of this could be a reduction in Canadian lumber available to the United States.

Several factors have definitely favored continued softwood log exports, and they may very well continue to do so. Management of timber involves large capital investment. Return on forest investment is influenced heavily by values derived at harvest. Log exports, particularly of species and sizes of timber which are lower valued on domestic markets, enhance the value per acre of forest land, and this value in turn affects the length of the holding period and reinvestment rate on each acre following harvest. Increased value per acre has apparently encouraged more intensive forest management on private and State forest lands in Oregon and Washington (*2*). Over considerable areas in Washington and Oregon, particularly west of the Cascades, these new markets have enabled the economic disposal of heretofore low-valued logs and also lumber and plywood mill wastes, with accompanying environmental benefits and important contributions to the general economy of the region.

Japan is likely to remain the major market for exports of United States softwood logs, and conceivably lumber, barring further export restrictions. How large Japanese demand for United States exports of wood will be depends on several factors (to be examined later), including: (1) The size of total domestic wood requirements in Japan, (2) how much of this demand can be met from Japan's native forests and plantations, (3) how much of the resulting future import market will be supplied by Canada and other countries, and (4) the ability of United States suppliers to provide softwood products at acceptable prices.

On the supply side, prohibition of wood exports beyond present restrictions may not be feasible, despite the continuing controversy, primarily because the practice of forestry in the West would be made less attractive. Reduced exports would reduce the income of timber growers. Wood products with lower domestic demands would lose their present markets unless these species were somehow to become a much more important source of domestic lumber (a possibility, of course). The loss of present markets for low-quality logs and mill residues would reduce the attractiveness of intensive management when just the opposite action is required in a domestic effort to increase timber output on those private and public forest lands which show considerable economic potential for increased yield. If increased productivity is not forthcoming, it is almost certain that log exports to Japan will be reduced because of increased price; and Japan's softwood needs, whatever they may be, will be satisfied from alternative sources.

### Softwood and Hardwood Lumber

Both exports and imports of hardwood lumber have varied narrowly between 100 and 400 million fbm annually since 1950 (table 7).

Softwood lumber exports have always been much larger than hardwood lumber exports and over the years since 1950 have increased substantially (table 4). Softwood lumber imports have been more important, and over the last 20 years have more than doubled, increasing from 3.1 billion fbm in 1950 to 7.2 billion fbm in 1971. Canada has been the important source, contributing 99 percent of the total in 1971. Softwood lumber imports are expected to reach 9 billion fbm in 1972 and possibly 10 billion fbm by the late 1970's.

The rapid rise in softwood lumber imports in recent years has accompanied the development of sawmilling in interior British Columbia. A number of reasons for increased imports from this region have been suggested. Probably one of the most compelling reasons is that the move of lumber manufacturing into interior British Columbia is merely a shift in production into another area of accessible virgin timber, not unlike earlier moves from the Northeast to the Lake States, to the South, to Washington, Oregon, and northern California. British Columbia is in the process of expanding its role as a competitor in U.S. markets with a product undistinguishable from that produced in the Pacific Northwest States.

Other reasons which have been advanced to explain increased imports from British Columbia include transportation cost advantages, stumpage price policies which favor Canadian processors, and labor cost differentials. Whereas the Jones Act, which requires that goods shipped between U.S. ports must move in U.S. flag vessels, does place west coast mills at a cost disadvantage ($10–$15 per M fbm) relative to coastal British Columbia mills when lumber is shipped by water, it is hard to see how the act has seriously disadvantaged western lumber manufacturers shipping to midwestern and eastern markets when both United States and British Columbian lumber manufacturers ship lumber by rail.

British Columbian lumber processors may enjoy a stumpage cost advantage, although even this is hard to evaluate because of the differences in stumpage characteristics and logging costs between coastal and interior timber stands. Whereas logging and milling labor costs may have been considerably lower in British Columbia than in the Pacific Northwest some years ago, it is questionable whether this cost advantage exists to any significant degree today. Tariff restrictions have likewise not played a significant role in lumber traded across the border.

Perhaps more pertinent as an explanation of British Columbia's recent rapid growth in wood products output is the one advanced by the Council of Forest Industries of British Columbia (*4*). According to the Council, the Government of British Columbia has encouraged the dispersal of industry throughout the undeveloped areas * * * "in order to induce intercompany integration, to induce or force high utilization and manufacturing standards and to enforce a relatively high standard of forest management." This policy, combined with rapidly developing technology and the availability of larger trees, has spurred the rapid expansion of the British Columbian forest industry. According to the Council, a similar development will take place in Ontario and Quebec, the other areas of Canada with major potential for expanded output. Canadian provincial governments appear to favor the subsidizing of forest industries in order to promote employment and economic activity.

Regardless of the impact of the Jones act on shipping of lumber from Pacific coast mills to the east coast, it has very effectively eliminated Alaska as a major source of softwood lumber to the 48 contiguous States. Lumber shipped anywhere from Alaska must move by water. Because of the Jones act, and also because of the greater distance involved in shipping lumber from Alaska to the east coast, Alaskan lumber has become an important export item. About 98 percent of all the lumber produced in Alaska is exported (about 247 million fbm in 1971), almost all of it going to Japan. Unless the Jones act is amended to exclude lumber, Alaska's output is never likely to contribute to domestic U.S. needs.

Imports of softwood lumber accounted for almost 20 percent of total softwood lumber consumption in 1971 (7.1 billion fbm imported compared to 36.6 billion fbm consumed). The possibility of higher softwood lumber imports exists as U.S. demands increase as a result of future housing and other goals. The Canadians estimate that exports could be increased by 5–10 billion fbm if future market conditions in the United States warranted such increased imports and if processing costs can be held near present levels (discussed later).

### Softwood and Hardwood Plywood

Canada and the United States are the only two important softwood plywood producers and the use of this material, mainly in construction, is limited pretty much to these two nations. Neither imports nor exports of softwood plywood have been significant over the years because of mutual tariff restrictions (table 8).

Substantial markets for wood-based panel products exist in both Europe and Japan, and prospects are for increased demands. To date, however, neither market has attracted U.S. softwood plywood. In Japan, the lower grades of Philippine mahogany (luan) are used in construction. In Europe the lower grades of beech and African hardwood plywoods, and particle board are used in the same way. Thus, at present, softwood plywood is not an important item in international trade; nor is it likely to become important in the foreseeable future.

Exports of hardwood plywood (mostly to Canada) have always been very low. The situation for hardwood plywood and veneer imports has been very different, however. From 5 million $ft^3$ in 1950, hardwood plywood imports rose to 205 million $ft^3$ in 1971. This was about 58 percent more than domestic production (table 8).

Over 95 percent of all imported hardwood plywood comes from Asia; i.e., from South Korea, Taiwan, Japan, and the Philippines. Imports of veneer come from a number of regions, but Canada (41 percent) and Southeast Asia (40 percent) were the most important. The major species group represented in hardwood plywood and veneer imports from Asia is luan (Philippine mahogany). Practically all the imports from Canada and Europe (Finland) in 1971 were birch, with some birch plywood also coming from Japan.

The remarkable growth in hardwood plywood and veneer imports is related in part to a scarcity of preferred, high quality hardwood timber in the United States and to the wide acceptance of Philippine mahogany as door-skins for flush doors and for wall paneling. An improving domestic hardwood timber supply may reduce the rate of increased imports of hardwood plywood and veneer somewhat. Demands, however, are expected to increase. If the price of these imported products can be maintained as they have since 1950, most of the projected increases in U.S. demands are likely to be met from imports. Because of the composition and inaccessibility of tropical forests in Latin America, most of these increased imports will continue to originate in Asia (*12* (pp. 7–9)).

### Pulpwood, Pulp, and Paper Products

In 1971, the U.S. consumption of pulp and paper products represented the equivalent of 79.4 million cords of pulpwood (table 9). Of this total, about 90 percent was provided by domestic production and 10 percent by imports of paper, board, and pulp products. In 1963, fully 22 percent of total consumption was accounted for by imports. The improved position stems primarily from increased domestic production relative to imports.

Before 1969, the United States was a net importer of pulpwood (including chips). However, in 1969, the United States imported 1 million cords of pulpwood, but exported 1.7 million cords, thus becoming a net exporter for the first time—primarily because of increased exports of chips to Japan.

Consumption, exports, and imports of paper, paperboard, and building board over the last 20 years are shown in tables 10 and 11. U.S. imports and exports of pulp over this period are shown in tables 12 and 13. The principal regions of import origin and export destination for all pulp and paper products for 1971 are shown in tables 14 to 17.

In 1971, Canada supplied 96 percent of U.S. newsprint imports; the balance came from Western Europe (Finland). Canada's share of the U.S. market (about 73 percent) has declined slightly over the past several years due mainly to increased production from new mills in the Southern United States. The proportion of imports from Scandinavia has increased in recent years, although the historic trend is downward. According to Manning and Grinnell (*14*), production in the southern

United States may be largely offset by continued cost advantages on Canada's west coast and by an expected increase in the capacity of Canadian mills of about a million tons over the next few years. Expectations are that if the U.S. newsprint market continues to grow (as projected), Canada will be able to keep pace. It would appear that the United States will probably continue to rely on Canadian newsprint exports for 70–75 percent of its consumption. United States exports of newsprint were only 166,000 tons in 1971, mainly to Latin America and Japan.

Imports of paperboard and building board are of minor importance and come almost entirely from Western Europe; this situation is not expected to change much in the future. However, exports of paperboard and building board amounted to 3 million tons in 1971, most of which was container board shipped mainly to Western Europe, Latin America, and Japan.

Woodpulp imports have increased gradually over the years, amounting to 3.5 million tons in 1971. Exports, however, have grown almost twice as fast as imports since 1960, resulting in a rapid downward trend in net imports. Woodpulp imports are heavily dominated by bleached sulfate pulps and Canada is almost the exclusive source of this material. Woodpulp exports in 1971 were concentrated in the bleached sulfate and special alpha and dissolving grades. Western Europe was the most important market, taking over half the bleached sulfate and alpha and dissolving pulp exports. Latin America and Japan were the other major markets for pulp exports.

### Projections of Exports and Imports of Wood Products to the Year 2000 as Estimated by the U.S. Forest Service Under Several Price Assumptions

In connection with its recent timber trends reappraisal work, the U.S. Forest Service has made some projections of forest products imports and exports for 1980, 1990, and the year 2000 under several price level assumptions. These are based primarily on judgment, and there is, of course, no assurance that the volumes will actually materialize. Nevertheless, they can serve as useful targets against which the future U.S. wood products import-export position, as influenced by world trends in wood trade, may be viewed. The projections are only one set of a number of possible sets, depending on the assumptions used.

The basis for the projections are as follows (medium population and GNP assumptions):

1. Relative prices of stumpage and timber products will remain constant in 1970.

2. Relative prices of stumpage and timber produts will rise as follows: For lumber, the annual rise will be 1.5 percent; for plywood and other panel products, 1 percent per year; for pulp, paper, and board, 0.5 percent per year; for stumpage, 2.5 percent per year.

3. Relative prices will be, for lumber and plywood, 30 percent above 1970 prices; and for pulpwood, woodpulp, and paper and board, 10 percent above 1970 prices.

Marty in his PAPTE study "Timber Supply and Demand Projections," (app. C), uses these same price assumptions. Also, the resulting wood products import projection incorporates the import and export projections developed by the Forest Service. The projections are shown in table 18. They are based mainly on judgment of the effects of changing domestic wood products prices on the volumes of future imports and exports. Obviously, internal price changes will be only one factor affecting future trade. Price changes in the other countries will also influence the trading situation. Making estimates of future wood price levels in foreign markets is even more difficult than projecting domestic price levels because it is harder to visualize the future wood products demand-supply situation in the foreign market.

Implicit in the estimation of imports and exports is the knowledge of import-export price elasticities; i.e., quantitative coefficients which show, for instance, what percentage increase in import volume can be expected if softwood lumber prices rise a certain percent. There is little such information available. Furthermore, price change is not the only factor which can influence imports and exports. Unforeseeable modifications of trade conditions such as the erection or removal of trade barriers, changed comparative production cost patterns or changed political conditions in a foreign market area may completely override price change effects, one way or the other.

Despite these difficulties, estimates of future imports and exports can be useful and, indeed, must be made if projections of future domestic production required to meet potential consumption are to be estimated. Later in this paper, the projections shown in table 18 will be evaluated in the light of possible trends in wood products consumption, production, and estimates of future trade in the major wood using and wood producing regions of the world.

## THE MAJOR FACTORS INFLUENCING THE FUTURE U.S. IMPORT-EXPORT POSITION

### The Canadian Position in World Wood Trade and the Interdependent United States-Canadian Trade Relationship

The future United States wood products import-export position will be influenced in a major way by what happens to wood production, trade, and consumption in several other parts of the world, but particularly in Canada, Europe, and Japan. Canada promises to remain a major source of wood supply; Japan, a potentially important market for United States softwood logs, chips, lumber, pulp, and paper as well as a continuing source of hardwood plywood and veneer; Europe, a potentially important market for United States pulp and paper products. This section of the report briefly examines the present and potential wood marketing position of each of these regions.

#### Canada's Present International Trade in Wood Products

Canada is the world's most important exporter of wood products, accounting for a quarter of the total value of world exports in 1969. In 1969, Canada's exports of all products were valued at $14.4 billion; forest products exports accounted for $2.9 billion or 20.2 percent. The most important wood exporting province is British Columbia followed by Quebec, Ontario, and the Atlantic Provinces (*6*). Although domestic consumption of wood products is becoming more important, the major proportion of wood cut in Canada goes to support the export trade. British Columbia is the major supplier of softwood lumber, crude wood products, and woodpulp to the United States. Quebec and Ontario are the major sources of newsprint, other paper, and plywood and veneer products.

Most of the value of Canada's wood products exports is generated by a few products. Fully 40 percent of the total value of wood exports in 1969 came from the sale of newsprint; woodpulp and lumber exports were about equally important accounting for 25 percent each. Thus, these three products together made up 90 percent of the total value of wood products exported.

Canada exports wood products to more than 50 countries. The volumes and values of these exports by product and principal destination in 1969 are shown in tables 19 and 20. The United States was the largest single market, taking 75.3 percent of the value of all forest products exported and is by far Canada's best customer. Canadian wood imports are of only minor importance and are not discussed further in this report.

Canada's importance to the United States as a source of wood imports is obvious. By the same token the United States is even more important as Canada's major world market for wood exports. For instance, in 1968, Canada cut about 4 billion $ft^3$ of roundwood to meet its domestic and export commitments. Of this total, about 1.1 billion $ft^3$ was consumed in Canada, almost 2.5 billion $ft^3$ was exported in some form to the United States, and 0.4 billion $ft^3$ was exported to other nations. Thus, exports to the United States accounted for about 60 percent of all industrial wood—more than twice the volume of wood consumed domestically.

These figures represent somewhat more than a strong trade relationship between the United States and Canada. They also emphasis the close interrelationship between Canadian and U.S. forest products industries. The timber resources and technologies used by the two countries are essentially the same, and a number of the same wood processing corporations are to be found on both sides of the border. With very limited constraints on the flow of trade across the border, particularly since the "Kennedy Round", the Canadian and U.S. forest economies are, for all practical purposes, a single economy. This means that what the Canadians are willing and able to do will significally influence the future U.S. wood consumption picture. The future size of the U.S. wood market will also very greatly influence the Canadian trade position, and hence the management of Canadian forest resources and industries.

#### Canada's Timber Base and the Potential for Expanded Wood Output

The total land and water area of Canada is about 2.5 billion acres, roughly the same as for the United States. The population of Canada, about 21 million in 1968, is about one-tenth that of the United States. Of the total land and water area, 800 million acres or one-third is classed as forest land and 588 million acres is suitable for regular timber harvest. Table 21 shows the distribution of forest and other land and ownership of the nonreserved portion by Province as of 1968. British Columbia contains the largest area suitable for regular harvest and is followed by Quebec and the Prairie Provinces.

It is estimated that the total volume of available merchantable timber on land allocated to timber production in Canada is 498 billion $ft^3$, excluding Labrador, the Yukon, the Northwest Territories and the immature volumes in British Columbia. This growing stock volume is judged able to sustain a gross physical annual allowable cut of 8.5 billion $ft^3$. If so, this is about twice the volume cut for all purposes in 1969.

According to the Council of Forest Industries of British Columbia (*4*), the potential for expansion of timber output from Canada's inventory will depend on: (1) geographic, (2) economic, (3) market, and (4) political considerations. Geographically, the pattern of forest resource utilization has been from south to north as rail and port facilities developed. It is expected that this development will continue into the presently undeveloped portions of those provinces with the greatest potential.

It is further assumed that sufficient capital will be forthcoming when transportation, services, community, and mill investments are warranted. There appears to be little question that further development of Canadian forest potential will also be heavily conditioned on expanding markets, especially export markets. This latter fact is crucial, for, with the exception of plywood, expanded sales of Canadian forest products have historically been largely dependent on access to export markets.

Because 92 percent of the nonreserved forest land in Canada is publicly owned, Government policies are going to be a critical consideration in future development. Resource jurisdiction is a constitutional right of the individual provincial governments and, as is the case in the United States, there is no single nationwide forest policy or tenure system. However, it appears that all the provinces pursue policies of industrial development based on primary resources, including forest resources, and there is no reason to believe this trend will not be continued into the foreseeable future.

The case for British Columbia is particularly noteworthy. This province has been responsible for nearly all the expansion in Canadian forest industry over the last 20 years based on a vigorous Government policy of development of the province's forest resources.

Under these broad assumptions, and assuming only current levels of management, it is believed that Canadian forests can eventually sustain the calculated 8.5 billion $ft^3$ of annual cut on areas which are now physically accessible, or becoming so, and which can be developed under present cost-price levels for lumber and plywood and under somewhat improved prices for pulp and newsprint. Softwood products thus increased could amount to 4.3 of the 8.5 billion cubic feet projected economic annual allowable cut. About 33 percent of the potential increase in allowable cut is located in British Columbia, 23 percent in Quebec, 20 percent in Ontario, 18 percent in the Prairie Provinces, and 6 percent in the Atlantic Provinces. However, these estimates could be upset if recent increases in harvesting and manufacturing costs continue very far into the future.

### Canadian Wood Products Projections

Even as domestic consumption of wood products in Canada is expected to increase significantly to the year 2000 as population expands from the present 21 million to 37.5 million persons and gross national product expands from $47.4 billion to an estimated $162.0 billion, so, too, are exports of forest products. As is true of the situation in the United States, prices of wood and other products are also likely to rise between the present and the year 2000, and this assumption is built into Canadian projections of wood products exports.

Two sets of projections are available: one set made by the Council on Forest Industries of British Columbia (*4*) for softwood lumber and plywood based on informed judgment; and one set made by Manning and Grinnell (*14*) (table 1, p. 9) based primarily on an extrapolation of past trends using regression analyses.

The Council on Forest Industries estimates that total output of softwood lumber will increase from 12.4 billion fbm in 1971 to 24.0 billion fbm in the year 2000, with 70 percent coming from British Columbia. Softwood plywood is expected to increase from 2.1 billion $ft^2$ in 1971 to 3.8 billion $ft^2$ in the year 2000. Either 50 percent (12 billion fbm) or 60 percent (14 billion fbm) of softwood lumber could be made available for export to the United States if marketing opportunities and comparative cost advantages materialize. These projections bracket the estimates of softwood lumber imports made by the U.S. Forest Service for the year 2000 at rising relative lumber prices, and at prices 30 percent over the 1970 average softwood lumber price.

Manning and Grinnell have projected Canadian exports of all the major wood products to the year 2000 by principal market areas; i.e., the United States, Japan, and the United Kingdom. These projections are based on a set of assumptions pertaining to estimates of growth in demand in these markets, and a continuation of the present tariff structure in each country. The projections are shown in table 22.

Softwood and hardwood lumber export projections to the United States (10.1 billion fbm and 155 million fbm, respectively) appear to be less optimistic than either the COFI export projections or Forest Service import estimates. The pulpwood export estimate (260,000 cords plus about 470,000 cords of pulpchips) is a little over half the Forest Service import projections (1.3 million cords including chips). The projected export of woodpulp (5.5 million tons) is roughly equivalent to 11 million cords, about what the Forest Service estimates would be imported in 1990 under all price assumptions, but considerably short of projected imports in the year 2000. Some woodpulp will likely be imported from countries other than Canada.

Canadian projections of newsprint, paper, and paperboard (about 8.9 million tons in all, mostly newsprint) is roughly equivalent to 13–14 million cords of wood and fairly close to Forest Service estimates of imports of paper and board in the year 2000 at rising relative prices and at relative prices 30 percent above 1970. Canadian projections of hardwood plywood (23 million $ft^2$) to the United States are not important in this comparison because most of the U.S. requirement will likely come from the Pacific basin countries.

Manning and Grinnel estimate that, in total, the equivalent of 7.62 billion $ft^3$ of roundwood will be needed to satisfy domestic wood products consumption and exports by the year 2000. This volume is within the 8.5 billion $ft^3$ of economic annual allowable cut supposedly available now. One could conclude on the basis of these estimates that Canada could meet her expanded future consumption and export wood requirements, assuming no major change in present timber harvesting and processing costs.

## The Japanese Position in World Wood Trade

Japan represents a potential market for expanded U.S. exports of logs, lumber, chips, and pulp and paper products. To a certain extent, Japan may also remain an important, though declining, source of U.S. hardwood plywood imports.

The Japanese market has grown tremendously since the end of World War II. Actually there is no parallel to the growth of the Japanese economy since about 1955. From that year to 1968, gross national product increased at the rate of about 14 percent, 10 percent per year in real terms. In 1968, Japan's GNP was estimated to be $128 billion, larger than that of the United Kingdom, France, and West Germany. Indications are that Japan's growth rate may actually accelerate for a time. A recent study describing the Japanese economy and its potential as a market for wood products was carried out by the Boston Consulting Group (*3*). Much of the following discussion is based on this study.

Two characteristics of Japanese growth (and a continued growth is a continuing major goal) have contributed to Japan's fierce competition in world markets. First, Japanese industrial investment needs are financed in large measure by bank loans; most Japanese companies have debt-equity ratios of 80 percent debt, 20 percent equity. Expansion need not necessarily be financed out of earnings so long as interest charges are covered; there is thus little constraint on growth. This arrangement permits small profit margins on sales and encourages sales volume growth. The bank loans are backed up by the Bank of Japan, and for all practical purposes, are permanent capital.

Second, the Japanese industrial worker is relatively well-educated and is usually employed for life so long as his company survives. His salary is based primarily upon his age, family situation, education, length of service, and is not necessarily set by his job. The effect is to make labor cost a fixed cost and to introduce great flexibility into job assignment. If labor is the principal fixed cost, the remaining factor of importance is the variable cost of raw materials. The Japanese firm is thus encouraged to operate as near to capacity as possible, so long as revenues cover raw material costs and some profit; and the drive to locate low cost, quality raw materials is intense. This procedure can and has produced relatively low product prices for some goods and enables Japan to compete strongly in foreign markets.

Because status is not dependent upon job assignment, greater internal flexibility of job assignment is possible, interchange of jobs among personnel is encouraged, and work rule rigidities tend to be minimized; the effect is greater efficiency. This situation may be changing, however, as labor unions gain in popularity, and the costs of maintaining the old style of employee-management arrangement becomes more expensive relative to such low-cost areas as Korea and Taiwan.

Finally, although direct intervention into Japanese business affairs by the Government is uncommon, there is an informal complex interaction involving several governmental ministries and the Bank of Japan, on the one hand, and the business groups on the other. The basic objectives held by both groups is that maintenance of Japanese economic health and growth are of prime importance, and to a considerable degree, at least to date, there is cooperation between Government and business in striving for these goals. The drive to increase foreign trade, including trade in wood products, would seem assured for some time.

### Japan's Timber Base

Japan is a heavily forested country and traditionally a heavy user of wood products. In recent years with a relatively slow growth in population (about 100 million) and a rapidly growing economy, per capita disposable income has increased and demand for many things commensurate with a rapidly rising standard of living has grown tremendously. Despite what seems like a large forest resource (Japan is 68 percent forested with about 62 million acres of forest land), the nation must import very large volumes of wood to meet domestic and export requirements. One problem is that softwoods are in greatest demand, but the composition of Japan's forests is only 37 percent coniferous; 52 percent is broadleaved, and 11 percent mixed. About 57 percent of Japan's forest land is privately owned. As in the United States, there is a "small woodland ownership problem," and prospects for increased output from the private forest sector are similarly hard to determine.

### Japanese Wood Products Imports and Exports

Japan began importing relatively small volumes of softwood logs from the United States shortly after World War II for use primarily in shipbuilding, vehicle construction, and for piling. After 1952, residential construction began to increase rapidly, and imports of wood products rose. The following tabulation furnished by the Japanese Embassy shows Japan's increasing dependence on wood imports to meet total demand between 1965 and 1971 with estimates for 1972.[1]

| Year | Thousand cubic meters | | | Import dependency rate (percent) |
|---|---|---|---|---|
| | Total demand | Production | Imports | |
| 1965 | 70, 530 | 50, 375 | 20, 155 | 28. 6 |
| 1966 | 76, 876 | 51, 835 | 25, 041 | 32. 6 |
| 1967 | 85, 974 | 52, 741 | 33, 206 | 38. 6 |
| 1968 | 91, 806 | 48, 963 | 42, 843 | 46. 7 |
| 1969 | 95, 570 | 46, 817 | 48, 753 | 51. 0 |
| 1970 | 102, 679 | 46, 241 | 56, 438 | 55. 0 |
| 1971 | 101, 405 | 45, 966 | 55, 439 | 54. 7 |
| 1972 | 103, 310 | 45, 630 | 57, 680 | 55. 8 |

Although domestic timber output is expected to increase as plantations established after World War II mature and as Japan expands the conversion of publically owned old native coniferous and hardwood stands to more rapidly growing coniferous forest, it is unlikely that the increase in output can keep up with expanding demand; Japan's dependence on wood imports will remain high.

Most of Japan's accessible timber was cut during World War II. While reforestation was carried out on a large scale, many of these reforested areas are still not old enough to harvest. Much of Japan's less accessible timber is publically owned and conservatively managed for more than just wood production. Indications are that an increasing amount of public forest land will likely be withdrawn for preservation or multiple-use management. Areas which could be harvested and regenerated still lack access. There is no way to judge whether budgets for access road construction will be greatly enlarged in the near future.

Finally, there are nearly 3 million owners of the private forest land sector in Japan, 94 percent of whom are farmers. Only about 4 percent of these holdings exceed 25 acres in size. To date relatively little consolidation has

[1] Data contained in a letter to Henry vanZile Hyde, Jr., Executive Director, President's Advisory Panel on Timber and the Environment, dated Sept. 21, 1972.

taken place, and the extreme fragmentation of the private forest land sector will likely continue as a major obstacle to increased domestic output despite a fairly well developed cooperative forest management and marketing system among private forest owners.

According to the Boston Consulting Group (*3*), total imports of logs were apportioned among several major sources as follows in 1969:

| | Percent |
|---|---|
| Southeast Asia (luan) | 45 |
| Pacific Northwest, United States | 30 |
| Sibera | 18 |
| New Zealand, Canada, other | 7 |
| Total | 100 |

Three-quarters of the luan logs are made into plywood for domestic use and export and one-quarter into lumber.

Most of Japan's imported lumber comes from Canada (about 580 million fbm in 1968), and Canadian lumber imports are increasing. The United States is the second most important source (about 290 million fbm in 1968 and 325 million fbm in 1971). It is estimated that lumber imports are apportioned among the several major sources as follows:

| | Percent |
|---|---|
| Canada | 60 |
| United States (mostly cants from Alaska) | 30 |
| U.S.S.R | 6 |
| Other | 4 |
| Total | 100 |

According to the Boston Consulting Group (*3*), imported logs from the Pacific Northwest still appear to be a beter buy than domestic logs, despite their relatively high cost. It was estimated that Japanese logs 11 to 20 inches in diameter cost about $200 per M fbm, compared to United States logs 14 to 30 inches in diameter costing only about $130 per M fbm. Not only do the larger United States logs yield lumber commanding premium prices in Japan, but they can usually be purchased on credit from a trading company while domestic logs must be paid for in cash. So long as these economic benefits continue to apply, Japanese trading companies will continue to demand United States logs.

Japan exports only very small quantities of softwood logs and lumber, mainly to Asian destinations. Currently, Japan imports very litle softwood plywood, using instead plywood made from imported luan logs. However, imports of plywood, again mostly luan, are growing as Japan finds it economic to purchase from Korea and Taiwan where labor costs are lower.

Imports of paper and pulp products are also growing. In 1971, Japan imported over 500,000 tons of pulp (including 241,000 tons of alpha and dissolving grades probably from the Japanese controlled mill in Alaska); about 300,000 tons of paper and board, mostly linerboard, from the United States; and over 6 million m$^3$ of chips, almost entirely from the United States.

## The Domestic Market for Wood Products

The potential for increased exports of United States logs, lumber, chips, and pulp and paper products to Japan will depend on the projected demand for these products and on competition from Canadian, Soviet, and Southeast Asian suppliers. The demand for logs and lumber is tied to construction; roughly two-thirds of the total log supply in Japan is used for this purpose.

As noted earlier, construction, particularly residential construction, is growing rapidly in Japan, yet the population is still considered to be badly underhoused. It is believed that 90 percent of all residential units in urban areas were destroyed during World War II, and this deficit has not been made up. To make matters worse, the demand for housing has been spurred for other reasons. Urbanization continues as Japan's industrial economy continues to grow (95 percent of all Japanese are now said to live in urban areas). Babies born after the war are now at marrying age and demanding homes of their own, breaking with the old tradition of living with their parents after marriage.

Government plans called for construction of 7,800,000 residential units between 1968 and 1972. How many of these have actually been constructed is not known, but much of the demand for United States logs has undoubtedly been related to the Japanese housing boom. According to the Boston Consulting Group (*3*), construction has averaged about 1,700,000 per year. Furthermore, the past growth rate in housing of 15 percent per year is expected to continue, if not accelerate, in the future. Government estimates of the number of units required by 1985 total 27 million.

Despite the traditional Japanese preference for custom-built wood houses, the percentage of wooden buildings declined at the rate of about 1 percent per year over the period 1955–67. In contrast, the proportion of high-rise, multifamily structures which use relatively less wood per dwelling unit has been increasing rapidly. By 1985, the Building Research Institute of Tokyo (as reported by the Boston Consulting Group (*3*), estimates that the total number of residential units built in 1985 will break down as follows:

| | *Percent* |
|---|---|
| High rise | 30 |
| Wooden | 50 |
| Prefabricated | 20 |

By comparison in 1968 wooden dwellings accounted for 90 percent of all dwelling units in place and high-rise only about 1 percent.

Use of wood in construction of all kinds of buildings has declined. It is estimated that only about 8,480 fbm of lumber are used per 100 $m^2$ of floorspace in general wood construction. Lumber requirements for ferro-concrete construction are much lower—about one-half that of wooden construction.

Total use of plywood (luan) has been growing rapidly, primarily as a substitute for lumber in construction, as form material for siding, and flooring. Single family dwellings as well as high-rise units are making increasing use of plywood for walls, ceilings, and floors. The popular panel size is 3 by 6 feet, a size Canadian producers supply readily but which United States producers are reportedly unwilling to manufacture.

The largest potential market for plywood in Japan is tied to the trend toward prefabricated housing. The relative use of this type of house is expected to increase from 5 percent at present to 25–30 percent by 1985. There are as yet no institutional, building trade union, or building code restrictions in Japan which would prevent the widespread adoption of prefabricated housing which can be mass-produced at substantial savings in cost of labor and materials over conventional construction. Japan may become the first country in the world to mass-produce housing units, much as automobiles are produced today. The growth in plywood demand notwithstanding, the outlook for United States imports is not promising mainly because United States plywood is too closely relative to luan plywood and United States producers have yet to show a willingness to produce the sizes required by the Japanese market.

## Projections of Wood Products Demands

The projections discussed below are based on the Boston Consulting Group study (*3*) and major emphasis is on logs, especially softwood logs, softwood lumber, and plywood. There appears to be less reliable information on projected pulp and paper products demands.

In general the following represent the main trends in demand for the major wood products:

1. The Japanse demand for softwood logs will continue to grow until 1975. After 1975, growth in demand will be slow, but total demand will remain relatively high at about 13.25 billion fbm (log scale) per year. Demand for United States softwood logs may not continue to grow much over present levels, however, as Japan's need for lumber falls and other supply sources are developed.

2. The growth in demand for lumber is aslo expected to continue, but like log demand, at a diminshing rate and for about the same reasons. The estimate is that demand will level off at about 24.2 billion fbm per year by 1975. Beyond 1975 demand may decline somewhat. The demand for North American lumber is less clear than for North American logs. Canada expects to triple her present softwood lumber exports to Japan to 1.5 billion fbm by the year 2000. United States west coast lumber producers also have a good opportunity to enter the Japanese market more strongly than at present if they so choose, but this will involve some change in present attitudes.

It has been reported that large west coast wood processors are indeed much interested in developing a larger export trade in lumber, along with logs, pulp, and chips. The Japanese market is more attractive than the east coast of the United States for the sale of at least part of these firms' output because it costs less to ship to Japan (at least $10 less per M fbm for lumber) than to the east coast due to the Jones act restriction. The market for Alaska's lumber output will continue to be Japan because lumber and pulp manufactured there cannot compete with Canada in the lower 48 States, again because of the Jones act. Alaska's lumber exports could double to 500 million fbm by the year 2000.

United States west coast lumber producers have not as yet actively sought to develop a large export trade with Japan, despite the attractive market. One reason, of course, is that sales in the U.S. market have been deemed more important than export sales. Another reason is that United States lumber producers have been unwilling, or unable, to meet Japanese lumber specifications. The Japanese market is, in some respects, a custom-tailored one. That is, there is a wide range of size and quality specifications, in sharp contrast to the relatively narrow range of specifications accepted by U.S. lumber users.

The Japanese prefer unusual lengths such as 10-, 12-, 13-, and 20-foot lengths, and unusual widths like 10.5 cm. Furthermore, the Japanese attach a premium to the absence of knots, straight grain, and light color in exposed area use, characteristics not found in the mass lumber grades produced for the United States market. Canadian and Alaskan lumber producers do manufacture and ship cants which the Japanese can then cut to their own specifications. Perhaps U.S. west coast producers need to do the same if they are to increase their lumber exports to Japan.

3. Plywood demand will be the beneficiary of the trends working against lumber. The trend to high-rise and prefabricated dwellings, and the increasing use of plywood for concrete forms point to rising plywood demand. However, as noted earlier, the outlook for United States plywood producers is not encouraging unless they are willing to manufacture to Japanese specifications and can sell plywood in Japan at prices comparable with those for luan plywood (note a likely development).

4. The demand for pulp and paper in Japan is increasing at a rapid rate commensurate with the increase in gross national product. Estimates are that Japan's pulp and paper requirements may increase by 90 percent by the eend of this decade (*18*) (pp. 32–38). Consumption in 1970 was 12.3 million tons. Exports are not involved, as all the requirement goes for domestic consumption.

Imported raw material preferences have been influenced to some extent by Japan's concern with pollution in the pulp-making process; there is also a growing lack of space for such things as settling and clarifying ponds. However, on an economic basis Japanese producers and planners still prefer to import pulp logs (instead of market pulp which would avoid pollution). Chips are second choice and market pulp third. The objective is, as elsewhere in industrialized nations, to maximize domestic payrolls from wood processing.

The Japanese, looking for reliable pulpwood, chip, and plup supplies, are not committed to any particular source and are ranging far and wide in search of sources over which they may exert some control. Thus, Japan is considering greater use of tropical timbers for pulp from some of the undeveloped parts of the world as a longrun possibility. Furthermore, the Japanese are making a major long term effort to establish fast-growing softwood and eucalyptus plantations in those nations of the South Pacific not threatened by communism; i.e., Malaysia, Indonesia, Australia, and New Zealand.

In 1971 Japan concluded a 10-year agreement with the U.S.S.R. to obtain logs and chips from Siberia. Although Siberian logs do not compare in quality to U.S. logs for structural purposes, chips made from them are of usable quality, and the volmes available are very large. Closer to home the Japanese have entered into arrangements with British Columbia in securing pulpwood rights, although the eventual consummation of these arrangements involves construction of processing facilities. The Japanese have also obtained market pulp from the 100 percent Japanese venture at Sitka since 1953. This operation produces about 160,000 tons of dissolving sulfite pulp and 30,000 tons of sulfate pulp per year.

Despite the fact that the Japanese remain uneasy because they cannot control U.S. sources of export chips, they do prefer the product. The United States produces a higher quality chip than can be obtained anywhere else (British Columbia refuses to export chips). North America, particularly the Pacific Northwest, is the premier source of high-quality chips and market pulp for Japan's long-term needs. Because of uncertainties about prospects for chip exports from the United States, projections of chip imports from the United States in 1985 are only about one-third the 1971 volume (2.0 million $m^3$). Obviously the United States is capable of exporting much larger volumes of chips than this is if only the effort is made to cultivate the Japanese market.

In summary, the following tabulation shows potential demands for some forest products in Japan in 1985. The estimates for logs and lumber were made by the Boston Consulting Group (*3*). The pulp and paper estimate originates with Vernon S. White (*18*) and applies to 1980.

| | | |
|---|---|---|
| Total logs | billion board feet | 22.9 |
| Softwood logs | do | 12.3 |
| Total lumber | do | 21.6 |
| Softwood lumber | do | 18.7 |
| Hardwood plywood | do | 3.5 |
| Pulp and paper products | million metric tons | 23.5 |

For 1985, the total demand for all logs (22.9 billion fbm) could be supplied from the following sources:

| | Percent |
|---|---|
| Supplied from domestic sources | 57 |
| Supplied from imports | 43 |
| Southeast Asia | 60 |
| United States | 13 |
| Canada | 4 |
| U.S.S.R. | 22 |
| Others | less than 1 |

According to these figures, United States logs exports to Japan would be about 1.4 billion fbm by 1985 with perhaps a like volume in the year 2000. Such volumes are considerably less than the Forest Service log export projections under all price assumptions and are more likely of attainment in view of probably increased restrictions on log exports from the Pacific Northwest.

How much of Japan's future pulp and paper demand could be met by increased shipments from the United States would depend on comparative manufacturing costs among the principal export competitors. Total wood costs for newsprint are lowest in western Canada, a distinct advantage in estimating future competitive advantage in export of newsprint to Japan. Next lowest costs are found in southern United States, followed by eastern Canada, Finland, and Sweden. In the manufacture of kraft pulp, western Canada has the lowest manufacturing cost (*14*). On balance, the long-term advantage in pulp and paper trade with Japan would seem to lie with western Canada, with increased United States exports going more to Europe.

## The European Position in World Wood Trade

Europe is the world's most important wood-using region after the United States. In 1969 total removals of industrial wood amounted to 192.5 million m$^3$, 16 percent of total world removals (*11*).

The most recent study of European timber trends has been carried out by the FAO (*9*). The discussion below is based in major part on this appraisal and on an earlier European timber trends study (*11*).

After a short period as a net exporter of wood products in the immediate post-World II years, Europe reverted by 1955 to a net import position, importing primarily lumber from the U.S.S.R., pulp and paper from North America, and tropical logs from West Africa. Net imports have continued to grow since that time and prospects are for increasing wood deficits in the future as shown by the following tabulation:

| | Million cubic meters | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1950 | 1955 | 1960 | 1965 | 1970 | 1975 | 1980 |
| Domestic supply | 179 | 208 | 226 | 258 | 289 | 324 | 364 |
| Exports | 57 | 70 | 83 | 100 | 118 | 139 | 165 |
| Imports | 53 | 74 | 99 | 132 | 157 | 192 | 231 |
| Apparent consumption | 175 | 212 | 242 | 290 | 328 | 377 | 430 |
| Net imports | −4 | 4 | 16 | 32 | 39 | 53 | 66 |
| Imports as a percent of apparent consumption | 30 | 35 | 41 | 45 | 48 | 51 | 54 |

NOTE.—The volume preceded by a minus sign is a net export volume.

Consumption of all wood products has increased over the years, but the rates of increase have varied depending on the product. Consumption of sawnwood, plywoods, and veneers rose by 53 percent between 1950 and 1965. All other industrial wood products, of which paper and paperboard accounts for a major and growing share, expanded by 77 percent. Within this group, however, consumption of wood used in the round form declined.

These rates of growth are expected to diverge still more between 1965 and 1980. Consumption of lumber, plywood, and veneer is expected to increase by 15 percent. Consumption of paper, paperboard, dissolving pulp, particleboard, and fiberboards are expected to increase by 86 percent.

Actual consumption of industrial wood products by region is shown for the period 1950–65, together with estimates for 1970–80 as follows:

| Year | Million cubic meters | | | | | | |
|---|---|---|---|---|---|---|---|
| | Europe | Northern Europe | European Economic Community | British Isles | Central Europe | Southern Europe | Eastern Europe |
| 1950 | 177. 6 | 20. 2 | 64. 3 | 28. 2 | 12. 0 | 8. 8 | 44. 0 |
| 1955 | 213. 7 | 23. 0 | 81. 2 | 33. 3 | 12. 3 | 11. 2 | 52. 7 |
| 1960 | 246. 6 | 25. 2 | 97. 1 | 38. 0 | 15. 4 | 13. 3 | 57. 4 |
| 1965 | 291. 4 | 31. 0 | 119. 2 | 44. 4 | 18. 6 | 19. 0 | 59. 3 |
| 1970 [1] | 329. 0 | 34. 0 | 135. 0 | 49. 0 | 21. 0 | 24. 0 | 65. 0 |
| 1975 [1] | 378. 0 | 38. 0 | 158. 0 | 55. 0 | 24. 0 | 32. 0 | 71. 0 |
| 1980 [1] | 431. 0 | 41. 0 | 181. 0 | 62. 0 | 28. 0 | 42. 0 | 77. 0 |

[1] Estimate.

With the exception of the northern and central European countries, all the other European countries have been deficit in total wood, and this situation is expected to continue. The FAO estimates (*9*) (supplement No. 7) industrial wood balances for Europe as follows for the period 1950–80:

| | Million cubic meters | | | | | |
|---|---|---|---|---|---|---|
| | 1950 | 1960 | 1965 | 1970 | 1975 | 1980 |
| Northern Europe | +44. 2 | +59. 8 | +66. 7 | +79 | +92 | +100 |
| European Economic Community | −21. 0 | −41. 1 | −55. 8 | −68 | −85 | −109 |
| British Isles | −25. 0 | −34. 9 | −40. 9 | −45 | −50 | −59 |
| Central Europe | +8. 1 | +5. 8 | +5. 1 | +6 | +6 | +5 |
| Euthern Europe | −4. 3 | −4. 4 | −6. 5 | −6 | −8 | −12 |
| Sastern Europe | −. 5 | −5. 8 | −2. 6 | −6 | −8 | −12 |

Within Europe the northern region (Sweden, Finland, and Norway) is expected to have a substantial surplus by 1980, the European Economic Community and the United Kingdom will have substantial deficits, central Europe a small surplus, and southern and eastern Europe small deficits at relatively low levels of consumption.

With respect to 1980, Europe's net wood deficit will likely amount to 66 million m³, with her dependency on imports growing for some time beyond 1980 despite the substantial expected increased contribution of Scandinavian forest products to total European requirements.

Europe's wood imports from the outside amounted to 47 million m³ in 1965. The U.S.S.R. supplied about 40 percent of Europe's wood imports (mainly softwood lumber and roundwood); North America, 38 percent (mainly lumber, pulp paper, and panel products); and the rest of the world (chiefly the developing countries of the tropics), 22 percent.

With respect to 1980 and beyond, the FAO suggests the following possibilities for increased trade with Europe in the light of her expected, very substantial, wood deficit:

1. The U.S.S.R. and Canada are likely to remain Europe's dominant outside suppliers of lumber and pulp and paper products, even as the Scandinavian countries expand their exports. As noted earlier, the cost advantages, especially in pulp and paper manufacture, now lie with Canada and the United States. Russian exports appear to be more closely related to internal demands for foreign exchange rather than to comparative manufacturing costs and will involve lumber primarily. However, it should be noted that Scandinavia is at present Europe's largest supplier of pulp; its exports to Europe are at least seven times as large as Canada's. Because of Scandinavia's close proximity to the European market this ratio will probably remain large even as the Scandinavian contribution decreases in magnitude.

2. Woodpulp, especially long-fibered pulp, and its products are expected to constitute the largest item in Europe's increasing requirements. Europe's supply of hardwood pulpwood and short-fibered pulps are expected to be adequate. The FAO estimates (*9*) (supplement No. 7) that Europe's deficit in long-fibered pulps could reach

the equivalent of 33 million $m^3$ by 1980. This deficit is almost sure to grow beyond 1980.

3. While both Canada and the U.S.S.R. will continue to be the main sources of lumber imports for Europe, Canada, and increasingly the United States are the most likely sources of future expanded imports of pulp and paper, especially kraft paper and linerboard.

Although projections of future United States exports of pulp and paper products to Europe are not specifically broken out of the Forest Service estimates, it is clear that there is room for considerable increase over the present export volumes of 1 million tons of pulp and 1.3 million tons of paper and board in each of the target years under any of the price assumptions. The Canadians and, to a degree, United States pulp producers, are likely to benefit from the trend in the Scandinavian countries toward vertical integration in pulp and paper manufacture, resulting in higher paper exports and lower exports of pulp to Europe from those countries.

## OTHER POTENTIAL WOOD PRODUCTS MARKET AREAS AND THEIR POSSIBLE INFLUENCE ON THE U.S. TIMBER IMPORT-EXPORT POSITION

### Mainland China

There is very little recent information useful for critically assessing China as a potential trader in wood products on the world market. The data that are available suggest strongly that if China is to be an important factor in international wood trade, her role will almost surely be that of an importer, conceivably of some magnitude.

China is believed to be practically self-sufficient in consumption of wood at very low levels. According to the FAO (*7*), total removals amounted in 1969 to about 169 million $m^3$, of which 130 million $m^3$ was fuelwood. The industrial wood removals (39 million $m^3$) amounted to 3 percent of the world total; saw logs, veneer logs, and logs for railway ties made up over one-half of all industrial wood removals. Wood products output figures are also available for 1961 as follows (*7*):

| | |
|---|---|
| Sawnwood | 13.5 million $m^3$ (60 percent softwood, 40 percent hardwood). |
| Wood-based panels | 0.1 million $m^3$. |
| Pulp | 2.9 million metric tons (about 65 percent nonwood pulp). |
| Paper and paperboard | 3.6 million metric tons (about 86 percent industrial paper and paperboard). |

China had virtually no exports of wood and almost no imports except for 163 thousand tons of pulp and 236 tons of paper and paperboard which came primarily from Sweden, Finland, and Norway. With a population of about 815 million people, consumption of all wood products is extremely low and it is likely to remain low for some time. By the same token, the potential market for wood in China is immense, assuming, of course, the eventual availability of foreign exchange with which to import.

China had in 1961 an estimated 96.4 million ha (about 241 million acres) of forest land, roughly 10 percent of the total land area of the country and about 2.5 percent of the world's total. No breakdown of this area as to coniferous and broadleaf forest is available. At present China very likely has increased her forest area over the 1961 estimate through a major planting effort said to be the largest such effort in a wood-poor area in the world. Plans called for 100 million ha to be planted between 1956 and 1967. Supposedly 30–60 million acres were planted during the 1950's. However, survival rates are known to be quite low and it is not possible to say just how much plantation forest does actually exist in China. The planting effort continues, however, and in due course this effort will improve the wood supply situation in the country (*10*) (p. 51).

According to Richardson (*16*) China's forests which are located in the northeastern part of the country, contain about 265 billion $ft^3$. Most of China's population lives far away from this resource in areas containing almost no wood except what is planted.

In 1965 the FAO (*10*) (p. 117) estimated that China's consumption of industrial wood products would be 62 million $m^3$ by 1975 or about 80 percent greater than in 1961. No estimate of production by 1975 was made. Richardson cites a Chinese analysis made in 1958 that estimated requirements by 1972 to be 120 million $m^3$ while planned production was to be 79 million $m^3$ (*19*). The Chinese estimate was obviously highly optimistic with respect to industrial wood consumption, production, and ability to import the wood needed to close the expected gap between production and require-



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ments. Even the FAO consumption estimate for 1975 appears to be optimistic, considering that only 39 million m³ of industrial wood was removed in 1969.

The realization of any substantial level of wood imports to China in the foreseeable future will depend upon the generation of foreign exchange through increased agricultural and/or industrial production and export and a decision to allocate some part of this to the purchase of foreign wood. Even though this may not happen on a large scale for some time, China has reportedly already begun negotiations with Canada for the import of some timber products. Apparently China has decided to become a more active trader on world markets, although what she may offer for sale is not yet well-defined.

If a Chinese import market does develop, it is likely that hardwood logs would come from Southeast Asia. Softwoods could come from Siberia or North America. Zivnuska (*19*) cites a passage from Solecki (*17*) which throws some light on the potential attractiveness of these two sources for possible Chinese imports. Solecki states that "At first sight the Soviet Union appears to have an advantage, but this is not necessarily so. The timber stand of eastern Siberia is needed for the processing centers recently completed or under construction on the Angara and Yenisei Rivers. In addition, the cost of transporting timber to the North Sea and transloading it to oceangoing ships in the short ice-free season is likely to be rather high, while transport by rail would be even more so. The forest stands of the Far East (Maritime Province), on the other hand, are primarily still undeveloped mixed forests with very high costs of exploitation. Their proximity to the Chinese markets is also somewhat illusory. The Amur flows east and then north where the handling of timber becomes difficult due to prolonged winters. Transport by rail or small craft by water against the current will be expensive."

Conceivably, Japan could play a part in supplying certain processed wood products to China on some scale consistent with her own future requirements; so could Taiwan and Korea, two countries which are close by. On balance, it seems more likely that increased trade in softwood timber products will originate in Canada, although some trade with the United States is a possibility.

## Australia and New Zealand

Both Australia and New Zealand have highly developed economies with high per-capita wood use. However, neither nation figures importantly in total world wood requirements simply because neither has a large population or industrial complex to support.

Australia's native forests are largely of the hardwood type. To add to domestic supply of softwood timber, Australia undertook the establishment of coniferous plantations (mainly *Pinus radiata*, *Larix spp.*, and *Araucaria* spp.). By 1963, some 500,000 acres had been planted with plans for an additional 150,000 acres to be established by 1967 (*10*) (p. 50). Despite this effort, Australia is still dependent on imports of softwood timber products which in 1969 consisted mainly of softwood lumber and pulp from New Zealand, Canada, and the United States, and newsprint from Canada. Pulp and paper products accounted for two-thirds of the total value of all wood imports. Conceivably, Australia could become a minor source of wood for Japan.

The establishment of fast-growing coniferous plantations through conversion of native forests has been much greater in New Zealand. By 1963, about 1,663,000 acres had been planted with another 150,000 acres planned for establishment by 1967 (*10*) (p. 50). New Zealand is today essentially self-sufficient in wood products, with an increasing potential for exports on at least a small scale, primarily to Australia. However, consumption of wood products will undoubtedly be greater than production for these two countries in the future. The FAO estimates the deficit will be about 5 million m³ by 1975. Thus, Australia could at least represent a small future market for United States and Canadian exports of softwood lumber, chemical pulp, Kraft paper, and linerboard.

## The Developing Nations

In order to complete the overview of potential world market areas for wood, some attention needs to be directed to the so-called developing nations. Despite the very large forest area and number of countries involved, only a brief examination of market potential is warranted. To date the developing nations have not represented important markets for wood products although some of them have been relatively important sources of wood, primarily logs. Included in the classification, developing nations, are the countries of Latin America, Africa (excluding South Africa), Asia, and the Far East (excluding Japan, Australia, and New Zealand). These nations now account for less than 10 percent of world wood consumption. Despite the expectation of rising wood demands, this proportion is not expected to change by 1985.

U.S. exports of lumber (mostly softwood) to Latin America have never reached 200 million fbm in any year since 1950; in 1971, they were only 77.1 million fbm. Lumber exports to other countries have averaged about 180 million fbm per year, but not all of this went to the developing countries of Africa or Asia. Of the total wood pulp exported from the United States in 1971 (2,175,000 tons), about 15 percent went to the developing countries. Exports of paper and paperboard to the developing countries have been more important, accounting for about 30 percent of total paper and paperboard exports in recent years. Latin America took the largest volume (700,000 tons) in 1971, about 72 percent of the total volume sent to the developing countries. Thus, with the exception of paper, the U.S. exports of wood products to the developing countries have been of minor importance.

Although the developing countries do not represent an important market for U.S. wood exports now, the question is: Will they in the future? The FAO has made the most recent projections of wood products consumption for the developing countries in its Indicative World Plan for Agriculture (provisional) (*8*). The estimates relate to 1975 and 1985 and are based on the demand side on assumptions of certain increases in income derived from projections of gross national product. On the supply side certain assumptions are made regarding the progress of exploitation of native forests or the development of plantations and the establishment of forest industries to process domestically grown wood. The developing countries taken together are referred to in the FAO report as zone C.

The assumed levels of forest industries expansion used in the FAO Indicative World Plan (IWP) projections (*8*) (pp. 307–326) may well be considered highly optimistic. For instance, it is estimated that about $4 billion would have to be invested in forest industries establishment over the IWP period 1962–85 if the production estimates are to be met. Where all this investment is to come from is not clear. In addition to solving the investment problem, the developing countries must somehow generate the professional expertise to carry out the expansion programs. In Africa, for example, the present 300 professionals and 1,860 technicians will need to be expanded to 1,800 professionals and 9,600 technicians by 1985. Latin America, including Central and South America and the Caribbean Islands, will require about 6,500 professionals and 30,000 technicians by 1985. For Asia, 5,700 professionals and 28,800 technicians will be needed. Finally the developing countries must somehow create rational national forest policies designed to aid in the expansion programs while protecting the longrun productivity of their forest resources, and the forest services to carry out the programs of management. This is a pretty large order under the best of circumstances, and there is not, at least to date, a clear indication that the developing countries are moving to meet the requirements for the scale of forest products expansion assumed in the IWP.

By the same token one may legitimately question the demand side assumptions. For the world as a whole the IWP estimates that consumption of sawnwood products will be 40 percent higher in 1985 than in 1968; wood-based panels, 260 percent higher; and pulp and paper, over 240 percent higher. For zone C the IWP assumes that consumption of these products will rise at much larger rates than the world averages because incomes in zone C are going to increase and, supposedly of more importance, income elasticities of demand for wood products are higher at low-income levels than at high ones. Consumption of sawnwood in zone C is estimated to be almost 150 percent higher in 1985 than consumption in 1962, and consumption of wood-based panels and pulp and paper will be 4 to 10 times higher than consumption in 1962. At best, projections of development possibilities and forest products consumption in developing nations are highly speculative, and despite the FAO's belief that the projections to 1985 are capable of achievement, economically and technically, the figures must be viewed with considerable care.

Table 23 shows 1962 consumption of wood products in zone C together with the FAO's projections for 1975 and 1985. By 1985, Latin America supposedly would have a small surplus of coniferous sawnwood, most likely derived from plantations established some time ago, particularly those in Chile and Brazil. This surplus will almost surely be marketed in Latin America itself. All the regions of zone C show small, broadleaf sawnwood surpluses except the Near East, which is a timber poor area generally. Latin America, Africa, and Asia show possible surpluses of veneer and plywood (hardwood). As will be noted later, African surpluses are most apt to be marketed in Europe, assuming some relaxation of present import restrictions on processed wood. The Asian surplus will most likely be marketed in Japan or the United States. These values are consistent with the trend toward export of processed wood instead of raw logs, particularly in West Africa and Asia. The figures also suggest possible moderate deficits of paper, paperboard, and pulp products in all regions of zone C. Conceivably, the United States could increase its present exports of these products to zone C countries by 1985, but competition from Canada would likely be strong, and export increases would probably be of minor importance. All the zone C regions are expected to be self-sufficient in fuelwood and unprocessed wood used in the round, neither of which enters world trade importantly.

## MAJOR WORLD WOOD SURPLUS AREAS (EXCLUDING CANADA) AND THEIR POSSIBLE IMPACT ON THE UNITED STATES IMPORT-EXPORT POSITION

### The U.S.S.R.

Over the years there has been much speculation about the future wood trade potential of the U.S.S.R. After all, it is difficult to overlook the fact that the U.S.S.R. accounts for perhaps 20 percent of the total forest area of the world, 30 percent of the total growing stock, and 50 percent of the world's softwood reserves (*13*) (p. 79). However, despite the vastness of these resources, it is still necessary to estimate how much progress in their utilization the Soviet Union will make, and what proportion of increased future output of forest products will actually enter world trade as exports. A number of analyst (*1, 5, 13*) (pp. 79–87) have examined the problem and have arrived at different conclusions. However, all are essentially agreed that the U.S.S.R. will continue to increase the output of all forest products, possibly at a rate greater than in the past, if: (1) The technical problems of access can be solved, and (2) investment in the necessary processing facilities are forthcoming. The following brief overview of the wood export potential of the U.S.S.R. draws on a number of recent studies, several of them conducted in considerable detail. Although the Soviet Union does import some wood products (1.5 million $m^3$ of saw logs, 274,000 metric tons of pulp, and 403,000 metric tons of paper and board in 1969) (*7*), the following discussion concerns her exports and export potential only.

#### The Soviet Timber Base

As in other countries, forest inventory data for the U.S.S.R. have changed from time to time as better information became available. As cited by Zivnuska (*19*) (p. 88), Solecki (*17*) states that the total area under forestry jurisdiction is 2,905 million acres, 1,697 million acres of which are actually forested. Of the forested land, about 568 million acres are not considered suitable for exploitation because they are not economically accessible (too far north). An additional 136 million acres are said to be too steep or too marshy for exploitation. Finally, 190 million acres have been overexploited (in southern and western U.S.S.R.) or are restricted. This leaves a net of 803 million acres as yet underexploited and containing an estimated 1,660 billion $ft^3$ of timber (about 85 percent softwoods). This compares with 495 million acres of commercial forest land in the United States containing about 649 billion $ft^3$ of timber (66 percent softwood).

Four features characterize the Soviet timber base: (1) It is extensive; (2) the timber is of reasonably high quality, particularly for the more highly processed wood products; (3) the number of species is limited making for homegeneity (typical of "taiga" forests); and (4) the major portion of the resource is not well-located with respect to the consuming centers of the nation or Europe.

#### Wood Products Exports

The Soviet Union has been an exporter of wood products for a long time. Exports were highest during the 1930's, and it was not until the 1960's that exports exceeded these highs. Exports of sawnwood have consistently made-up about half the total volume of wood in terms of roundwood equivalent. Wood exported in the round form has usually made up less than half the total, while plywood and other more highly processed products have accounted for only about 5 percent. Only after World War II did the Soviet Union become an exporter of pulp, paper, and paperboard. Since World War II the export of pulpwood has increased while other roundwood exports have declined. In 1969, the following volumes of wood products were exported (in roundwood equivalents) [7]:

| | *Million cubic meters* |
|---|---|
| Pulpwood | 5.4 |
| Sawnwood | 8.2 |
| Panel products | 0.5 |
| Pulp | 0.4 |
| Paper and board | 0.6 |

The Soviet Union exports wood products to about 60 countries. The following tabulation shows the most important destinations of these exports in 1965 (*5*) (p. 7):

| Country | Thousand cubic meters | | | | | | Thousand tons | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total roundwood equivalent | Sawnwood | Pulpwood | Pitprops | Saw logs | Sleepers | Veneer | Pulp | Paper and board |
| Great Britain | 4,965 | 2,195 | 48 | 623 | 10 | 71 | 130 | 44 | - |
| Finland | 2,267 | 393 | 956 | 50 | 603 | - | - | - | - |
| Japan | 2,381 | 36 | 582 | - | 1,737 | - | - | - | - |
| East Germany | 3,444 | 1,308 | 752 | - | - | 12 | 6 | 49 | 60 |
| Hungary | 2,363 | 641 | 288 | 524 | 187 | 15 | 1 | 31 | 31 |
| China (Taiwan) | 1,521 | - | - | - | 1,511 | - | - | - | - |
| West Germany | 1,168 | 499 | 150 | 168 | 3 | - | 1 | 20 | - |
| France | 779 | 245 | 302 | - | - | - | - | 14 | - |
| Belgium | 739 | 239 | 276 | 9 | 13 | - | 10 | - | 5 |
| Italy | 727 | 296 | 120 | - | 14 | 2 | - | 19 | - |
| Others | 5,665 | 2,051 | 705 | 91 | 152 | 85 | 61 | 84 | 138 |
| Total | 26,019 | 7,903 | 4,179 | 1,465 | 4,230 | 185 | 209 | 261 | 234 |

About 80 percent of the total roundwood equivalent of exported wood products went to 10 countries in Europe and to Japan. The two most important markets were Great Britain and East Germany. The most important market for Soviet lumber exports has been, and still is, Great Britain. By 1961, the Soviet Union had become the largest exporter of lumber to Europe, and this position still stands today. There is an active trade in woodpulp across the Finnish border, and both East Germany and Japan are also important markets for Soviet pulp. Japan and China (probably Taiwan) are the two most important export markets for Soviet sawlogs, which most likely originate in eastern Siberia.

### Consumption and Production

The population of the Soviet Union was about 238 million in 1968, and 15 percent larger than that of the United States (201 million). However, despite the very large forest base, per capita consumption of wood products in the country tends to be very low, a reflection of present underutilization of the timber resource.

Because of low present wood use, an argument often used in discussions of the Soviet Union's export potential is that most of the country's future production of wood products will go to satisfy growing domestic needs leaving little for export. According to Algvere (*1*), this may be a misconception. Both before and after World War II, opinion in the West was that internal consumption would not allow exports of forest products. Nevertheless, the Soviet Union has regained its former position on world markets. Whether the older notion will yet prevail will certainly depend on how rapidly the Soviet Union proceeds to develop its forest industries and whether it decides to satisfy growing consumer demands for wood products, or export wood products in order to generate foreign exchange needed to purchase higher priority products. It is reasonable to expect that an increased demand for wood within the Soviet Union will make it more difficult to expand exports rapidly, and they may rise only slowly for some time.

In the opinion of a number of analysts, the forest industries in the Soviet Union are not necessarily to be favored in overall Soviet investment planning. Certainly since 1950, only about 5 percent of all industrial investments have been made to develop the forestry sector compared to 33 percent for fuel and power; 25 percent for steel, metalworking, and engineering; and 10 percent for chemicals (*5*). Forestry development in the new industrial centers of east Siberia, for example, has been more or less incidental to power generation and mineral extraction and processing. In west Siberia, main investment emphasis is in the development of a petroleum industry, not forestry. Despite the growing demand for both export and domestic consumption of pulp and paper products, their manufacture have not increased very rapidly. Pulp and paper manufacture is capital intensive and an increase in their production requires considerable outlay. Because capital is still relatively scarce, and overall investment demands heavy, it is not surprising that expansion in this industry has not been more rapid.

It seems highly improbable that the Soviet investment pattern will be greatly different over the next 10 to 15 years. The industrialization of Siberia will be advanced, but it appears that the oil, gas, petrochemical, and mineral industries will be favored. According to Ekstrom (*5*), the strategy of the Soviet Union seems to be to allow the pulp and paper industry to grow at about the average overall industrial rate, while the forestry sector as a whole grows considerably slower. The future development of the forestry sector will likely depend in part on how successful the U.S.S.R. is in production and export in other sectors. The more successful these are, the less it will be necessary to rely on forest products produced for export. Of course, the growing domestic requirements for all wood products will have to be satisfied, but this will not require as much forest industry development as would production for both domestic consumption and export.

## Soviet Export Potential

A number of analysts and agencies, including the official planners in the Soviet Union, have estimated future wood products output to cover domestic and export requirements. Table 24 summarizes the most recent plan targets together with estimates made by Ekstrom (*5*) which are generally more likely of attainment, assuming continued efforts to develop the forestry sector at about past rates. Ekstrom's estimates for 1970 and 1975 are considerably less than the official planned target volumes except for sawtimber removals for 1970. His lower projections also reflect the impression that Soviet authorities are not yet prepared to invest sufficiently in development of the forestry sector. It is of interest to note that almost never in the past have official targeted production goals been met.

The increase in forest products output embodied in the table figures are expected to be attained by the construction of new, large-scale complexes in the forest surplus areas far to the east of population centers. This involves a continued effort to relocate the older, established forest industry from western and southern U.S.S.R. to the more plentiful forest resources of northern European U.S.S.R., eastern Siberia, and the Soviet far east. By 1968 it was estimated that about 75 percent of total forest production was already coming from the newly developed areas of the Soviet Union.

However, further utilization of these distant reserves really depends on their economic accessibility. Considerable progress has been made in reducing onsite harvesting and processing costs, but there is still a lack of suitable labor and adequate infrastructure in the newly developed areas. Transportation costs from producing to consuming centers will also be high. The average transport distance for industrial wood is said to have increased from 415 km in 1913 to 1,600 km in 1967.

Despite the very substantial problems which must be solved if the Soviet Union is to continue or expand its wood exports, there are several factors which are working in its favor. Harvesting of timber is being rapidly mechanized, and harvest costs should fall as this trend proceeds. The following tabulation shows how the degree of mechanization has increased since the end of World War II (*13*) (p. 80):

| Operation | 1948 | 1950 | 1955 | 1960 | 1966 |
|---|---|---|---|---|---|
| Felling | 12 | 38 | 86 | 98 | 99 |
| Skidding | 4 | 29 | 73 | 94 | 96 |
| Hauling | 43 | 57 | 78 | 95 | 100 |
| Loading: | | | | | |
| Upper landing | | 15 | 55 | 88 | ------ |
| Lower landing | | | 28 | 68 | ------ |

A second possibility for lowering costs exists in the better utilization of raw material which has not been particularly close in the U.S.S.R. Wage costs are considerably lower in the Soviet Union than in Scandinavia or North America. While labor costs may not be so important in the pulp and paper manufacturing process, they do constitute a substantial element in raw material procurement costs. Capital costs are also said to be lower in the Soviet Union than elsewhere, although it is hard to see that this would make much difference in a country where capital investments are still based on political decisions. Finally, the new processing facilities being constructed in the U.S.S.R. are large and modern with attendant lower manufacturing costs per unit of output.

Considering the possible cost advantages and disadvantages the Soviet Union may face in developing the forest sector in the new forest areas of the country, Ekstrom has projected the future export shares of total forest products output for 1970, 1975, 1980, and 1985 and compared these to the actual shares in 1968 (*5* (p. 80)):

| | Percent | | | | |
|---|---|---|---|---|---|
| | 1968 | 1970 | 1975 | 1980 | 1985 |
| Roundwood | 3. 9 | 5 | 4 | 3 | 2 |
| Sawnwood | 7. 2 | 7 | 7 | 7 | 7 |
| Board products | 10 | 10 | 11 | 12 | 13 |
| Pulp | 6. 5 | 6. 5 | 7. 5 | 7. 5 | 7. 5 |
| Paper and paperboard | 7. 9 | 8 | 9 | 10 | 11 |

On balance it appears that roundwood exports and sawnwood should decrease while exports of the more highly processed products, particularly pulp, paper, paperboard, and board products, should increase. In terms of quantities, Ekstrom offers the following:

| | 1968 | 1970 | 1975 | 1980 | 1985 |
|---|---|---|---|---|---|
| Roundwood (million cubic meters) | 11. 4 | 14. 9 | 12. 5 | 9. 8 | 6. 8 |
| Sawnwood (million cubic meters) | 7. 9 | 8. 0 | 8. 2 | 8. 4 | 8. 6 |
| Board products (thousand metric tons) | 445 | 570 | 1, 030 | 1, 780 | 2, 850 |
| Pulp (thousand metric tons) | 400 | 470 | 795 | 1, 120 | 1, 500 |
| Paper and paperboard (thousand metric tons) | 473 | 560 | 900 | 1, 390 | 2, 100 |
| Total roundwood equivalent (million cubic meters) | 28. 7 | 33. 6 | 35. 1 | 37. 3 | 40. 8 |

In terms of roundwood equivalent, exports could increase over 40 percent by 1985, although the increase in export value would be more because of the higher value of later exports.

Despite the long transport west by water from Siberia, it is estimated that the U.S.S.R. will be able to compete in west European markets at least as well as today. The same situation also applies to the markets of eastern Europe.

The best opportunities for exporting forest products in the future lie to the east, i.e., to Japan and southern Asia in general. These exports will originate in the Soviet far east and will likely impact future export possibilities from Canada and the United States in the Pacific basin.

Although trade between the Soviet Union and the United States has not been very important in the past, it is likely to increase as a result of the recent sessions of the U.S.-U.S.S.R. Commercial Commission held earlier this year. The Soviet Union has actually expressed to the United States Government an interest in exporting lumber to the United States.[2] Should some agreement be reached between the two nations, softwood lumber from the eastern Siberian provinces (Yenisei-Angara River Basin and the Khaborovsk region) might be exported to the United States under a joint arrangement similar to the U.S.S.R.-Japanese agreement under which the Japanese exchange wood processing equipment for Soviet timber products. If Congress extends the "Most Favored Nation" treatment to the U.S.S.R. as provided for in the U.S.-U.S.S.R. trade agreement signed October 18, 1972, opportunities for American firms to import Soviet lumber would defiinitely be improved.

[2] This statement based on a letter to Henry vanZile Hyde, Jr., Executive Director, President's Advisory Panel on Timber and the Environment from A. E. Gibson, Assistant Secretary for Domestic and International Business, Office of the Assistant Secretary of Commerce, dated Oct. 30, 1972.

## Scandinavia

Scandinavia is Europe's surplus forest products region and a traditional source of imports, particularly for the northwestern European countries. In 1969 Norway, Finland, and Sweden together accounted for 48 percent of total timber removals in Europe. Sweden alone accounted for 26 percent and Finland 18 percent. Of the four northern European countries, Sweden is the largest producer of forest products, followed by Finland, Norway, and Denmark.

In 1969 Denmark was a net importer of all the wood products except roundwood. Finland exported two-thirds of her sawnwood, 35 percent of her pulp production, and almost 85 percent of her paper and paperboard production. Finland is the world's largest single exporter of plywood (mainly birch), exporting 90 percent of her production in 1969. Among the Scandinavian countries, Sweden is the heaviest exporter of sawnwood and pulp.

The major portion of wood products exported from Scandinavia goes to western European countries as shown in the following tabulation for 1969 (*1*):

| Product | From | To western Europe (percent of total exports) |
|---|---|---|
| Sawnwood | Finland | 85 |
| | Norway | 84 |
| | Sweden | 91 |
| Plywood | Finland | [1] 70 |
| Particle board | do | 87 |
| Fiberboard | do | 65 |
| | Sweden | 84 |
| Pulp | Finland | 74 |
| | Norway | 93 |
| | Sweden | 80 |
| Paper and paperboard | Finland | 57 |
| | Norway | 65 |
| | Sweden | 69 |

[1] 16 percent to the United States.

In recent years Canada and increasingly the United States have competed with Finland, Norway, and Sweden in western European markets for pulp, paper, and paperboard, especially kraft linerboard.

It is estimated that output of wood from Scandinavian forests can be increased only moderately. Swedish forests are apparently able to produce about 20 percent more wood over the next 20 years, although the longer range outlook is brighter. The cut in Norway and Denmark can also be expanded somewhat. However, in Finland expansion will be more difficult. Despite a strong effort to intensify management, the cut in Finland is not expected to rise significantly over the next 15 years. In all the Scandinavian countries, expansion of growth is centered on such intensive practices as drainage of swamps, forest fertilization, and the planting of genetically superior trees.

In recent years the Scandinavian countries have shifted toward export of the more highly processed wood products, particularly paper and paperboard. Offsetting a less favorable raw material supply position, Finland has the most modern and efficient pulp and paper mill capacity of any of the Scandinavian countries. Swedish mills are both older and smaller than those in Finland; Norwegian mills are older and smaller still.

The FAO estimates (*9*) that by far the major part of prospective increases in industrial wood removals from European forests will occur in northern Europe by 1975, where the increase is estimated to be about 25 million $m^3$ or 33 percent more than 1965 removals. Removals from southern European forests are also expected to increase by about 12 million $m^3$. Despite these increases Europe's wood deficits are estimated to be 53 million $m^3$ in 1975 and 66 million $m^3$ in 1980. These deficits must be met by imports from outside.

Increased output from Scandinavian forests, although possible, will most likely be accomplished at rising cost, especially in Norway, Finland, and Denmark. At best, northern European forests can be expected to make only a moderate increased contribution to Europe's projected wood requirements. The large deficits will remain to be filled by increased sawnwood imports from the U.S.S.R. and Canada and pulp and kraft paper from Canada and the United States.

## Fast-Growing Plantations

The planting of forest trees is a long-established practice and has been done in order to supplement or substitute for natural regeneration or to extend or create new forests for wood production or soil and water protection. By and large most forest planting has occurred in the temperate zones of the world, but there is increasing interest in the establishment of plantations in some parts of the developing world, especially in the warm zones, as the basis for wood products manufacture.

Where intensive plantation forestry is practiced, yields can be very high. For example, where conditions are good, eucalyptus grown to pole size can produce an annual average per hectare of 20 to 30 $m^3$ in Latin America and 15 to 25 $m^3$ in tropical Africa. For the faster growing pines grown to saw-log size, yields can be 12 to 17 $m^3$ per hectare per year. Thus, fuelwood poles and pulpwood can be produced in less than 10 years and saw logs of acceptable size in about 15 years *(10)* (p. 49). These rates of growth are 5 to 10 times as high as those in temperate natural forests where the world's pulp and paper capacity is presently located. There are many areas in Africa, Latin America, and Asia where new sources of wood can be created in specific locations by planting fast-growing conifers and hardwoods.

That plantations can become the basis for the development of wood-processing industries where none existed before is well illustrated by the experience in Chile, Brazil, South Africa, and New Zealand, where *Pinus radiata* and eucalyptus are the principal trees planted. Although up-to-date figures are lacking, it has been estimated that there are about 2.2 million acres of softwood and 8.6 million acres of hardwood plantations in the developing world exclusive of mainland China. Chile's plantation forests and those of South Africa provide lumber for domestic use and are the basis for developing pulp and paper industries for limited export. New Zealand's plantations are the basis for its present small export trade with Australia and other Pacific basin countries.

The importance of plantation-grown wood in the developing countries will most likely increase as a source of wood for local use and in the case of Chile, South Africa, New Zealand, and perhaps other countries, as the basis for limited export. However, the total area of exotic softwood plantations is only 4 to 5 million acres, and their total volume is still too limited to be of much significance in world wood trade. Furthermore, except in a few instances, it is yet to be demonstrated that low wood cost itself can insure success in wood trade on world markets in competition with already established large-scale producers of mass-grade products in the north Temperate Zone.

## Tropical Hardwood Forests

There is little question that the world's unexploited coniferous forests, especially those in North America, Scandinavia, and the U.S.S.R., are going to be of major importance in meeting expanded world wood requirements. Much more uncertainty surrounds the utility of the world's tropical forests in this role.

Because these forests are as yet so little used, information on their magnitude is still far from complete. According to the FAO, there are about 850 million ha (2.13 billion acres) of tropical rain forests carrying roughly 125,000 million $m^3$ of wood. This is about the same volume of wood to be found in the much larger area of the temperate forests *(10)* (p. 49). In Latin America, stocking is believed to average 200–300 $m^3$ per hectare in old-growth forests. These forests carry an unusually large mixture of species, very few of which are presently being used commercially. West African tropical forests carry about 300 $m^3$ per hectare, but only 20 $m^3$ per hectare are in commercial log sizes and species. Old-growth forests of Asia, particularly of Southeast Asia, also carry about 300 $m^3$ per hectare, but roughly half this volume is in presently acceptable species and log sizes.

Tropical rain forests are overly rich in species, with hundreds often being found on a single hectare. Single species may be represented by only a few trees per hectare, and only a few of these are usable commercially. Along with this abundance of species, there is great lack of information of many of their physical and mechanical properties and very limited experience in their utilization. To date commercial exploitation of tropical hardwood forests has been limited to a few areas where commercially acceptable species are to be found in reasonable density and volume and where access can be developed. The tropical forests of West Africa have long been exploited with most of the material going to Europe. The forests of Southeast Asia containing the world's greatest reserve of usable tropical hardwoods (the luan-type timbers), are being opened up increasingly in Indonesia, Malaysia, and New Guinea, with much of this wood going to North America.

Although the FAO in its IWP study *(8)* remains fairly optimistic about the economic potential for exploiting the world's tropical forests (see below), this optimism is based on some favorable assumptions about economic and political developments in the countries of the developing world where these forests are located and on the idea that hardwoods will become more important relative to softwoods generally. To date exports of tropical wood products other than veneer and plywood to the developed countries where most consumption takes place have been fairly limited. In the United States, the world's lorgest consumer of wood products, imports of tropical wood, primarily in the form of hardwood plywood and veneer, constituted only 1.5 percent of total wood consumption in 1971. Indeed, the tropical forest nations are net importers of forest products even as consumption remains at very low levels.

The question of increased use of tropical hardwoods in pulp and paper manufacture is of continuing interest. It is technically feasible to make pulp from tropical hardwoods if large enough volumes of mixed wood can be harvested and separated into groups with similar physical and chemical properties. The question is one of economic feasibility, and it has not yet been answered. To date, except in certain instances, plantation-grown coniferous and hardwood timber together with non-wood fibers would appear to be more attractive source materials.

Embodied in the assumptions made by the FAO for the economic growth of zone C countries (and hence their production, consumption, and trade in wood products) is some projected increase in the export availability of wood products, primarily tropical hardwood. The following tabulation shows exports from zone C countries in 1962 and estimated export availability in 1975 and 1985 (*8*) (p. 317):

| Region | Thousand cubic meters | | | Thousand metric tons | |
|---|---|---|---|---|---|
| | Logs | Sawnwood | Veneer and plywood | Fiberboard and particleboard | Pulp and pulp products |
| 1962: | | | | | |
| Africa | 5, 030 | 680 | 170 | | 58 |
| Asia | 5, 710 | 490 | 340 | 1 | 34 |
| Latin America | 350 | 1, 400 | 40 | 4 | 98 |
| Near East | 10 | 50 | 3 | | |
| Total | 11, 100 | 2, 620 | 550 | 5 | 190 |
| 1975: | | | | | |
| Africa | 5, 200 | 1, 040 | 670 | 20 | 280 |
| Asia | 21, 500 | 2, 300 | 2, 000 | 20 | 40 |
| Latin America | 300 | 1, 750 | 330 | 50 | 300 |
| Near East | | | | | |
| Total | 27, 000 | 5, 090 | 3, 000 | 90 | 620 |
| 1985: | | | | | |
| Africa | 4, 700 | 1, 500 | 1, 250 | 50 | 940 |
| Asia | 32, 000 | 3, 200 | 3, 000 | 40 | 70 |
| Latin America | 300 | 1, 880 | 910 | 160 | 990 |
| Near East | | | | | |
| Total | 37, 000 | 6, 580 | 5, 160 | 250 | 2, 000 |

With respect to the ultimate destinations of these estimated exports, assuming they materialize, the FAO has the following comments (*8*):

1. While consumption of wood products is expected to increase within zone C, 90 percent of total world consumption will still take place in zones A and B; i.e., in the industrialized capitalistic nations and in those with planned economies.

2. Two subregions of zone A, Western Europe and Japan, will increasingly become deficit industrial wood regions.

3. So far as coniferous wood requirements are concerned these deficits will be met from the wood surplus countries of zones A and B, i.e., North America, northern Europe, and the U.S.S.R.

4. Present exports from zone C countries go mainly to a relatively few countries in Western Europe and east Asia (Japan) from a relatively few countries in West Africa and Southeast Asia. This pattern is not expected to change very much, although North America (U.S.A.) could become a more important market.

Even though the targets shown above are met by 1985 or at some later period, it is unlikely that the U.S. wood consumption picture will be affected by increased exports from the tropical forest areas of the world in a major way. However, an increased proportion of Latin America's pulp and paper consumption will likely be met from pulp and paper produced in Chile, Argentina, Brazil, and Uruguay, thus reducing opportunities for United States exports to this part of the hemisphere. Increased imports of hardwool plywood and veneer are projected by the U.S. Forest Service for 1980, 1990, and the year 2000. These will most likely continue to come from southeastern Asian forests after processing in the Philippines, Taiwan, Korean, and Japan.

## SUMMARY APPRAISAL AND RECOMMENDATIONS

### Summary Appraisal

Total future domestic consumption of wood products in the United States will depend not only on future domestic demand for wood products and the success of our production efforts to meet these demands, but also on the opportunities for exports of those products we can sell competitively in world markets and on the availability of certain wood products we find it advantageous to import rather than produce at home.

The United States is today a net importer of wood to the extent of 12 percent of total consumption because of relatively heavy imports of softwood lumber, pulp, and newsprint from Canada and hardwood plywood and veneer from Southeast Asia. Although a 12 percent wood deficit is not a major problem in itself, some particular import and export items are of considerable concern and worthy of attention. For example:

1. Softwood lumber is a major material in construction, and its importation constitutes fully 20 percent of total lumber consumption. Greater imports in the future could help meet building needs should shortages develop. Increased imports could also dampen price increases to a certain extent by augmenting domestic lumber supplies.

2. Hardwood plywood imports account for fully 57 percent of total consumption at present, and this item will most likely have to be imported indefinitely if construction and manufacturing needs are to be met. There appears to be little we can do about these imports except to recognize continuing dependence on them for some time.

3. Newsprint imports amount to around 70 percent of total U.S. consumption, and this large dependency rate is likely to be with us indefinitely.

4. The export of softwood logs amounts to only about 7 percent of softwood products consumption, but these exports are and will continue to be, highly controversial. If all the exported softwood volume (about 2.0–2.5 billion fbm per year) could be manufactured into merchantable lumber and plywood in the Pacific Northwest, domestic supplies would be significantly augmented and some downward pressure on prices effected. However, so long as the wood being exported includes mainly species and grades which do not enter U.S. markets in large volumes, greater benefits are likely to accrue to the forest industry through incentives for more intensive forest management and closer utilization, and to the region through greater economic activity, than would be the case if all log exports are prohibited.

The following points summarize those developments which will most likely condition the future U.S. wood import-export position:

1. The primary influence will be internal. How large the gap between future requirements (including exports) and domestic timber production turns out to be will determine how much wood we actually import and/or to what extent we substitute nonwood products for wood.

2. The most important external conditions which will influence the future U.S. wood import position are:

A. The extent to which Canada, the major source of United States wood imports, is able to meet increased United States demands for imported softwood lumber, pulp, and newsprint. Indications are that Canadian output can be expanded to meet at least those increased import demands projected for U.S. softwood products by the U.S. Forest Service, as well as to meet some increased exports to Europe, Latin America, and the Pacific basin, although rising, harvesting, and processing costs cast some doubt on this prognosis.

B. The extent to which U.S. hardwood plywood, and veneer imports can be enlarged from present southeast Asian sources. Althought it is difficult to estimate the rate of future exploitation of southeast Asian tropical timber, most analysts believe that increased supply from this part of the world will be forthcoming without major difficulty, and projected imports can be met.

3. The most important external conditions which will influence the future U.S. wood export position are:

A. The extent to which United States producers of chemical pulps and kraft papers enter the attractive, future European market, in competition with Canada, and to a lesser extent with the U.S.S.R. The competitive edge in increased exports of long-fibered pulp and paper products to Europe may rest with United States producers in the Southeastern United States, although the Canadians will surely be strong competitors. The total European wood deficit is expected to reach 53 million $m^3$ by 1975 and 66 million $m^3$ by 1980. The Scandinavian countries are expected to be able to increase their traditional wood products exports to the rest of Europe only moderately, so the bulk of these softwood products deficits must be met by imports from the U.S.S.R. and North America. The U.S.S.R. and Canada will be the major import sources for Europe's needed softwood lumber, but the United States and Canada must supply Europe's import needs for pulp and paper products.

B. The extent to which the United States enlarges its present wood exports to Japan and other Pacific basin countries. Next to Europe, Japan represents the largest potential market for imported wood. It is conservatively estimated that Japan will be able to satisfy only about 50 percent of future wood requirements from her domestic forest resource. Japan will need to increase imports of softwood logs and lumber, pulp and paper, tropical hardwood logs, lumber, and plywood, and softwood chips and/or pulpwood.

The major export competitors in the Japanese softwood products market will most likely be Canada, the United States, and the U.S.S.R. Hardwood products made from tropical timber and tropical logs will continue to be supplied from southeastern Asian forests, especially from Malaysia, Indonesia, and New Guinea; most of the processing will take place in South Korea, Taiwan, the Philippines, Hong Kong, and Singapore.

The Japanese market is potentially the most attractive for the United States because it is large and will demand a larger number of wood products which could be supplied from the United States, than is the case for Europe. Development of this market, however, will depend not only on the capability and willingness of United States producers to become reliable, long-term suppliers, but also on their ability to compete with Canada and the U.S.S.R. in the export of at least some products. The major considerations involve the following:

1. A continued American willingness to export softwood logs, at least those species which do not enter the domestic market in large volumes. The Canadians are prohibited from exporting logs; the Japanese prefer United States logs over those from the Soviet Union.

2. The continued development of more efficient methods for utilizing unused logging and milling residues as export chips. The Canadians cannot enter this market because of restrictions against the export of raw wood. United States chips are preferred over Soviet pulpwood, but Japan will not hesitate to increase imports of Russian logs and/or pulpwood if United States supplies are not forthcoming.

3. A continued effort to increase exports of chemical pulp and paper products. In this endeavor United States producers in the Pacific Northwest can expect severe competition from western Canadian producers, increasing competition from pulp and paper manufactured in far eastern Siberia, and pulp produced in Alaska.

4. A deliberate attempt on the part of United States softwood lumber producers in the Pacific Northwest to either manufacture lumber to Japanese specifications or to export cants for resaw in Japan. Canadians and Alaskan lumber manufacturers already export lumber in cant form. Although increased lumber exports to Japan from the Pacific Northwest may be attractive, mainly because this product can be shipped to Japan at lower cost than to the east coast, Canada and Alaska are likely to be the big suppliers.

Sources for increased United States wood imports, other than Canada and Southeast Asia, are judged to be relatively unimportant in the period between now and the year 2000. Further exploitation of tropical forests, other than those presently being used in Southeast Asia, is not expected to yield a significant volume of mechantable wood on world markets. Neither will the developing countries be important markets for wood products exports from the United States or other exporting countries. Mainland China could eventually become a major market for wood, including some exports from the United States, but this may not develop for some time. Despite the proximity of the Siberian forest resource to Mainland China, wood imports are more likely to come from Canada. Canadian wood processors are apparently planning to ship long timber and lumber to China sometime in the future. Should this come to pass, Canadian exports of softwood lumber to the United States could be reduced.

If the conclusions about world wood consumption, production, and trade are reasonable, what can be said for Forest Service import-export projections? Estimates of Canadian export possibilities suggest that the Forest Service import projections for softwood lumber, newsprint, pulp, and pulpwood can be met. However, there is surely some limit to United States imports from Canada in view of her commitments to other countries, particularly in Europe, and the almost inevitable rise in production costs. Projected imports of hardwood plywood and veneer also appear attainable.

Evaluations of the U.S. wood export projections are more difficult. There is no question that the future Japanese market could sustain more than the 1971 export volume of 1.9 billion fbm, but it is hard to visualize the export of logs in the volumes projected by the U.S. Forest Service, even at the higher assumed price levels, especially if pressures for export restrictions develop. The Boston Consulting Group estimated (*3*) that 13 percent of Japan's total log imports could come from the United States by 1980. This would be only about 1.4 billion fbm. Conceivably, the export potential for softwood logs could be greater than this, but it is difficult to see how it could reach 5.9 billion fbm projected by the Forest Service in the year 2000 at constant relative prices. Although it is impossible to judge accurately, annual exports of softwood logs are unlikely to be much more than 2 to 3 billion fbm. At the assumed higher prices, Japan is likely to import more softwood logs from the U.S.S.R., substitute luan logs for softwood logs to a greater extent than at present, and import more lumber from Canada.

Projected exports of hardwood lumber may be reasonable, but they are so low as to be relatively unimportant. Exports of softwood lumber as projected are roughly the same as exports today. As noted earlier, the Japanese market will likely grow, but whether Pacific Northwest lumber manufacturers will take advantage of this is hard to judge. Some increase in Alaska's shipments to Japan will undoubtedly occur. The present proportion exported to Canada will also probably be sustained. The amount exported to Europe and Latin America may also increase, but Canada and the U.S.S.R. may hold a strong advantage here. Perhaps an export potential of 1.0 to 1.5 billion fbm would be more likely by the year 2000 at any of the price assumption levels.

Projected exports of 4 to 5 million cords of pulpwood, including the roundwood equivalent of chips, may seem high considering that exports in 1971 were only 1.5 million cords. However, the potential for increased chip exports to Japan is great, and these volumes may very well be attainable.

The Forest Service estimates that exports of wood pulp will reach between 12 and 13 million cords, roundwood equivalent, by the year 2000, depending on the particular price level assumption. Projections of paper and board exports are equal to about 7 million cords for a total of 19 to 20 million cords roundwood equivalent. The roundwood equivalent of pulp, paper, and paperboard exports in 1971 was 8.1 million cords. Thus, the Forest Service is projecting about a 150 percent increase in the export of these products. The increase in total market demand for pulp and paper products in Europe and Japan is expected to be very large, and it is possible that United States exports could reach the projected levels. However, they may be somewhat high in view of Canada's expected dominance in the pulp and paper field and northern Europe's expected continued exports to the rest of Europe.

In general then, Forest Service import projections appear to be attainable, and imports will dominate exports in the import categories of lumber, newsprint, and hardwood plywood. Export projections may be somewhat high for softwood logs and pulp and paper products.

If the entire set of projected imports and exports are accepted as reasonable, the U.S. net import dependency for softwood lumber will fall from about 20 percent in 1971, to about 10 percent in the year 2000, if relative prices remain at 1970 levels. This dependency will increase to 34 percent if relative lumber prices rise according to the Forest Service schedule, and to 26 percent if relative lumber prices rise 30 percent above the 1970 schedule.

**TABLE 1.—U.S. Production, Consumption, and Net Imports of Industrial Wood Products, 1900–71**

[Volumes in billions of cubic feet]

| Year | Production | Net imports | Consumption | Net imports as percent of consumption |
|---|---|---|---|---|
| 1900 | 7.3 | [1] 0.1 | 7.1 | [1] 1.4 |
| 1901 | 7.6 | [1] .1 | 7.5 | [1] 1.3 |
| 1902 | 7.9 | [1] .1 | 7.8 | [1] 1.3 |
| 1903 | 8.2 | [1] .1 | 8.1 | [1] 1.2 |
| 1904 | 8.5 | [1] .2 | 8.3 | [1] 2.4 |
| 1905 | 8.6 | [1] .1 | 8.5 | [1] 1.2 |
| 1906 | 9.2 | [1] .1 | 9.1 | [1] 1.2 |
| 1907 | 9.5 | [1] .1 | 9.4 | [1] 1.2 |
| 1908 | 8.7 | [1] .1 | 8.6 | [1] 1.2 |
| 1909 | 9.3 | [1] .1 | 9.2 | [1] 1.2 |
| 1910 | 9.3 | [1] .1 | 9.2 | [1] 1.1 |
| 1911 | 9.0 | [1] .1 | 8.9 | [1] 1.1 |
| 1912 | 9.3 | [1] .1 | 9.2 | [1] 1.1 |
| 1913 | 9.2 | [1] .2 | 9.0 | [1] 1.1 |
| 1914 | 8.6 | 0 | 8.6 | 0 |
| 1915 | 8.0 | .2 | 8.2 | 2.4 |
| 1916 | 8.5 | .2 | 8.7 | 2.3 |
| 1917 | 8.0 | .2 | 8.2 | 2.4 |
| 1918 | 7.3 | .2 | 7.5 | 2.7 |
| 1919 | 7.7 | .1 | 7.8 | 1.3 |
| 1920 | 7.8 | .2 | 8.0 | 2.5 |
| 1921 | 6.6 | .1 | 6.7 | 1.5 |
| 1922 | 7.6 | .3 | 7.9 | 3.8 |
| 1923 | 8.6 | .3 | 8.9 | 3.4 |
| 1924 | 8.3 | .3 | 8.6 | 3.5 |
| 1925 | 8.4 | .3 | 8.7 | 3.4 |
| 1926 | 8.2 | .4 | 8.6 | 4.7 |
| 1927 | 7.8 | .3 | 8.1 | 3.7 |
| 1928 | 7.7 | .3 | 8.0 | 3.8 |
| 1929 | 8.1 | .3 | 8.4 | 3.6 |
| 1930 | 6.4 | .4 | 6.8 | 5.9 |
| 1931 | 4.7 | .3 | 5.0 | 6.0 |
| 1932 | 3.4 | .3 | 3.7 | 8.1 |
| 1933 | 4.1 | .3 | 4.4 | 6.8 |
| 1934 | 4.4 | .3 | 4.7 | 6.4 |
| 1935 | 5.1 | .4 | 5.7 | 7.0 |
| 1936 | 6.0 | .6 | 6.4 | 9.4 |
| 1937 | 6.4 | .6 | 6.6 | 9.1 |
| 1938 | 5.6 | .5 | 6.0 | 8.3 |
| 1939 | 6.4 | .5 | 6.9 | 7.2 |
| 1940 | 7.0 | .4 | 7.9 | 5.1 |
| 1941 | 8.1 | .7 | 8.6 | 8.1 |
| 1942 | 8.1 | .7 | 8.8 | 8.0 |
| 1943 | 7.6 | .6 | 8.8 | 6.8 |
| 1944 | 7.5 | .6 | 8.2 | 7.3 |
| 1945 | 6.6 | .7 | 7.6 | 9.2 |
| 1946 | 7.7 | .8 | 8.3 | 9.6 |
| 1947 | 8.1 | .8 | 8.6 | 9.3 |
| 1948 | 8.4 | 1.1 | 9.1 | 12.0 |
| 1949 | 7.4 | .9 | 8.6 | 10.5 |
| 1950 | 8.5 | 1.4 | 9.1 | 15.4 |
| 1951 | 8.7 | 1.2 | 10.0 | 12.0 |
| 1952 | 8.8 | 1.2 | 9.9 | 12.1 |
| 1953 | 8.8 | 1.2 | 10.0 | 12.0 |
| 1954 | 8.8 | 1.2 | 9.9 | 12.1 |
| 1955 | 9.2 | 1.3 | 10.5 | 12.4 |
| 1956 | 9.6 | 1.3 | 11.0 | 11.8 |
| 1957 | 8.6 | 1.2 | 9.7 | 12.4 |
| 1958 | 8.5 | 1.2 | 9.7 | 12.4 |
| 1959 | 9.4 | 1.3 | 10.7 | 12.1 |
| 1960 | 8.9 | 1.2 | 10.1 | 11.9 |
| 1961 | 8.7 | 1.2 | 10.0 | 12.0 |
| 1962 | 9.0 | 1.4 | 10.4 | 13.5 |
| 1963 | 9.6 | 1.4 | 10.9 | 12.8 |
| 1964 | 10.2 | 1.3 | 11.5 | 11.3 |
| 1965 | 10.5 | 1.4 | 11.9 | 11.8 |
| 1966 | 10.6 | 1.4 | 12.1 | 11.6 |
| 1967 | 10.4 | 1.2 | 11.6 | 10.3 |
| 1968 | 11.0 | 1.3 | 12.2 | 10.7 |
| 1969 | 10.9 | 1.4 | 12.3 | 11.4 |
| 1970 | 11.0 | 1.0 | 12.1 | 8.3 |
| 1971 | 11.5 | 1.6 | 13.1 | 12.2 |

[1] Values are net exports.

Source: Data for 1900–1949 from USDA, Forest Service "Historical Statistics of the United States," compiled by Dwight Hair, Division of Forest Economics Research, 1958. Table 19, pp. 19; 1950–71. Based on data published by the U.S. Departments of Commerce and Agriculture.

For hardwood plywood the net dependency rate would be 31 percent by the year 2000, under stable relative prices as against about 56 percent in 1971. However, if relative prices rise as assumed the dependency rates would be 64 and 59 percent, respectively, by the year 2000. Although they may be of academic interest, these figures are probably not very important so long as there is little question of the import availability of these materials. The overall wood import dependency rate is not expected to change over the present rate.

## Recommendations

1. The export of softwood logs, primarily from the Pacific Northwest to Japan, should not be prohibited so long as the material exported shows a stronger export than domestic demand and its value adds to incentives for more intensive forest management and closer utilization. The discouragement of Douglas-fir log exports may be justified in view of the fact that its supply to smaller, dependent wood processors in particular areas is reduced through export.

2. Because the United States is a relatively heavy net importer of softwood lumber, and be-

**TABLE 2.—U.S. Trade in Wood, Selected Products [1]**

| Product | Unit of measure | Commercial measure | | | Roundwood equivalent (million cubic feet) | | |
|---|---|---|---|---|---|---|---|
| | | Imports | Exports | Net imports | Imports | Exports | Net imports |
| Lumber, softwood | Million board feet | 7, 249 | 936 | 6, 313 | 1, 233 | 159 | 1, 074 |
| Lumber, hardwood | do | 358 | 160 | 198 | 58 | 26 | 32 |
| Plywood, softwood | Million square feet | 3 | 99 | [3] −96 | (2) | 10 | −10 |
| Plywood, hardwood | do | 2, 545 | 15 | 2, 530 | 181 | 1 | 180 |
| Veneer, hardwood | do | 2, 303 | 571 | 1, 731 | 35 | 9 | 26 |
| Pulpwood | Thousand cords | 1, 225 | 1, 530 | −305 | 95 | 118 | −23 |
| Woodpulp: | | | | | | | |
| Alpha and dissolving | Thousand tons | 315 | 790 | −475 | 51 | 127 | −76 |
| Bleached sulfate | do | 2, 584 | 1, 164 | 1, 420 | 377 | 170 | 207 |
| Other | do | 615 | 222 | 393 | 86 | 31 | 55 |
| Newsprint and other paper | do | 7, 306 | 563 | 6, 743 | 649 | 50 | 599 |
| Paperboard | do | 23 | 2, 381 | −2, 358 | 2 | 159 | −157 |
| Building boards | do | 255 | 52 | 203 | 19 | 4 | 15 |
| Saw logs, softwood | Million board feet | 56 | 2, 233 | −2, 177 | 10 | 381 | −371 |
| Saw logs, hardwood | do | 28 | 59 | −31 | 5 | 10 | −5 |
| Total | | | | | 2, 801 | 1, 255 | 1, 546 |

[1] Preliminary.
[2] Less than 500,000 ft³.
[3] Volumes preceded by a minus sign are net exports.

NOTE.—See table 2a for the factors used to convert commercial units to roundwood equivalents.

Source: Data from Forest Service originating from Department of Commerce, Bureau of the Census; American Paper Institute, "The Statistics of Paper"; U.S. Department of Commerce, Bureau of the Census, "Pulp, Paper, and Board," Cur. Indust. Reps. Ser. M26A (annual); U.S. Department of Commerce, "Pulp, Paper, and Board," Quart. Indust. Rep., and U.S. Department of Agriculture, Forest Service.

**TABLE 2a.—Factors Used To Convert Commercial Wood Products Units to Cubic Feet Roundwood Equivalent**

| Product | Commercial unit | Roundwood equivalent (cubic feet) |
|---|---|---|
| Lumber: | | |
| Softwood | 1,000 fbm | 170 |
| Hardwood | do | 162 |
| Plywood: | | |
| Softwood | 1,000 ft² | 100 |
| Hardwood | do | 72 |
| Pulpwood | cord | 78 |
| Woodpulp: | | |
| Alpha dissolving | ton | 160 |
| Bleached sulfate | do | 146 |
| Other pulp | do | 140 |
| Paper: | | |
| Newsprint and other | do | 88 |
| Paperboard | do | 67 |
| Building boards | do | 76 |
| Saw logs: | | |
| Softwood | 1,000 fbm | 179 |
| Hardwood | do | 166 |

Source: Derived from Zivnuska, J. A. "Timber Resources in a World Economy." Resources for the Future, 1967; table 2, p. 29.

cause this product will likely remain a major construction material for a long time, its increased export is not recommended except for those exports from Alaska. Exports of softwood lumber from Alaska to Japan and other Pacific basin countries should be encouraged in the interest of a better balance of payments, as long as the provisions of the Jones Act as applied to lumber and wood products make it cheaper to ship this material to Japan than to the east coast.

3. The increased export of pulp and paper products and chips should be greatly encouraged. External markets for these products in Europe and Japan are large, and the United States can compete well with Canada in pulp and paper and strongly with the U.S.S.R. in chip material.

4. The Jones Act should be amended to exempt lumber from its provisions so that lumber from Alaska and the west coast could be shipped to the east coast as cheaply as it can from British Columbian ports.

## TABLE 3.—U.S. Imports of Logs by Major Species, 1950–71 [1]

[Million board feet log scale]

| Year | Total | Softwoods | Hardwoods | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Total | Mahogany | Cativo | Luan | Birch and maple | Other |
| 1950 | 268.5 | 156.5 | 111.9 | 56.5 | --- | --- | --- | 55.4 |
| 1951 | 212.0 | 84.8 | 127.2 | 48.4 | --- | --- | --- | 78.8 |
| 1952 | 190.8 | 113.8 | 77.1 | 34.8 | --- | --- | --- | 42.3 |
| 1953 | 227.1 | 115.5 | 111.6 | 47.7 | --- | --- | --- | 63.9 |
| 1954 | 220.9 | 128.2 | 92.6 | 37.8 | --- | 29.5 | --- | 25.4 |
| 1955 | 198.8 | 74.4 | 119.3 | 50.8 | --- | 33.8 | --- | 34.7 |
| 1956 | 160.3 | 39.7 | 120.6 | 46.6 | --- | 37.9 | --- | 36.1 |
| 1957 | 131.3 | 40.5 | 90.9 | 27.8 | --- | 33.4 | --- | 29.7 |
| 1958 | 95.3 | 21.6 | 73.8 | 21.2 | --- | 17.9 | --- | 34.6 |
| 1959 | 98.2 | 25.4 | 72.8 | 22.5 | --- | 23.5 | --- | 26.8 |
| 1960 | 112.5 | 32.3 | 80.2 | 25.2 | --- | 16.8 | --- | 38.3 |
| 1961 | 105.7 | 57.1 | 48.6 | 15.5 | --- | 9.1 | --- | 24.0 |
| 1962 | 100.1 | 38.1 | 62.1 | 16.6 | --- | 15.4 | --- | 30.1 |
| 1963 | 97.9 | 44.1 | 53.9 | 13.7 | 4.5 | 8.7 | 1.8 | 25.2 |
| 1964 | 65.1 | 8.7 | 56.3 | 16.1 | 10.0 | 7.5 | 6.9 | 15.8 |
| 1965 | 68.1 | 13.5 | 54.6 | 12.8 | 11.4 | 11.0 | 6.2 | 13.2 |
| 1966 | 95.6 | 42.5 | 53.1 | 16.1 | 14.7 | 2.8 | 6.3 | 13.2 |
| 1967 | 76.9 | 33.9 | 43.1 | 10.5 | 9.7 | 9.6 | 6.6 | 11.6 |
| 1968 | 85.3 | 39.4 | 45.9 | 8.5 | 10.2 | 2.0 | 6.5 | 18.7 |
| 1969 | 81.8 | 41.7 | 40.2 | 6.5 | 7.3 | 3.1 | 7.6 | 15.7 |
| 1970 | 144.4 | 106.5 | 37.9 | 6.8 | 7.3 | .7 | 8.2 | 14.9 |
| 1971 [2] | 84.0 | 55.7 | 28.3 | 3.3 | 4.3 | .2 | 8.7 | 11.8 |

[1] Data may not add to totals due to rounding.
[2] Preliminary.

Source: U.S. Department of Commerce, Bureau of the Census. "U.S. Imports—General and Consumption, Schedule A Commodity and Country," FT 135 (annual).

## TABLE 4.—U.S. Imports of Logs by Major Regions of Origin, 1950–71 [1]

[Volumes in millions of board feet]

| Year | Total | Canada | Percent of total | Mexico and Central America | Percent of total | South America | Percent of total | Africa | Percent of total | Asia | Percent of total | Other | Percent of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1950 | 268.5 | 173.0 | 64.4 | 29.1 | 10.8 | 4.1 | 1.5 | 41.4 | 15.4 | 20.8 | 7.7 | 0.1 | 0.2 |
| 1951 | 212.0 | 104.0 | 49.0 | 24.6 | 11.6 | 4.2 | 2.0 | 38.2 | 18.1 | 41.0 | 19.2 | .1 | .1 |
| 1952 | 190.8 | 127.0 | 66.5 | 24.2 | 12.7 | 1.2 | .6 | 17.8 | 9.3 | 20.7 | 10.8 | .1 | .1 |
| 1953 | 227.1 | 132.5 | 58.4 | 19.3 | 8.5 | 5.2 | 2.3 | 36.1 | 15.9 | 33.9 | 14.9 | ------ | ([2]) |
| 1954 | 220.9 | 139.1 | 63.0 | 13.5 | 6.1 | 10.1 | 4.6 | 26.4 | 12.0 | 31.6 | 14.3 | .1 | [2] 1 |
| 1955 | 198.8 | 92.0 | 46.3 | 15.0 | 7.5 | 13.7 | 6.9 | 39.5 | 19.9 | 38.6 | 19.4 | ------ | ------ |
| 1956 | 160.3 | 52.8 | 32.9 | 14.0 | 8.7 | 19.5 | 12.2 | 35.5 | 22.1 | 38.4 | 24.0 | .1 | .1 |
| 1957 | 131.3 | 49.1 | 37.3 | 13.1 | 10.0 | 16.4 | 12.5 | 18.6 | 14.2 | 34.0 | 25.9 | .2 | .1 |
| 1958 | 95.3 | 27.7 | 29.0 | 15.7 | 16.5 | 15.6 | 16.4 | 17.6 | 18.5 | 18.6 | 19.5 | .1 | .1 |
| 1959 | 98.2 | 31.9 | 32.5 | 4.7 | 4.8 | 13.1 | 13.3 | 21.5 | 21.9 | 26.3 | 26.8 | .7 | .7 |
| 1960 | 112.5 | 39.2 | 34.8 | 5.5 | 4.9 | 19.8 | 17.6 | 27.4 | 24.4 | 19.9 | 17.7 | .7 | .6 |
| 1961 | 105.7 | 62.5 | 59.1 | 7.0 | 6.6 | 13.3 | 12.6 | 12.7 | 12.0 | 9.7 | 9.2 | .6 | .5 |
| 1962 | 100.1 | 42.6 | 42.6 | 8.8 | 8.8 | 21.9 | 21.9 | 10.9 | 10.9 | 15.6 | 15.6 | .3 | .2 |
| 1963 | 97.9 | 51.5 | 52.6 | 3.5 | 3.6 | 20.3 | 20.7 | 13.5 | 13.8 | 8.8 | 9.0 | .3 | .3 |
| 1964 | 65.1 | 18.1 | 27.8 | 4.5 | 6.9 | 16.7 | 25.7 | 17.5 | 26.9 | 7.8 | 12.0 | .4 | .7 |
| 1965 | 68.1 | 20.3 | 29.8 | 3.5 | 5.1 | 18.0 | 26.4 | 14.1 | 20.7 | 11.7 | 17.2 | .6 | .8 |
| 1966 | 95.6 | 49.4 | 51.7 | 3.7 | 3.9 | 21.3 | 22.3 | 17.4 | 18.2 | 3.6 | 3.8 | .2 | .1 |
| 1967 | 76.9 | 40.6 | 52.8 | 3.0 | 3.9 | 18.3 | 23.8 | 9.7 | 12.6 | 4.9 | 6.4 | .3 | .6 |
| 1968 | 85.3 | 46.2 | 54.2 | 3.1 | 3.6 | 26.8 | 31.4 | 6.8 | 8.0 | 2.1 | 2.5 | .3 | .3 |
| 1969 | 81.8 | 49.5 | 60.5 | 2.1 | 2.6 | 18.3 | 22.4 | 8.3 | 10.1 | 3.5 | 4.3 | .2 | .1 |
| 1970 | 144.4 | 114.9 | 79.3 | 2.3 | 1.6 | 17.6 | 12.2 | 8.3 | 5.7 | 1.0 | .6 | .3 | .6 |
| 1971 [3] | 84.0 | 64.6 | 76.9 | 1.9 | 2.3 | 13.1 | 15.6 | 3.2 | 3.8 | .9 | 1.1 | .3 | .3 |

[1] Data may not add to totals because of rounding.
[2] Less than 50,000 fbm.
[3] Preliminary

NOTE.—A dash indicates volumes were less than 50,000 fbm.

Source: U.S. Department of Commerce, Bureau of the Census. "U.S. Imports—General and Consumption, Schedule A Commodity and Country." FT 135 (annual).



505-287 O - 73 - 22

**TABLE 5.—U.S. Exports of Logs by Major Species, 1950–71** [1]

[Volumes in million board feet, log-scale]

| Year | Total | Softwoods | | | | | Hardwoods | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Percent | Douglas-fir | Port Oxford cedar | Other | Total | Percent | Walnut | Other |
| 1950 | 48. 2 | 28. 9 | 60. 0 | 1. 0 | 0. 3 | 27. 6 | 19. 3 | 40. 0 | 1. 0 | 18. 3 |
| 1951 | 79. 4 | 57. 9 | 73. 0 | 2. 4 | . 6 | 54. 9 | 21. 5 | 27. 0 | 1. 0 | 20. 5 |
| 1952 | 63. 7 | 44. 4 | 69. 7 | 4. 2 | 1. 9 | 38. 3 | 19. 2 | 30. 3 | . 3 | 18. 9 |
| 1953 | 115. 1 | 86. 0 | 74. 7 | 12. 4 | 3. 5 | 70. 0 | 29. 2 | 25. 3 | . 5 | 28. 6 |
| 1954 | 139. 5 | 106. 4 | 76. 3 | 12. 8 | 13. 8 | 79. 8 | 33. 1 | 23. 7 | . 6 | 32. 5 |
| 1955 | 166. 2 | 144. 2 | 86. 8 | 9. 8 | 10. 7 | 123. 7 | 22. 0 | 13. 2 | 1. 2 | 20. 8 |
| 1956 | 187. 7 | 154. 9 | 82. 5 | 15. 8 | 13. 9 | 125. 2 | 32. 8 | 17. 5 | 1. 1 | 31. 6 |
| 1957 | 139. 3 | 107. 3 | 77. 0 | 8. 1 | 22. 8 | 76. 4 | 32. 0 | 23. 0 | 1. 4 | 30. 6 |
| 1958 | 169. 8 | 127. 3 | 75. 0 | 12. 4 | 32. 3 | 82. 7 | 42. 5 | 25. 0 | 2. 3 | 40. 2 |
| 1959 | 204. 6 | 167. 6 | 81. 9 | 20. 8 | 39. 2 | 107. 7 | 37. 0 | 18. 1 | 3. 7 | 33. 2 |
| 1960 | 266. 3 | 210. 3 | 79. 0 | 27. 5 | 37. 2 | 145. 6 | 56. 0 | 21. 0 | 10. 2 | 45. 9 |
| 1961 | 481. 8 | 432. 2 | 89. 7 | 66. 8 | 61. 2 | 304. 2 | 49. 5 | 10. 3 | 7. 2 | 42. 4 |
| 1962 | 522. 2 | 452. 7 | 86. 7 | 48. 1 | 41. 5 | 363. 1 | 69. 5 | 13. 3 | 10. 3 | 59. 2 |
| 1963 | 951. 3 | 879. 6 | 92. 5 | 71. 6 | 63. 9 | 744. 1 | 71. 8 | 7. 5 | 16. 5 | 55. 3 |
| 1964 | 1, 086. 3 | 1, 022. 6 | 94. 1 | 94. 6 | 37. 0 | 891. 0 | 63. 7 | 5. 9 | 11. 1 | 52. 6 |
| 1965 | 1, 192. 8 | 1, 111. 4 | 93. 2 | 111. 3 | 39. 1 | 961. 0 | 81. 4 | 6. 8 | 23. 6 | 57. 9 |
| 1966 | 1, 393. 1 | 1, 317. 5 | 94. 6 | 130. 5 | 43. 0 | 1, 144. 0 | 75. 6 | 5. 4 | 12. 8 | 62. 8 |
| 1967 | 1, 970. 7 | 1, 873. 6 | 95. 1 | 272. 0 | 34. 6 | 1, 567. 0 | 97. 1 | 4. 9 | 16. 4 | 80. 7 |
| 1968 | 2, 568. 1 | 2, 473. 2 | 96. 3 | 396. 5 | 38. 4 | 2, 038. 3 | 94. 9 | 3. 7 | 21. 9 | 73. 0 |
| 1969 | 2, 397. 0 | 2, 316. 8 | 96. 7 | 380. 6 | 40. 7 | 1, 895. 6 | 80. 2 | 3. 3 | 20. 6 | 59. 5 |
| 1970 | 2, 753. 0 | 2, 684. 1 | 97. 5 | 487. 7 | 54. 1 | 2, 142. 3 | 68. 9 | 2. 5 | 17. 4 | 51. 5 |
| 1971 [2] | 2, 292. 4 | 2, 233. 4 | 97. 4 | 448. 1 | 40. 2 | 1, 745. 1 | 59. 0 | 2. 6 | 13. 9 | 46. 2 |

[1] Data may not add to totals because of rounding.
[2] Preliminary.

Source: U.S. Department of Commerce, Bureau of the Census. "U.S. Exports—Schedule B Commodity and Country," FT 410 (annual).

**TABLE 6.—U.S. Exports of Logs by Major Region of Destination, 1950–71**

[Volumes in million board feet]

| Year | Total | Canada | Percent | Western Europe | Percent | Japan | Percent | Other | Percent |
|---|---|---|---|---|---|---|---|---|---|
| 1950 | 48. 2 | 42. 5 | 88. 2 | 3. 6 | 7. 5 | ---------- | 0 | 2. 1 | 4. 3 |
| 1951 | 79. 4 | 71. 8 | 90. 4 | 4. 7 | 5. 9 | 1. 4 | 1. 8 | 1. 6 | 1. 9 |
| 1952 | 63. 7 | 53. 8 | 84. 5 | 3. 0 | 4. 7 | 6. 5 | 10. 2 | . 4 | . 6 |
| 1953 | 115. 1 | 69. 2 | 60. 1 | 3. 8 | 3. 3 | 41. 6 | 36. 1 | . 6 | . 5 |
| 1954 | 139. 5 | 75. 4 | 54. 1 | 4. 8 | 3. 4 | 54. 5 | 39. 1 | 4. 7 | 3. 4 |
| 1955 | 166. 2 | 138. 4 | 83. 3 | 8. 9 | 5. 3 | 18. 0 | 10. 8 | . 8 | . 6 |
| 1956 | 187. 7 | 160. 2 | 85. 3 | 5. 7 | 3. 0 | 20. 5 | 10. 9 | 1. 2 | . 8 |
| 1957 | 139. 3 | 97. 1 | 69. 7 | 5. 3 | 3. 8 | 36. 0 | 25. 8 | 1. 0 | . 7 |
| 1958 | 169. 8 | 112. 6 | 66. 3 | 7. 7 | 4. 5 | 47. 9 | 28. 2 | 1. 6 | 1. 0 |
| 1959 | 204. 6 | 126. 6 | 61. 9 | 7. 2 | 3. 5 | 70. 1 | 34. 3 | . 7 | . 3 |
| 1960 | 266. 3 | 150. 7 | 56. 6 | 15. 9 | 6. 0 | 98. 6 | 37. 0 | 1. 1 | . 4 |
| 1961 | 481. 8 | 99. 6 | 20. 7 | 16. 3 | 3. 4 | 364. 8 | 75. 7 | 1. 1 | . 2 |
| 1962 | 522. 2 | 167. 3 | 32. 0 | 24. 8 | 4. 7 | 329. 0 | 63. 0 | 1. 2 | . 3 |
| 1963 | 951. 3 | 209. 3 | 22. 0 | 32. 2 | 3. 4 | 691. 1 | 72. 6 | 18. 8 | 2. 0 |
| 1964 | 1, 086. 3 | 288. 5 | 26. 6 | 19. 0 | 1. 7 | 755. 4 | 69. 5 | 23. 4 | 2. 2 |
| 1965 | 1, 192. 8 | 352. 9 | 29. 6 | 29. 4 | 2. 5 | 804. 4 | 67. 4 | 6. 2 | . 5 |
| 1966 | 1, 393. 1 | 266. 2 | 19. 1 | 17. 3 | 1. 2 | 1, 083. 0 | 77. 7 | 26. 5 | 2. 0 |
| 1967 | 1, 970. 7 | 335. 8 | 17. 0 | 20. 8 | 1. 1 | 1, 583. 6 | 80. 4 | 30. 6 | 1. 5 |
| 1968 | 2, 568. 1 | 341. 8 | 13. 3 | 28. 8 | 1. 1 | 2, 119. 2 | 82. 5 | 78. 4 | 3. 1 |
| 1969 | 2, 397. 0 | 324. 6 | 13. 5 | 29. 9 | 1. 2 | 2, 007. 8 | 83. 8 | 34. 8 | 1. 5 |
| 1970 | 2, 753. 2 | 291. 8 | 10. 6 | 23. 6 | . 9 | 2, 377. 3 | 86. 3 | 60. 3 | 2. 2 |
| 1971 | 2, 292. 4 | 343. 6 | 15. 0 | 20. 8 | . 9 | 1, 847. 1 | 80. 6 | 80. 9 | 3. 5 |

Source: U.S. Department of Commerce, Bureau of the Census. "U.S. Exports—Schedule B Commodity and Country," FT 410 (annual).

## TABLE 7.—Softwood and Hardwood Lumber Production, Imports, Exports, and Consumption, 1920–71 [1]

[Billion board feet]

| Year | Production | | | Imports | | | | Exports | | | | Consumption | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Softwood | Hardwood | Total | Softwood | Hardwood | Mixture [2] | Total | Softwood | Hardwood | Mixture [2] | Total | Softwood | Hardwood | Softwood imports percent total | Hardwood imports percent total |
| 1920 | 35.0 | 27.6 | 7.4 | 1.4 | NA | — | — | 1.7 | 1.5 | 0.2 | 0 | 34.6 | 26.1 | 7.2 | — | — |
| 1921 | 29.0 | 23.4 | 5.6 | .8 | NA | — | — | 1.3 | 1.2 | .1 | 0 | 28.5 | 22.2 | 5.5 | — | — |
| 1922 | 35.3 | 28.9 | 6.4 | 1.6 | 0.6 | — | 1.0 | 1.9 | 1.6 | .3 | .1 | 34.9 | 27.9 | 6.1 | 2.2 | — |
| 1923 | 41.0 | 33.2 | 7.8 | 2.0 | 1.9 | 0.1 | 0 | 2.5 | 2.1 | .3 | .1 | 40.5 | 33.0 | 7.6 | 5.8 | 1.3 |
| 1924 | 39.5 | 31.5 | 8.0 | 1.7 | 1.6 | .1 | 0 | 2.7 | 2.3 | .3 | .1 | 38.5 | 30.8 | 7.8 | 5.2 | 1.3 |
| 1925 | 41.0 | 33.3 | 7.7 | 1.8 | 1.7 | .1 | 0 | 2.6 | 2.2 | .4 | — | 40.2 | 32.8 | 7.4 | 5.2 | 1.4 |
| 1926 | 39.8 | 32.1 | 7.7 | 1.9 | 1.8 | .1 | 0 | 2.8 | 2.4 | .4 | — | 38.8 | 31.5 | 7.4 | 5.7 | 1.4 |
| 1927 | 37.3 | 30.0 | 7.3 | 1.7 | 1.6 | .1 | 0 | 3.1 | 2.6 | .5 | — | 35.9 | 29.0 | 7.1 | 5.5 | 1.4 |
| 1928 | 36.8 | 29.9 | 6.9 | 1.5 | 1.4 | .1 | 0 | 3.2 | 2.7 | .5 | — | 35.0 | 28.6 | 6.5 | 4.9 | 1.5 |
| 1929 | 38.7 | 30.8 | 7.9 | 1.5 | 1.4 | .1 | 0 | 3.2 | 2.7 | .5 | — | 37.1 | 29.5 | 7.5 | 4.7 | 1.3 |
| 1930 | 29.4 | 23.2 | 6.2 | 1.2 | 1.2 | — | — | 2.3 | 1.9 | .4 | — | 28.2 | 22.5 | 5.8 | 5.3 | (3) |
| 1931 | 20.0 | 15.9 | 4.1 | .7 | .7 | — | — | 1.7 | 1.4 | .3 | — | 19.0 | 15.2 | 3.8 | 4.6 | (3) |
| 1932 | 13.5 | 10.8 | 2.7 | .4 | .4 | — | — | 1.2 | 1.0 | .2 | — | 12.7 | 10.2 | 2.5 | 3.9 | (3) |
| 1933 | 17.2 | 13.8 | 3.4 | .4 | .4 | — | — | 1.3 | 1.0 | .3 | — | 16.2 | 13.2 | 3.1 | 3.0 | (3) |
| 1934 | 18.8 | 14.6 | 4.2 | .3 | .3 | — | — | 1.3 | 1.0 | .3 | — | 17.7 | 13.9 | 3.9 | 2.1 | (3) |
| 1935 | 22.9 | 18.2 | 4.7 | .4 | .4 | .1 | 0 | 1.3 | 1.0 | .3 | — | 23.3 | 17.6 | 4.5 | 1.7 | 2.2 |
| 1936 | 27.6 | 22.0 | 5.6 | .7 | .6 | .1 | 0 | 1.3 | 1.0 | .3 | — | 25.7 | 21.6 | 5.4 | 2.8 | 1.9 |
| 1937 | 29.0 | 23.1 | 5.9 | .7 | .6 | .1 | — | 1.4 | 1.1 | .3 | — | 25.8 | 22.6 | 5.7 | 2.7 | 1.8 |
| 1938 | 24.8 | 20.0 | 4.8 | .5 | .4 | .1 | — | 1.0 | .7 | .3 | — | 38.6 | 19.7 | 4.6 | 2.0 | 2.2 |
| 1939 | 28.8 | 23.3 | 5.5 | .7 | .6 | .1 | — | 1.1 | .8 | .2 | — | 28.4 | 23.1 | 5.4 | 2.6 | 1.9 |
| 1940 | 31.2 | 25.6 | 5.6 | .7 | .6 | 0 | — | 1.0 | .7 | .2 | .1 | 34.3 | 25.5 | 5.4 | 2.4 | 0 |
| *1941 | 36.5 | 29.9 | 6.6 | 1.3 | 1.1 | .2 | — | .7 | .5 | .2 | — | 36.2 | 30.5 | 6.6 | 3.6 | 3.0 |
| *1942 | 36.3 | 29.5 | 6.8 | 1.5 | 1.4 | .1 | — | .5 | .3 | .1 | .1 | 43.9 | 30.6 | 6.8 | 4.6 | 1.5 |
| *1943 | 34.3 | 26.9 | 7.4 | .9 | .8 | .1 | — | .3 | .2 | .1 | — | 38.7 | 27.5 | 7.4 | 2.9 | 1.4 |
| *1944 | 32.9 | 25.2 | 7.7 | 1.0 | .8 | .2 | — | .3 | .2 | .1 | — | 34.6 | 25.8 | 7.8 | 3.1 | 2.6 |
| *1945 | 28.1 | 21.1 | 7.0 | 1.1 | .9 | .2 | — | .4 | .3 | .1 | — | 30.6 | 21.7 | 7.1 | 4.1 | 2.8 |
| *1946 | 34.1 | 25.9 | 8.2 | 1.2 | 1.0 | .2 | — | .6 | .5 | .1 | — | 33.5 | 26.4 | 8.3 | 3.8 | 2.4 |
| *1947 | 35.4 | 27.9 | 7.5 | 1.3 | 1.1 | .2 | — | 1.4 | 1.0 | .2 | .2 | 33.8 | 28.0 | 7.5 | 3.9 | 2.7 |
| *1948 | 37.0 | 29.6 | 7.4 | 1.9 | 1.7 | .2 | — | .6 | .4 | .1 | .1 | 36.3 | 30.9 | 7.5 | 5.5 | 2.7 |
| *1949 | 32.2 | 26.5 | 5.7 | 1.6 | 1.5 | .1 | — | .7 | .5 | .2 | 0 | 34.4 | 27.5 | 5.6 | 5.5 | 1.8 |
| *1950 | 38.0 | 30.6 | 7.4 | 3.4 | 3.1 | .3 | — | .5 | .4 | .1 | 0 | 40.7 | 33.3 | 7.6 | 9.3 | 3.9 |
| *1951 | 37.2 | 29.5 | 7.7 | 2.5 | 2.3 | .3 | — | 1.0 | .9 | .1 | — | 38.7 | 30.9 | 7.8 | 7.4 | 3.8 |
| *1952 | 37.5 | 30.2 | 7.2 | 2.5 | 2.3 | .2 | — | .7 | .6 | .2 | — | 39.2 | 31.9 | 7.3 | 7.2 | 2.7 |
| *1953 | 36.7 | 29.6 | 7.2 | 2.8 | 2.5 | .2 | — | .6 | .5 | .1 | — | 38.9 | 31.6 | 7.3 | 7.9 | 2.7 |
| *1954 | 36.4 | 29.3 | 7.1 | 3.1 | 2.9 | .2 | — | .7 | .6 | .1 | — | 38.7 | 31.5 | 7.1 | 9.2 | 2.8 |
| *1955 | 37.4 | 29.8 | 7.6 | 3.6 | 3.3 | .3 | — | .8 | .7 | .2 | — | 40.1 | 32.5 | 7.6 | 10.2 | 3.9 |
| *1956 | 38.2 | 30.2 | 8.0 | 3.4 | 3.2 | .3 | — | .8 | .6 | .2 | — | 40.9 | 32.8 | 8.1 | 9.8 | 3.7 |
| 1957 | 32.9 | 27.1 | 5.8 | 3.0 | 2.7 | .2 | — | .8 | .6 | .2 | — | 35.0 | 29.2 | 5.8 | 9.2 | 3.4 |
| 1958 | 22.3 | 27.4 | 6.0 | 3.4 | 3.2 | .2 | — | .7 | .6 | .2 | — | 36.1 | 30.0 | 16.1 | 10.7 | 3.3 |
| 1959 | 37.2 | 30.5 | 6.7 | 4.1 | 3.8 | .3 | — | .8 | .6 | .2 | — | 40.5 | 33.7 | 6.8 | 11.3 | 4.4 |
| 1960 | 32.9 | 26.7 | 6.3 | 3.9 | 3.6 | .3 | — | .9 | .7 | .2 | — | 36.0 | 29.6 | 6.4 | 12.2 | 4.7 |
| 1996 | 32.0 | 26.1 | 6.0 | 4.3 | 4.0 | .2 | — | .8 | .6 | .2 | — | 35.5 | 29.5 | 6.0 | 13.6 | 3.3 |
| 1162 | 33.2 | 26.8 | 6.4 | 4.9 | 4.6 | .3 | — | .8 | .6 | .1 | — | 37.3 | 30.8 | 6.5 | 14.9 | 4.6 |
| 1963 | 34.7 | 27.6 | 7.2 | 5.3 | 5.0 | .3 | — | .9 | .7 | .1 | — | 39.2 | 31.8 | 7.3 | 15.7 | 4.1 |
| 1964 | 36.7 | 29.3 | 7.3 | 5.2 | 4.9 | .3 | — | 1.0 | .8 | .1 | — | 40.8 | 33.4 | 7.4 | 14.7 | 4.1 |
| 1965 | 36.8 | 29.3 | 7.5 | 5.2 | 4.9 | .3 | — | .9 | .8 | .1 | — | 41.1 | 33.4 | 7.7 | 14.7 | 3.9 |
| 1966 | 36.6 | 28.8 | 7.7 | 5.2 | 4.8 | .4 | — | 1.0 | .9 | .2 | — | 40.8 | 32.8 | 8.0 | 14.6 | 5.0 |
| 1967 | 34.7 | 27.3 | 7.4 | 5.1 | 4.8 | .3 | — | 1.1 | 1.0 | .2 | — | 38.8 | 31.1 | 7.6 | 15.4 | 3.9 |
| 1968 | 36.5 | 29.3 | 7.2 | 6.2 | 5.8 | .3 | — | 1.2 | 1.0 | .1 | — | 41.5 | 34.0 | 7.4 | 17.1 | 4.1 |
| 1969 | 35.8 | 28.3 | 7.5 | 6.3 | 5.9 | .4 | — | 1.1 | 1.0 | .1 | — | 41.0 | 33.2 | 7.8 | 17.8 | 5.1 |
| 1970 | 34.4 | 27.3 | 7.1 | 6.1 | 5.8 | .3 | — | 1.3 | 1.2 | .1 | — | 39.2 | 31.9 | 7.3 | 18.2 | 4.1 |
| 1971 | 36.6 | 30.3 | 6.3 | 7.6 | 7.2 | .4 | — | 1.1 | .9 | .2 | — | 43.1 | 36.6 | 6.5 | 19.7 | 6.2 |

[1] As estimated by the Forest Service except years preceded by an asterisk for which data are those published by the Bureau of the Census.
[2] Includes small volumes of mixed species (not classified as softwoods or hardwoods).
[3] Negligible.

NOTE.—A dash indicates volumes less than 50 million fbm.

Source: Data for 1900–49 from USDA, Forest Service, compiled by Dwight Hair, Division of Forest Economic Research, State Bul. No. 228. October 1958. Data for 1950–71 from U.S. Department of Commerce, Bureau of the Census, and U.S. Department of Agriculture, Forest Service.

**TABLE 8.—Plywood and Veneer Consumption, Production, Imports, and Exports, 1950–71** [1]

[In millions of cubic feet]

| Year | Total consumption | Softwoods | | | | Hardwoods | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Consumption | Domestic production | Imports | Exports | Consumption | Domestic production | Imports | Exports |
| 1950 | 350 | 185 | 185 | — | — | 165 | 160 | 5 | — |
| 1951 | 395 | 195 | 195 | — | — | 200 | 195 | 10 | — |
| 1952 | 440 | 245 | 250 | — | — | 195 | 185 | 10 | — |
| 1953 | 490 | 295 | 300 | — | — | 195 | 180 | 15 | — |
| 1954 | 505 | 315 | 315 | — | — | 190 | 165 | 30 | — |
| 1955 | 615 | 390 | 390 | — | — | 225 | 190 | 40 | — |
| 1956 | 635 | 400 | 400 | — | — | 235 | 190 | 45 | — |
| 1957 | 600 | 390 | 395 | — | — | 210 | 165 | 45 | — |
| 1958 | 665 | 460 | 460 | — | — | 205 | 155 | 50 | — |
| 1959 | 795 | 555 | 560 | — | — | 240 | 160 | 75 | — |
| 1960 | 765 | 550 | 550 | — | — | 215 | 155 | 60 | — |
| 1961 | 825 | 615 | 615 | — | — | 210 | 150 | 60 | — |
| 1962 | 870 | 650 | 650 | — | — | 220 | 150 | 75 | — |
| 1963 | 950 | 725 | 725 | — | — | 225 | 145 | 80 | — |
| 1964 | 1, 045 | 800 | 800 | — | — | 245 | 160 | 90 | 5 |
| 1965 | 1, 125 | 870 | 870 | — | — | 255 | 160 | 100 | — |
| 1966 | 1, 140 | 900 | 900 | 5 | 5 | 240 | 135 | 110 | — |
| 1967 | 1, 130 | 895 | 895 | 5 | 5 | 235 | 130 | 105 | — |
| 1968 | 1, 215 | 920 | 920 | 5 | 5 | 295 | 135 | 160 | 5 |
| 1969 | 1, 125 | 825 | 835 | 5 | 15 | 300 | 130 | 175 | 5 |
| 1970 | 1, 150 | 870 | 875 | 5 | 10 | 280 | 120 | 165 | 5 |
| 1971 | 1, 325 | 990 | 995 | 5 | 15 | 335 | 130 | 205 | 5 |

[1] Columns may not add to totals because of rounding.

NOTE.—A dash means volumes were less than 2.5 million ft$^3$.

Source: Department of Commerce, Bureau of the Census, and Department of Agriculture, as transmitted by Dwight Hair, Division of Forest Economics Research, U.S. Forest Service.

**TABLE 9.—Pulpwood Consumption, Production, Imports, Exports, and Equivalent Wood Volumes of Imports and Exports of Paper, Board, and Woodpulp, 1950–71** [1]

[Millions of cords]

| Year | Total U.S. consumption | Domestic production [2] | | | | Net Imports | Imports | Exports | Paper, board, and woodpulp (pulpwood equivalent) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Total | Softwood | Hardwood | Chips | | | | Net imports | Imports | Exports |
| 1950 | 32.1 | 20.7 | 16.7 | 2.8 | 1.2 | 1.4 | 1.4 | — | 10.0 | 10.6 | 0.6 |
| 1951 | 37.2 | 25.1 | 20.1 | 3.6 | 1.4 | 2.5 | 2.5 | — | 9.5 | 10.6 | 1.1 |
| 1952 | 36.1 | 25.0 | 20.0 | 3.5 | 1.6 | 2.1 | 2.1 | — | 8.9 | 10.0 | 1.1 |
| 1953 | 37.4 | 26.3 | 20.7 | 4.1 | 1.5 | 1.5 | 1.5 | — | 9.6 | 10.5 | .9 |
| 1954 | 37.1 | 27.0 | 20.9 | 4.5 | 1.5 | 1.6 | 1.6 | — | 8.5 | 10.2 | 1.7 |
| 1955 | 41.2 | 31.0 | 23.4 | 5.2 | 2.3 | 1.7 | 1.8 | 0.1 | 8.5 | 10.8 | 2.3 |
| 1956 | 46.5 | 35.2 | 26.2 | 5.9 | 3.0 | 1.8 | 1.9 | .1 | 9.5 | 11.5 | 2.0 |
| 1957 | 44.4 | 34.4 | 24.5 | 6.0 | 3.9 | 1.7 | 1.8 | .1 | 8.3 | 10.6 | 2.3 |
| 1958 | 42.6 | 33.2 | 22.4 | 5.6 | 5.2 | 1.3 | 1.4 | .1 | 8.1 | 10.1 | 2.0 |
| 1959 | 46.7 | 36.7 | 23.4 | 7.2 | 6.1 | 1.1 | 1.2 | .1 | 8.9 | 11.3 | 2.4 |
| 1960 | 49.1 | 40.0 | 25.4 | 8.0 | 6.5 | 1.1 | 1.3 | .2 | 8.0 | 11.4 | 3.4 |
| 1961 | 49.3 | 40.3 | 24.0 | 8.1 | 8.2 | 1.2 | 1.4 | .2 | 7.9 | 11.5 | 3.6 |
| 1962 | 52.5 | 42.8 | 24.3 | 9.0 | 9.4 | 1.3 | 1.4 | .1 | 8.5 | 12.2 | 3.7 |
| 1963 | 54.0 | 44.7 | 25.1 | 9.5 | 10.0 | 1.5 | 1.6 | .1 | 7.7 | 12.0 | 4.3 |
| 1964 | 57.9 | 48.6 | 26.9 | 10.5 | 11.2 | 1.4 | 1.5 | .1 | 7.9 | 13.0 | 5.1 |
| 1965 | 62.4 | 52.3 | 29.2 | 11.0 | 12.0 | 1.2 | 1.3 | .1 | 8.9 | 13.8 | 4.9 |
| 1966 | 67.0 | 56.1 | 29.6 | 12.2 | 14.2 | 1.1 | 1.4 | .3 | 9.8 | 15.1 | 5.3 |
| 1967 | 66.9 | 57.5 | 30.1 | 11.7 | 15.7 | 1.0 | 1.6 | .6 | 8.5 | 14.3 | 5.8 |
| 1968 | 69.9 | 61.7 | 32.1 | 12.1 | 17.4 | .2 | 1.4 | 1.2 | 8.0 | 14.7 | 6.7 |
| 1969 | 75.1 | 66.9 | 33.6 | 13.5 | 19.0 | —.7 | 1.0 | 1.7 | 8.9 | 16.2 | 7.3 |
| 1970 [3] | 75.9 | 70.5 | 36.7 | 13.6 | 20.2 | —.7 | 1.1 | 1.8 | 6.1 | 15.2 | 9.1 |
| 1971 [3] | 79.4 | 71.9 | 36.7 | 13.7 | 21.5 | —.3 | 1.2 | 1.5 | 7.8 | 15.9 | 8.1 |

[1] Data may not add to totals because of rounding.
[2] Data for the years 1950–63 are domestic receipts at the mill.
[3] Preliminary estimates.

NOTE.—A dash means volumes were less than 50,000 cords.

Source: U.S. Department of Commerce, Bureau of the Census, "U.S. Imports—General and Consumption, Schedule A Commodity and Country," FT 135 (annual); "U.S. Exports—Schedule B Commodity and Country," FT 410 (annual); American Pulpwood Association; U.S. Department of Agriculture, Forest Service; American Paper Institute.

**TABLE 10.—U.S. Consumption, Exports, Imports, and Production of Paper and Paperboard,[1] 1950–71**

[In millions of tons]

| Year | Paper | | | | Paperboard | | | |
|---|---|---|---|---|---|---|---|---|
| | Consumption | Exports | Imports | Domestic production | Consumption | Exports | Imports | Domestic production |
| 1950 | 16. 8 | 0. 2 | 4. 9 | 12. 1 | 11. 0 | 0. 1 | 0. 06 | 11. 1 |
| 1951 | 17. 6 | . 3 | 5. 0 | 13. 0 | 11. 6 | . 2 | . 08 | 11. 8 |
| 1952 | 16. 8 | . 3 | 5. 1 | 12. 2 | 10. 8 | . 1 | . 06 | 10. 9 |
| 1953 | 17. 7 | . 2 | 5. 1 | 12. 7 | 12. 4 | . 2 | . 10 | 12. 5 |
| 1954 | 17. 9 | . 3 | 5. 1 | 13. 1 | 12. 1 | . 2 | . 06 | 12. 3 |
| 1955 | 19. 4 | . 4 | 5. 3 | 14. 5 | 13. 9 | . 3 | . 10 | 14. 0 |
| 1956 | 20. 5 | . 3 | 5. 7 | 15. 4 | 14. 2 | . 3 | . 07 | 14. 4 |
| 1957 | 19. 8 | . 4 | 5. 3 | 14. 9 | 13. 9 | . 3 | . 05 | 14. 2 |
| 1958 | 19. 6 | . 3 | 5. 0 | 14. 9 | 14. 0 | . 4 | . 05 | 14. 3 |
| 1959 | 21. 5 | . 3 | 5. 4 | 16. 5 | 15. 2 | . 4 | . 06 | 15. 6 |
| 1960 | 22. 1 | . 4 | 5. 6 | 16. 8 | 15. 4 | . 5 | . 04 | 15. 9 |
| 1961 | 22. 5 | . 4 | 5. 6 | 17. 2 | 16. 1 | . 6 | . 04 | 16. 6 |
| 1962 | 23. 2 | . 3 | 5. 6 | 18. 0 | 17. 0 | . 6 | . 05 | 17. 6 |
| 1963 | 24. 0 | . 4 | 5. 5 | 18. 8 | 17. 7 | . 7 | . 04 | 18. 4 |
| 1964 | 25. 3 | . 4 | 6. 1 | 19. 7 | 18. 7 | 1. 0 | . 02 | 19. 8 |
| 1965 | 26. 8 | . 5 | 6. 5 | 20. 8 | 19. 9 | 1. 1 | . 02 | 21. 0 |
| 1966 | 28. 7 | . 5 | 7. 2 | 22. 1 | 21. 5 | 1. 3 | . 06 | 22. 7 |
| 1967 | 28. 8 | . 5 | 6. 9 | 22. 4 | 20. 8 | 1. 4 | . 02 | 22. 2 |
| 1968 | 30. 2 | . 5 | 6. 7 | 24. 0 | 22. 7 | 1. 8 | . 03 | 24. 6 |
| 1969 | 31. 8 | . 5 | 7. 1 | 25. 2 | 24. 2 | 2. 0 | . 02 | 26. 2 |
| 1970 [2] | 31. 5 | . 5 | 7. 0 | 25. 0 | 23. 5 | 2. 1 | . 02 | 25. 6 |
| 1971 [2] | 31. 8 | . 6 | 7. 3 | 25. 1 | 23. 6 | 2. 4 | . 02 | 26. 0 |

[1] Includes wet machine board.
[2] Preliminary.

NOTE.—Data may not add to totals due to rounding.

Source: U.S. Forest Service originating from American Paper Institute, the statistics of paper (annual, 1960 ed. and 1971 sup.), and "Monthly Statistical Summary:" U.S. Department of Commerce, Bureau of the Census, "Pulp, Paper, and Board." Air. Reps. Ser. M26A (annual); U.S. Department of Commerce, Bureau of Domestic Commerce. Pulp, paper, and board, Quart. Indust. Rep; and U.S. Department of Agriculture, Forest Service.

**TABLE 11.—U.S. Consumption, Exports, Imports, and Domestic Production of Building Boards, 1950–71 [1]**

[In thousands of tons]

| Year | Consumption | | | Exports | | | Imports | | | Domestic production | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | Insulation board | Hard-board | Total | Insulation board | Hard-board | Total | Insulation board | Hard-board | Total | Insulation board | Hard-board |
| 1950 | 1, 228 | 826 | 402 | 23 | 16 | 8 | 31 | 3 | 27 | 1, 221 | 838 | 383 |
| 1951 | 1, 274 | 901 | 373 | 25 | 20 | 5 | 33 | 3 | 30 | 1, 266 | 918 | 348 |
| 1952 | 1, 311 | 886 | 425 | 25 | 17 | 8 | 27 | 4 | 23 | 1, 309 | 899 | 410 |
| 1953 | 1, 379 | 939 | 440 | 21 | 17 | 4 | 26 | 5 | 20 | 1, 374 | 951 | 423 |
| 1954 | 1, 495 | 993 | 502 | 23 | 18 | 5 | 45 | 4 | 42 | 1, 473 | 1, 008 | 465 |
| 1955 | 1, 668 | 1, 089 | 579 | 26 | 20 | 6 | 64 | 9 | 55 | 1, 630 | 1, 100 | 530 |
| 1956 | 1, 699 | 1, 091 | 609 | 29 | 22 | 7 | 86 | 11 | 76 | 1, 642 | 1, 102 | 540 |
| 1957 | 1, 610 | 975 | 634 | 26 | 20 | 7 | 78 | 6 | 72 | 1, 558 | 989 | 569 |
| 1958 | 1, 725 | 1, 052 | 673 | 20 | 14 | 6 | 79 | 9 | 70 | 1, 666 | 1, 057 | 609 |
| 1959 | 2, 018 | 1, 172 | 845 | 20 | 14 | 6 | 133 | 15 | 117 | 1, 905 | 1, 171 | 734 |
| 1960 | 1, 869 | 1, 096 | 774 | 20 | 14 | 6 | 106 | 12 | 94 | 1, 784 | 1, 098 | 686 |
| 1961 | 1, 933 | 1, 077 | 856 | 22 | 16 | 6 | 110 | 9 | 100 | 1, 845 | 1, 084 | 762 |
| 1962 | 2, 066 | 1, 079 | 987 | 22 | 16 | 6 | 143 | 15 | 128 | 1, 945 | 1, 080 | 865 |
| 1963 | 2, 255 | 1, 142 | 1, 113 | 27 | 19 | 8 | 183 | 22 | 161 | 2, 098 | 1, 139 | 959 |
| 1964 | 2, 448 | 1, 218 | 1, 230 | 30 | 19 | 11 | 214 | 23 | 190 | 2, 265 | 1, 215 | 1, 050 |
| 1965 | 2, 566 | 1, 265 | 1, 301 | 29 | 16 | 13 | 244 | 23 | 221 | 2, 351 | 1, 258 | 1, 093 |
| 1966 | 2, 395 | 1, 161 | 1, 236 | 35 | 18 | 16 | 187 | 24 | 163 | 2, 243 | 1, 155 | 1, 089 |
| 1967 | 2, 407 | 1, 185 | 1, 222 | 32 | 16 | 15 | 188 | 25 | 163 | 2, 250 | 1, 176 | 1, 074 |
| 1968 | 2, 831 | 1, 352 | 1, 480 | 36 | 17 | 18 | 252 | 36 | 217 | 2, 615 | 1, 333 | 1, 282 |
| 1969 | 3, 000 | 1, 362 | 1, 638 | 46 | 24 | 21 | 272 | 34 | 238 | 2, 773 | 1, 352 | 1, 421 |
| 1970 [2] | 2, 882 | 1, 308 | 1, 574 | 45 | 19 | 26 | 192 | 35 | 156 | 2, 735 | 1, 292 | 1, 443 |
| 1971 [2] | 3, 317 | 1, 393 | 1, 924 | 52 | 25 | 28 | 255 | 35 | 219 | 3, 114 | 1, 382 | 1, 732 |

[1] Data may not add due to rounding.
[2] Preliminary.

Source: See table 10.

## TABLE 12.—U.S. Imports of Woodpulp, 1950–71 [1]

[In thousands of tons]

| Year | Total | Dissolving and alpha [2] | Sulfite [3] | Sulfate | Soda | Ground wood | All other [4] |
|---|---|---|---|---|---|---|---|
| 1950 | 2, 385 | 239 | 930 | 891 | 34 | 281 | 10 |
| 1951 | 2, 361 | 231 | 906 | 857 | 33 | 318 | 15 |
| 1952 | 1, 937 | 223 | 708 | 727 | 28 | 242 | 8 |
| 1953 | 2, 158 | 256 | 714 | 883 | 36 | 259 | 11 |
| 1954 | 2, 051 | 230 | 628 | 907 | 38 | 237 | 11 |
| 1955 | 2, 214 | 223 | 730 | 954 | 41 | 254 | 12 |
| 1956 | 2, 332 | 193 | 797 | 1, 014 | 43 | 271 | 15 |
| 1957 | 2, 101 | 138 | 666 | 1, 017 | 37 | 228 | 15 |
| 1958 | 2, 105 | 141 | 631 | 1, 094 | 27 | 199 | 13 |
| 1959 | 2, 431 | 186 | 633 | 1, 347 | 28 | 229 | 10 |
| 1960 | 2, 389 | 232 | 631 | 1, 221 | 32 | 262 | 12 |
| 1961 | 2, 467 | 196 | 650 | 1, 271 | 28 | 310 | 12 |
| 1962 | 2, 789 | 275 | 678 | 1, 474 | 25 | 328 | 9 |
| 1963 | 2, 775 | 261 | 636 | 1, 502 | 27 | 339 | 9 |
| 1964 | 2, 942 | 274 | 699 | 1, 589 | 28 | 348 | 9 |
| 1965 | 3, 130 | 279 | 714 | 1, 766 | 8 | 346 | 17 |
| 1966 | 3, 357 | 297 | 691 | 2, 634 | (5) | 311 | 23 |
| 1967 | 3, 170 | 271 | 604 | 1, 994 | (5) | 276 | 24 |
| 1968 | 3, 532 | 309 | 559 | 2, 385 | 1 | 246 | 32 |
| 1969 | [6] 4, 040 | 311 | 570 | 2, 837 | (5) | 279 | 24 |
| 1970 | [6] 3, 513 | 277 | 518 | 2, 526 | (5) | 178 | 22 |
| 1971 | [6] 3, 515 | 315 | 408 | 2, 584 | (5) | 179 | 28 |

[1] Data may not add to totals because of rounding.
[2] Includes sulfate dissolving pulp beginning in 1955.
[3] Includes sulfate dissolving pulp prior to 1955.
[4] Includes imports of semichemical, defibrated or exploded pulps, screenings, etc.
[5] Less than 500 tons.
[6] Preliminary.

Source: U.S. Department of Commerce, Bureau of the Census. "U.S. Imports." FT 135. 1971 (annual).

## TABLE 13.—U.S. Exports of Woodpulp by Type, 1950–71 [1]

| Year | Total | Dissolving and alpha [2] | Sulfite | Sulfate [3] | Soda [4] | All others [5] |
|---|---|---|---|---|---|---|
| | Thousand tons | | | | | |
| 1950 | 96 | 28 | 51 | 14 | -------- | 3 |
| 1951 | 202 | 31 | 87 | 81 | 1 | 2 |
| 1952 | 212 | 65 | 58 | 87 | -------- | 1 |
| 1953 | 162 | 69 | 49 | 42 | -------- | 2 |
| 1954 | 442 | 153 | 109 | 174 | 2 | 4 |
| 1955 | 631 | 194 | 118 | 310 | 5 | 4 |
| 1956 | 525 | 197 | 90 | 231 | 2 | 6 |
| 1957 | 622 | 250 | 113 | 255 | 1 | 3 |
| 1958 | 515 | 223 | 66 | 222 | 1 | 4 |
| 1959 | 653 | 287 | 81 | 281 | 1 | 3 |
| 1960 | 1, 142 | 408 | 146 | 584 | 1 | 3 |
| 1961 | 1, 178 | 435 | 150 | 587 | 2 | 4 |
| 1962 | 1, 186 | 480 | 202 | 500 | 1 | 3 |
| 1963 | 1, 422 | 524 | 248 | 644 | 1 | 5 |
| 1964 | 1, 580 | 581 | 272 | 725 | 1 | 1 |
| 1965 | 1, 402 | 535 | 240 | 621 | -------- | 6 |
| 1966 | 1, 572 | 563 | 246 | 753 | -------- | 10 |
| 1967 | 1, 721 | 607 | 254 | 850 | -------- | 10 |
| 1968 | 1, 902 | 671 | 236 | 983 | -------- | 12 |
| 1969 [6] | 2, 103 | 744 | 265 | 1, 086 | -------- | 8 |
| 1970 [6] | 3, 093 | 869 | 394 | 1, 830 | -------- | 13 |
| 1971 [6] | 2, 175 | 790 | 213 | 1, 164 | -------- | 9 |

[1] Data may not add to totals because of rounding.
[2] Includes sulfate dissolving pulp beginning in 1952.
[3] Includes sulfate dissolving pulp prior to 1952.
[4] Type data for years 1954–65 estimated from census combined data by U.S. Pulp Producers Association, Inc,
[5] Includes exports of groundwood, semichemical, defibrated, or exploded pulps, screenings, etc.
[6] Preliminary.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Exports. FT 410. 1971 (annual).

## TABLE 14.—U.S. Imports of Paper and Board by Grade and Major Region of Origin, 1971 [1]

| Region | Thousand tons | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Total paper and board | Paper | | | | | | Board | | |
| | | Total | News-print | Book paper | Fine paper | Coarse industrial | Other paper | Total | Build board | Other board |
| Canada | 7, 001 | 6, 910 | 6, 564 | 246 | 1 | 61 | 38 | 91 | 75 | 16 |
| Latin America | 41 | (2) | -------- | (2) | -------- | (2) | (2) | 41 | 41 | (2) |
| Western Europe | 508 | 394 | 317 | 42 | 9 | 25 | 1 | 115 | 108 | 7 |
| Eastern Europe | (2) | -------- | -------- | -------- | -------- | -------- | -------- | (2) | (2) | -------- |
| Africa | 20 | -------- | -------- | -------- | -------- | -------- | -------- | 20 | 20 | -------- |
| Near and Middle East | 6 | -------- | -------- | -------- | -------- | -------- | -------- | 6 | 6 | -------- |
| Far East | 3 | 2 | -------- | 2 | (2) | (2) | (2) | (2) | (2) | (2) |
| Oceania | 5 | (2) | -------- | (2) | (2) | (2) | -------- | 5 | 5 | (2) |
| Other countries | -------- | -------- | -------- | -------- | -------- | -------- | -------- | -------- | -------- | -------- |
| Total | 7, 584 | 7, 306 | 6, 881 | 291 | 10 | 86 | 39 | 278 | 255 | 23 |

[1] Data may not add to totals because of rounding.
[2] Less than 500 tons.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Imports. FT 135. 1971 (annual).

## TABLE 15.—U.S. Exports of Paper and Board by Grade and Major Region of Destination, 1971 [1]

| Region | Total paper and board | Paper: Total | Paper: News-print | Paper: Book paper | Paper: Fine paper | Paper: Coarse industrial | Paper: Other paper | Board: Total | Board: Build board | Board: Other board |
|---|---|---|---|---|---|---|---|---|---|---|
| | Thousand tons | | | | | | | | | |
| Canada | 307 | 121 | 2 | 26 | 36 | 48 | 10 | 186 | 33 | 153 |
| Latin America | 701 | 167 | 73 | 29 | 13 | 41 | 11 | 533 | 3 | 530 |
| Western Europe | 1, 323 | 90 | 7 | 31 | 21 | 28 | 2 | 1, 233 | 11 | 1, 222 |
| Eastern Europe | 24 | (2) | — | — | (2) | (2) | (2) | 24 | (2) | 24 |
| Africa | 153 | 25 | (2) | 3 | 3 | 18 | 1 | 128 | 2 | 126 |
| Near and Middle East | 117 | 11 | — | 1 | 1 | 9 | (2) | 106 | 1 | 106 |
| Far East | 303 | 127 | 81 | 4 | 24 | 17 | 1 | 176 | 1 | 175 |
| Oceania | 60 | 16 | 2 | 3 | 4 | 5 | 2 | 44 | (2) | 44 |
| Other countries | 8 | 5 | (2) | 1 | 1 | 2 | 1 | 3 | 1 | 2 |
| Total | 2, 996 | 563 | 166 | 97 | 102 | 169 | 29 | 2, 434 | 52 | 2, 381 |

[1] Data may not add to totals because of rounding.
[2] Less than 500 tons.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Exports. FT 410. 1971 (annual).

## TABLE 16.—U.S. Imports of Woodpulp by Type and Major Region of Origin, 1971 [1]

| Region | Total | Dissolving and alpha | Sulfite | Sulfate | Soda | Ground wood | All other |
|---|---|---|---|---|---|---|---|
| | Thousand tons | | | | | | |
| Canada | 3, 385 | 250 | 401 | 2, 583 | (2) | 179 | 22 |
| Latin America | 3 | — | 2 | 1 | — | — | — |
| Western Europe | 62 | 1 | 5 | 50 | — | (2) | 4 |
| Eastern Europe | — | — | — | — | — | — | — |
| Africa | 65 | 64 | — | — | — | (2) | 1 |
| Near and Middle East | — | — | — | — | — | — | — |
| Far East | — | — | — | — | — | — | — |
| Oceania | — | — | — | — | — | — | — |
| Total | 3, 515 | 315 | 408 | 2, 584 | (2) | 179 | 28 |

[1] Data may not add to totals because of rounding.
[2] Less than 500 tons.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Imports. FT 135. 1971 (annual).

## TABLE 17.—U.S. Exports of Woodpulp by Type and Major Region of Destination, 1971 [1]

| Region | Total | Dissolving and alpha | Sulfite | Sulfate | All other |
|---|---|---|---|---|---|
| | Thousand tons | | | | |
| Canada | 72 | 17 | 6 | 49 | 1 |
| Latin America | 277 | 106 | 27 | 144 | 1 |
| Western Europe | 1, 079 | 345 | 74 | 659 | 1 |
| Eastern Europe | 82 | 60 | (2) | 12 | — |
| Africa | 46 | (2) | 2 | 45 | — |
| Near and Middle East | 24 | 5 | 5 | 14 | — |
| Far East | 533 | 241 | 79 | 206 | 7 |
| Oceania | 60 | 6 | 20 | 35 | — |
| Other | 1 | (2) | (2) | (2) | (2) |
| Total | 2, 175 | 790 | 213 | 1, 164 | 9 |

[1] Data may not add to totals because of rounding.
[2] Less than 500 tons.

Source: U.S. Department of Commerce, Bureau of the Census. U.S. Exports. FT 410. 1971 (annual).

**TABLE 18.—Projections of Exports and Imports of Selected Wood Products Under Several Price Assumptions for the Years 1980, 1990, and 2000 (medium level projections)**

| Product | Unit of measure | Exports | | | Imports | | |
|---|---|---|---|---|---|---|---|
| | | 1980 | 1990 | 2000 | 1980 | 1990 | 2000 |
| | Projections—1970 relative prices | | | | | | |
| Softwood lumber | Billion board feet | 1. 2 | 1. 2 | 1. 2 | 6. 0 | 6. 0 | 6. 0 |
| Hardwood lumber | do | . 1 | . 1 | . 1 | . 4 | . 4 | . 4 |
| Softwood plywood | Million square feet, ⅜ in. | 300 | 400 | 500 | | | |
| Hardwood plywood | do | 300 | 400 | 500 | 3, 000 | 3, 000 | 3, 000 |
| Pulpwood | Million cords | 3. 3 | 3. 8 | 4. 3 | 1. 3 | 1. 3 | 1. 3 |
| Woodpulp | do | 8. 5 | 11. 2 | 12. 8 | 7. 9 | 10. 6 | 12. 9 |
| Paper and board | do | 6. 5 | 6. 8 | 7. 2 | 11. 0 | 12. 7 | 14. 4 |
| Softwood saw logs | Billion board feet [1] | 5. 0 | 5. 7 | 5. 9 | | | |
| | Projections—rising relative prices | | | | | | |
| Softwood lumber | Billion board feet | 1. 1 | 1. 0 | 0. 8 | 9. 0 | 12. 0 | 13. 0 |
| Hardwood lumber | do | . 1 | . 1 | . 1 | . 5 | . 7 | . 9 |
| Softwood plywood | Million square feet, ⅜ in. | 200 | 200 | 100 | | | |
| Hardwood plywood | do | 200 | 200 | 100 | 3, 270 | 3, 855 | 4, 235 |
| Pulpwood | Million cords | 3. 3 | 3. 7 | 4. 1 | 1. 3 | 1. 3 | 1. 3 |
| Woodpulp | do | 8. 4 | 10. 9 | 12. 3 | 8. 2 | 11. 4 | 14. 6 |
| Paper and board | do | 6. 4 | 6. 6 | 6. 9 | 11. 3 | 13. 6 | 16. 4 |
| Softwood saw logs [1] | Billion board feet | 4. 7 | 4. 2 | 3. 9 | | | |
| | Projections—relative prices 30 percent above 1970 average | | | | | | |
| Softwood lumber | Billion board feet | 0. 9 | 0. 9 | 0. 9 | 10. 5 | 12. 0 | 12. 0 |
| Hardwood lumber | do | . 1 | . 1 | . 1 | . 6 | . 6 | . 6 |
| Softwood plywood | Million square feet, ⅜ in. | 100 | 200 | 200 | | | |
| Hardwood plywood | do | 100 | 200 | 200 | 4, 080 | 4, 200 | 4, 290 |
| Softwood saw logs | Billion board feet | 4. 4 | 4. 4 | 4. 4 | | | |
| | Projections—relative prices 10 percent above 1970 average | | | | | | |
| Pulpwood | Million cords | 3. 2 | 3. 7 | 4. 2 | 1. 3 | 1. 3 | 1. 3 |
| Woodpulp | do | 8. 2 | 10. 9 | 12. 4 | 8. 8 | 11. 6 | 14. 2 |
| Paper and board | do | 6. 3 | 6. 6 | 7. 0 | 12. 2 | 14. 0 | 15. 8 |

[1] Net exports of saw logs plus softwood lumber.

Source: Forest Service, Division of Forest Economics and Marketing Research.

**TABLE 19.—Canada's Major Wood Products Exports by Principal Destination, 1968**

| Product | Unit of measure | United States | United Kingdom | Japan | Other countries | Total |
|---|---|---|---|---|---|---|
| Logs and bolts | Million board feet | 41.9 | 2.7 | 113.2 | 3.9 | 161.7 |
| Pulpwood | Thousand cords | 804.0 | 65.4 | ---------- | 194.0 | 1,063.4 |
| Chips | Thousand tons | 1,141.0 | 68.9 | ---------- | ---------- | 1,209.9 |
| Lumber, softwood | Million board feet | 5,423.5 | 579.5 | 541.4 | 496.1 | 7,040.5 |
| Lumber, hardwood | do | 131.6 | 7.0 | .7 | 2.5 | 141.8 |
| Veneer, softwood | Million square feet, 1/10 in | 146.1 | ---------- | ---------- | (2) | 146.1 |
| Veneer, hardwood | do | 261.7 | 2.3 | ---------- | 18.9 | 282.9 |
| Plywood, softwood | Million square feet, 1/4 in | 12.5 | 489.3 | 28.9 | 180.6 | 711.3 |
| Plywood, hardwood | do | 33.5 | 2.6 | ---------- | .6 | 36.7 |
| Hardwood flooring | Million board feet | 7.1 | 6.3 | ---------- | .2 | 13.6 |
| Shingles, shakes | Thousand squares | 2,619.3 | 10.7 | ---------- | 36.2 | 2,666.2 |
| Other | Million board feet | 39.9 | 1.1 | ---------- | .2 | 41.2 |
| Newsprint | Thousand tons | 6,139.0 | 438.0 | 110.5 | 791.3 | 7,478.8 |
| Printing paper | do | 117.2 | 8.0 | ---------- | 9.0 | 134.2 |
| Fine paper | do | 1.5 | 6.1 | ---------- | 20.3 | 27.9 |
| Tissue—sanitary | do | 5.4 | 1.1 | (1) | 11.6 | 18.1 |
| Wrapping paper | do | 9.9 | 89.1 | 3.5 | 8.6 | 111.1 |
| Other paper | do | 6,312.0 | 1.4 | 1.0 | 23.7 | 6,338.1 |
| Paperboard | do | 14.6 | 173.9 | (1) | 64.4 | 252.9 |
| Building board | do | 52.4 | 6.8 | (1) | 2.8 | 62.0 |
| Dissolving-alpha pulps | do | 283.7 | 21.9 | 30.6 | 31.6 | 367.8 |
| Other pulps | do | 2,941.2 | 294.5 | 379.7 | 987.0 | 4,602.4 |

[1] Less than 100 tons.
[2] Less than 100,000 ft$^2$.

Source: Manning, G. H., and H. R. Grinnell. "Forest Resources and Utilization in Canada to the Year 2000" Department of the Environments, Canadian Forest Service. Pub. No. 1304, Ottawa. 1971.

**TABLE 20.—The Value of Canada's Wood Products Exports by Principle Destination, 1968**

| Product | In thousands of dollars | | | | | |
|---|---|---|---|---|---|---|
| | United States | United Kingdom | Japan and Australia | Europe | All other countries | Total |
| Crude wood: | | | | | | |
| Logs | 4, 535. 1 | 115. 3 | 6, 286. 6 | 579. 1 | 85. 0 | 11, 601. 1 |
| Round timber | 7, 100. 2 | | 912. 6 | | 50. 6 | 8, 063. 4 |
| Pulpwood | 16, 489. 4 | 1, 488. 7 | | 6, 511. 1 | | 24, 489. 2 |
| Chips | 7, 036. 8 | 944. 1 | | | | 7, 980. 9 |
| Other | 5, 390. 9 | | | | 61. 4 | 5, 452. 3 |
| Total | 40, 552. 4 | 2, 548. 1 | 7, 199. 2 | 7, 090. 2 | 197. 0 | 57, 586. 9 |
| Sawmill products: | | | | | | |
| Lumber | 560, 220. 8 | 37, 298. 6 | 55, 014. 6 | 30, 617. 9 | 17, 451. 8 | 700, 603. 7 |
| Railway ties | 663. 8 | | | | | 663. 8 |
| Other | 55, 672. 9 | 633. 2 | 155. 9 | 164. 2 | 965. 5 | 57, 591. 7 |
| Total | 616, 557. 5 | 37, 931. 8 | 55, 170. 5 | 30, 782. 1 | 18, 417. 3 | 758, 859. 2 |
| Veneer, plywood and building boards | 31, 575. 9 | 32, 270. 6 | 411. 8 | 13, 592. 2 | 2, 244. 4 | 80, 094. 9 |
| Millwork | 2, 195. 7 | 174. 0 | | 3. 7 | 108. 3 | 2, 481. 7 |
| Other wood materials | 4, 457. 8 | 1, 298. 9 | 65. 5 | 8. 3 | 413. 5 | 6, 244. 0 |
| Woodpulp | 516, 879. 4 | 36, 583. 9 | 88, 795. 2 | 84, 460. 8 | 26, 769. 0 | 753, 488. 0 |
| Paper products: | | | | | | |
| Newsprint | 952, 920. 9 | 61, 739. 1 | 41, 481. 4 | 15, 065. 3 | 90, 477. 4 | 1, 161, 684. 7 |
| Fine paper | 4, 603. 3 | 1, 787. 3 | 262. 2 | 597. 0 | 5, 565. 8 | 12, 815. 6 |
| Tissue and sanitary | 1, 667. 6 | 332. 2 | 312. 9 | 177. 6 | 1, 631. 3 | 4, 121. 6 |
| Wrapping | 3, 432. 8 | 10, 375. 3 | 4. 2 | 556. 1 | 681. 3 | 15, 049. 7 |
| Special | 386. 0 | 471. 6 | 184. 1 | 166. 4 | 235. 4 | 1, 443. 5 |
| Paperboard | 2, 114. 1 | 19, 117. 8 | 0. 7 | 10, 108. 8 | 494. 6 | 31, 836. 0 |
| Building | 8, 309. 1 | 667. 1 | 183. 9 | 1, 403. 6 | 1, 161. 8 | 11, 725. 5 |
| Converted | 4, 198. 2 | 2, 223. 1 | 1, 925. 0 | 564. 9 | 1, 165. 1 | 10, 076. 3 |
| Total | 977, 632. 0 | 96, 714. 1 | 44, 354. 4 | 28, 639. 7 | 101, 412. 7 | 1, 248, 752. 9 |
| Grand total | 2, 189, 850. 7 | 207, 521. 4 | 195, 996. 6 | 164, 577. 0 | 149, 562. 2 | 2, 907, 507. 9 |

Source: Fitzpatrick, J. M. "A Profile of Regional Export Trade in Forest Products," Canada, 1969. Table 20, p. 36.

## TABLE 21.—Land Area Classification in Canada and Ownership of Nonreserved Forest Land by Province, 1968

| Land class | British Columbia | Prairie Provinces | Ontario | Quebec | Atlantic Provinces [1] | Yukon Northwest Territory | Total Canada |
|---|---|---|---|---|---|---|---|
| | Million acres | | | | | | |
| Forest land suitable for regular harvest [2] | 134. 8 | 119. 6 | 115. 5 | 121. 8 | 47. 7 | 48. 8 | 588. 3 |
| Forest land not suitable for regular harvest [3] | — | 5. 0 | . 1 | 49. 9 | 8. 3 | 127. 7 | 191. 0 |
| Reserved forest land [4] | 3. 2 | 8. 1 | 5. 0 | . 1 | . 7 | — | 17. 0 |
| Total forest land | 138. 1 | 132. 7 | 120. 5 | 171. 8 | 56. 7 | 176. 1 | 796. 3 |
| Wild land [5] | 85. 2 | 170. 2 | 80. 6 | 140. 2 | 63. 0 | 757. 1 | 1, 296. 3 |
| Agricultural land | 3. 8 | 129. 1 | 17. 5 | 9. 1 | 3. 1 | — | 162. 5 |
| Other (urban, etc.) | . 7 | 3. 7 | 1. 6 | 2. 0 | . 9 | — | 8. 9 |
| Total land | 234. 1 | 485. 1 | 264. 1 | 380. 7 | 133. 2 | 967. 7 | 2, 464. 9 |
| Water | 6. 4 | 49. 4 | 43. 8 | 57. 6 | 9. 6 | 34. 0 | 200. 8 |
| Ownership of nonreserved forest land: | | | | | | | |
| Crown—Provincial | 127. 9 | 116. 9 | 103. 0 | 153. 7 | 33. 7 | — | 535. 2 |
| Crown—Federal | . 5 | 1. 2 | 1. 1 | . 2 | . 3 | 176. 5 | 180. 0 |
| Private | 6. 4 | 6. 5 | 11. 5 | 17. 9 | 22. 0 | — | 64. 2 |
| Total | 134. 8 | 124. 6 | 115. 6 | 171. 8 | 56. 0 | 176. 5 | 779. 3 |

1 Including Labrador.
2 Land capable of producing stands of trees 4-in d.b.h. and larger on 10 percent or more of the area. Shelterbelts and areas of forest land 5 acres or less and scattered are excluded.
3 Forest land with an estimated productivity whereby a rotation period of an undetermined length is required to grow a merchantable stand of trees, but with an eventual harvest possibility.
4 Forest land in parks, game refuges, water conservation areas, and nature preserves where, by legislation, wood production is not a primary land use.
5 Baren, muskeg, rock, and land with scrub, and land with forest cover substandard to forest land.

Source: Manning, G. H., and H. R. Grinnell. "Forest Resources and Utilization in Canada to the Year 2000." Department of the Environment, Canadian Forest Service. (Data supplied by the Provinces.)

## TABLE 22.—Projected Exports of Wood Products from Canada to the United States, Japan, United Kingdom, and Other Countries in the Year 2000

| Product | Unit of measure | United States | Japan | United Kingdom | Other countries |
|---|---|---|---|---|---|
| Logs and bolts | Million board feet | 13 | 135 | 5 | 8 |
| Pulpwood | Thousand cords | 260 | — | 80 | 650 |
| Pulpchips | Thousand tons | 1, 200 | — | — | — |
| Poles and piling | Thousand pieces | 255 | 220 | — | 1 |
| Railroad ties | do | 125 | — | 100 | — |
| Fenceposts | do | 6, 155 | — | — | 1 |
| Softwood lumber | Million board feet | 10, 100 | 1, 460 | 1, 145 | 900 |
| Hardwood lumber | do | 155 | (1) | 10 | 4 |
| Softwood veneer | Million square feet, 1/10 in | 30 | — | — | — |
| Hardwood veneer | do | 700 | — | 1 | 37 |
| Softwood plywood | Million square feet, 3/8 in | 5 | — | 945 | 170 |
| Hardwood plywood | do | 23 | — | 6 | (2) |
| Hardwood flooring | Million board feet | 12 | — | 32 | 1 |
| Woodpulp | Thousand tons | 5, 545 | 3, 855 | 530 | 1, 444 |
| Newsprint | do | 8, 675 | 950 | 5, 000 | 1, 560 |
| Printing papers | do | 190 | 30 | 34 | 7 |
| Fine papers | do | 6 | — | 38 | 43 |
| Tissue and sanitary | do | 4 | — | 15 | 11 |
| Wrapping paper | do | 13 | 20 | 84 | 3 |
| Paperboard | do | 6 | — | 525 | 99 |
| Building board | do | 90 | — | 2 | 6 |

1 Less than 1.0 million fbm.
2 Less than 0.5 million $ft^2$.

Source: Manning, G. H., and H. R. Grinnell. "Forest Resources and Utilization in Canada to the Year 2000." Department of the Environment, Canadian Forest Service, Pub. No. 1304. Ottawa, 1971. Tables 6 and 7, pp. 18 and 20.

**TABLE 23.—Consumption and Production of Wood Products in the Developing Region**

| | Consumption | | | Production | | |
|---|---|---|---|---|---|---|
| | 1962 | 1975 | 1985 | 1962 | 1975 | 1985 |
| | Sawnwood, million cubic meters | | | | | |
| Coniferous: | | | | | | |
| Latin America | 5.3 | 9.1 | 11.6 | 5.3 | 9.4 | 12.0 |
| Africa [1] | .8 | 1.5 | 2.2 | .3 | .8 | 1.3 |
| Near East | .8 | 1.2 | 1.7 | .3 | .6 | .8 |
| Asia [2] | 1.3 | 2.0 | 2.5 | 1.3 | 1.9 | 2.5 |
| Total | 8.2 | 13.7 | 18.0 | 7.2 | 12.7 | 16.6 |
| Broadleaf: | | | | | | |
| Latin America | 7.4 | 11.2 | 20.0 | 7.5 | 11.8 | 21.2 |
| Africa [1] | 1.4 | 2.8 | 4.5 | 2.0 | 3.6 | 5.6 |
| Near East | .5 | .7 | 1.0 | .2 | .3 | .4 |
| Asia [2] | 8.0 | 13.0 | 18.9 | 8.4 | 14.1 | 20.4 |
| Total | 17.3 | 27.7 | 44.4 | 18.1 | 29.8 | 47.6 |
| Total sawnwood | 25.5 | 41.4 | 62.4 | 25.3 | 42.5 | 64.2 |
| | Wood-based panels, million cubic meters | | | | | |
| Plywood and veneer: | | | | | | |
| Latin America | 0.4 | 0.8 | 1.9 | 0.4 | 1.1 | 2.8 |
| Africa [1] | .1 | .4 | .7 | .2 | 1.0 | 1.8 |
| Near East | .1 | .2 | .3 | .1 | .2 | .3 |
| Asia [2] | .4 | 1.2 | 2.8 | .7 | 2.8 | 5.1 |
| Total | 1.0 | 2.6 | 5.7 | 1.4 | 5.1 | 10.0 |
| | Million metric tons | | | | | |
| Fiberboard and particleboard: | | | | | | |
| Latin America | 0.2 | 0.9 | 3.0 | 0.2 | 1.1 | 3.1 |
| Africa [1] | — | .1 | .2 | — | .1 | .2 |
| Near East | — | .1 | .2 | — | — | .1 |
| Asia [2] | .1 | 5 | 1.4 | — | .5 | 1.4 |
| Total | .3 | 1.6 | 4.8 | .2 | 1.7 | 4.8 |
| Total wood-based panels [3] | .9 | 3.2 | 8.2 | 1.0 | 4.8 | 10.8 |
| | Paper, paperboard, and pulp, million metric tons | | | | | |
| Paper and paperboard: | | | | | | |
| Latin America | 2.7 | 6.8 | 13.0 | 1.8 | 5.0 | 11.2 |
| Africa | .3 | .7 | 1.6 | .1 | .4 | 1.1 |
| Near East | .4 | 1.1 | 2.8 | .1 | .4 | .9 |
| Asia | 1.4 | 4.0 | 8.9 | .9 | 3.5 | 7.9 |
| Total | 4.8 | 12.6 | 26.3 | 2.9 | 9.3 | 21.1 |
| Of which newsprint | 1.0 | 3.0 | 6.3 | — | — | — |
| Printing, and writing | 1.2 | 3.0 | 6.5 | — | — | — |
| Other | 2.6 | 6.6 | 13.5 | — | — | — |

**TABLE 23.—Consumption and Production of Wood Products in the Developing Region—Continued**

| | Consumption | | | Production | | |
|---|---|---|---|---|---|---|
| | 1962 | 1975 | 1985 | 1962 | 1975 | 1985 |
| | Paper, paperboard, and pulp, million metric tons | | | | | |
| Pulp:[4] | | | | | | |
| Latin America | 1.4 | 4.0 | 9.4 | 1.1 | 3.6 | 8.0 |
| Africa | | .3 | 1.0 | .1 | .4 | 1.0 |
| Near East | .1 | .3 | .8 | | .2 | .4 |
| Asia | .8 | 3.1 | 7.2 | .9 | 2.9 | 7.0 |
| Total | 2.3 | 7.7 | 18.5 | 2.1 | 7.1 | 16.4 |
| | Consumption and production of roundwood,[5] production, and consumption of fuelwood, million cubic meters | | | | | |
| Latin America | 7.7 | 10.4 | 12.4 | 203 | 193 | 176 |
| Africa | 8.9 | 11.9 | 15.3 | 177 | 217 | 259 |
| Near East | 5.7 | 8.0 | 11.0 | 24 | 28 | 32 |
| Asia | 8.5 | 16.1 | 21.3 | 230 | 280 | 330 |
| Total | 30.8 | 46.4 | 60.0 | 634 | 718 | 797 |

1 Does not include South Africa.
2 Does not include Japan.
3 Cubic meter plywood assumed equal to 0.6 metric ton.
4 Includes mechanical, chemical, semichemical, and other fiber pulp; excludes dissolving pulp.
5 Wood used in the round form.

Source: FAO. "Indicative World Plan for Agricultural Development." Vol. 1. Rome, 1970. Data from tables 1 and 2, pp. 310-311.

**TABLE 24.—Soviet Production of Wood Products 1960-69, and Projections to 1985**

| Product | Actual production | | | | | Projected production | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1960 | 1965 | 1968 | 1969 | Plan 1970 | Ekstrom 1970 | Plan 1975 | Ekstrom 1975 | Ekstrom 1980 | Ekstrom 1985 |
| Sawtimber (million cubic meters) | 262 | 274 | 290 | 273 | 278 | 297 | NA | 312 | 327 | 342 |
| Sawnwood (million cubic meters) | 106 | 111 | 110 | NA | 116 | 111 | NA | 114 | 117 | 120 |
| Plywood (thousand cubic meters) | 1,354 | 1,712 | 1,832 | NA | 3,500 | 1,970 | 4,800 | 2,370 | 2,860 | 3,440 |
| Fiberboard (million square meters) | 68 | 138 | 173 | NA | 530 | 220 | NA | 370 | 600 | 920 |
| Particleboard (thousand cubic meters) | 161 | 798 | 1,507 | NA | 3,059 | 2,100 | 7,000 | 4,240 | 7,500 | 11,600 |
| Woodpulp (thousand metric tons) | 2,282 | 3,234 | 4,341 | NA | 8,700 | 5,090 | NA | 7,480 | 10,500 | 14,000 |
| Paper (thousand metric tons) | 2,334 | 3,231 | 3,955 | 4,000 | 5,100 | NA | 11,200 | NA | NA | NA |
| Paperboard (thousand metric tons) | 893 | 1,449 | 2,015 | 2,330 | 4,300 | NA | 8,700 | NA | NA | NA |
| Paper and paperboard (thousand metric tons) | 3,227 | 4,680 | 5,970 | 6,330 | 9,400 | 6,960 | 19,900 | 10,000 | 14,000 | 19,200 |

Source: Ekstrom, T. "Developmental Trends and Export Potential of Soviet Forestry." Department of Forest Economics, Royal College of Forestry, Stockholm, Sweden. 1970. Table 3.1. p. 25.
NA=Not available.

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# appendix K

BY JEROME F. SAEMAN [1]

# Solving Resource and Environment Problems by the More Efficient Utilization of Timber

## INTRODUCTION AND SUMMARY

In a nation that leads all others in consumption of resources and energy, wood is being looked on with increasing favor. This is accounted for by a number of facts, including its excellent inherent properties, domestic availability, renewability, and its low environmental impact.

With current levels of management and with current restraints on harvesting from national forests, timber supplies to the year 2000 are expected to increase by only 15 percent. The resulting economic scarcity and higher prices will lead to more use of alternative materials with their higher energy demands and higher environmental impact. Intensified management is called for, but added supplies of timber by that route come slowly. A large increase in supplies of structural products for near-term use is possible by more efficient utilization of the wood grown. The return on such investment is typically much higher than the return resulting from growing trees to provide the same added increment of wood products.

Historically, the wood industry has been highly dispersed and one of modest technological sophistication. Most of the saw logs are processed in a manner which involves relatively low capital investment, low management cost, low risk, and usually just adequate profit. While there are explanations for this situation, it does result in an inefficient use of the resource. The national interest now calls for more use of knowledge, technology, capital investment, and skills to extend our dwindling resources and protect our threatened environment. All this, it appears, can be done and higher profits achieved as well, but investment, innovation, and risks are involved. Much of the industry is aware of possible improvements in efficiency, but for many processors, an uncertain wood supply is said to be an inhibiting factor. Lack of adequate financing is frequently another problem; and the competition for investment funds includes new measures required to comply with pollution control regulations. Such problems, however, are solvable as pioneering firms are demonstrating.

There are many routes by which the utilization efficiency of our timber resources can be increased. For the purposes of this paper, four were selected for their high impact and feasibility. Others might have been chosen.

1. *Improved efficiency in the conversion of saw logs to lumber.*—Lumber constitutes some 60 percent by weight of the solid wood products in this country. Concern about a saw log shortage invites consideration of improved efficiency in the conversion of logs to lumber. The lumber recovery factor nationwide approximates 6.5 fbm/ft$^3$. This is only 40 percent of the wood in the log. With no new equipment, but with investment in management and maintenance, it is believed that the average mill can very profitably increase its recovery by 10 percent. The recovery of lumber from logs is dependent on very many factors, primarily on log size and quality. Speaking in general terms, however, the installation and proper use of available equipment could raise average recovery to 8.7 fbm of dimension lumber per cubic foot. Some mills now operate at this level and higher. The addition of automated systems based on predetermined arithmetic solutions to optimum sawing problems raises the recovery factor substantially, say another 10 percent, by the elimination of human error.

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In 1970, the Forest Service estimated that lumber recovery from available logs would increase at a rate of 3 to 4 percent per decade as a result of mill modernization. This was a valid estimate in 1970, but it is hardly an adequate goal in 1973. Our problems are perceived differently today.

On the basis of case histories we can talk in terms of what might be required to raise the national average lumber recovery factor by 20 percent. If the estimated 3- to 4-percent improvement per decade remains valid, a 20-percent improvement would not be achieved till well into the next century. A technical assistance program with public investment of, say, $10 million per year might reduce the time to 10 years or less, all assuming sound incentives and management motivation. Such investment of public funds would not be a continuing expense. Improvements in technology in a few plants would be sustained, and have a stimulating effect on the industry generally.

More efficient utilization should have the direct effect of raising both yields and profits. An indirect effect is to increase the importance and value of timber to the national economy, thus stimulating intensified timber management. In this sense, improved utilization is the key to better forestry in the United States.

Available information does not permit a more precise statement of costs and possible rate of improvement in lumber processing. The benefit-to-cost ratio is clearly very favorable. Studies are underway at the Forest Products Laboratory to define the opportunities in more specific terms.

Additional impressive gains in the production of lumber products are promised by other approaches in various stages of research and commercial development. These include end jointing, edge-gluing systems, and laminated veneer lumber. This latter provides a 50-percent higher yield, higher average properties, and a great decrease in variability of the product. It is now in the early stages of commercialization and is believed to have a bright future as a superior wood-based material of construction. Its superior performance as a material adds to savings of the wood resource.

2. *The practical equivalent of plywood and lumber from small logs and residues.*—Urgent forestry issues of the day have to do with the environment and with softwood sawtimber supplies. Forest residues constitute a major component of the environment problem. The amount of forestry residues and the standing residues in defective trees is so great that successfully converting the readily accessible fraction to structural products could take care of the sawtimber deficiency for decades into the future.

While high urgency is attached to improved efficiency in the production of lumber, we are overdue in moving on to a new generation of timber-based products which will supplement those already established These will be a family of residue-based reconstituted wood products designed to have a range of properties suited to various applications. First in this array is ordinary particleboard based on manufacturing residues and intended primarily for nonstructural applications. Its firm place in the market is shown by its growth rate of over 20 percent per year. This product is being followed by a type of flake-based particleboard which qualifies as a structural material. The important shortages of the day, however, are in structural lumber and plywood. Remaining to be fully developed is a high-performance flaked-based particleboard which is the practical equivalent of plywood. By alinement of flakes or strands, the technology can be extended to provide the practical equivalent of lumber. Such high-performance products promise to have a major effect in relieving the sawtimber shortage that looms ahead.

In the fields of agriculture, fuels, and minerals, industry and government have engaged in research, development, and demonstration work directed toward the accelerated introduction of new technology. There has been far less such activity in the wood industry. The time has come, however, to react to the needs that are upon us. Reconstituted products of this sort are not mere substitutes for familiar wood products, they are new products, and they will require a new body of information for their effective production and use. Available basic technical data provide excellent assurance of ultimate success. The importance of this potential solution to our timber supply problem warrants a massive coordinated attack. Such a program should begin now.

3. *Increased use of residues for pulp production.*—More than 7 billion fbm of softwood timber classed as saw log size was converted into pulp for paper manufacture during the year 1971. Lower grade raw material such as smaller sized trees removed in thinning, together with residues

from forestry and logging operations, could have substituted for much of the saw-log-size material. Major problems in the use of such residues include harvesting, transportation, storage, and bark removal from salvaged rough chips. Important progress has been made recently in all these areas. It is also being discovered that there are usually net economic advantages in pulping chips with substantial amounts of bark rather than holding to traditional requirements for bark removal. Further research development and application in these areas will relieve the pressure on roundwood capable of growing into larger sawtimber sizes.

4. *Improved efficiency in the use of wood in housing.*—The early 1930's saw the establishment of the stressed-skin principle permitting great economies in the use of wood in homes. Such principles have been adopted and applied in prefabricated, modular, and mobile home construction, but they have not affected the bulk of housing represented by onsite construction. It is widely believed that the combination of a number of economies would permit the construction of four durable houses with the material now required for three. The use of adhesives to fasten plywood or other panel products to framing members results in greatly increased efficiency. In more innovative systems, stressed-skin or sandwich panels can permit a 40-percent savings of wood. Mechanical grading of lumber used in conjunction with design improvements can achieve a 20-percent saving in material for framing. These potential savings are impressive, and with successful implementation can relieve our supply problem. Much can be done to accelerate the acceptance of innovative systems and improved practices by supplying sound technical information to code and lending authorities. Improving the flow of information can have substantial effects.

This is a crucial time for forestry and the wood industry. Timber ranks with our most prominent resources in terms of tonnage and value to the economy. We are now passing from a period of abundance to one of scarcity, not only for wood but for all materials. We are growing timber at a rate perhaps half as fast as it could be grown. From the wood that is grown we could have higher yields of higher performance products. The products in turn can be used more efficiently. From a given area of present-day forest, we could hope to get twice as many houses as we do now. The national interest requires that we vigorously pursue the goal of using this resource to best advantage.

## PART I. RESOURCE AND ENVIRONMENTAL CONSIDERATIONS

This environmental decade has brought a new appreciation for forests, and unprecedented concern over their use and misuse. Forests contribute greatly to the quality of our lives and the contributions range from the esthetic to the utilitarian. A great challenge in this decade is to gain an improved understanding of resource and environment problems and needs, and to fit forests into this picture.

Life is sustained through the use of resources, but their use usually results in depletion or other adverse effects. Recently we have become very aware of the finite nature of our resources, of an exploding world population, of even more rapidly rising demands, and of the increasing damage being inflicted on the environment. Our rational course at this time is to examine alternatives and to seek a balance in resource use, which in the long run promises the greatest benefits and the least adverse effects. This discussion, while concentrating on timber as an industrial raw material, in no way implies that other values of the forest are less important. It is presumed that a high level of timber production is fully compatible with other values of the forest. Careful study of many interacting considerations leads to the conviction that we should affirm the unique values of our forest resource and maintain positive policies favoring the efficient production and use of timber. Such policies are a means of reducing pressure on nonrenewable resources, on energy sources, and on the environment; and they offer social and economic advantages as well.

Ecologists have succeeded in impressing on us the fact that everything is connected to everything else. This, of course, is not a new idea, but current and prospective pressures give it new importance. Matters of population, adequacy of resources, pollution, energy demands, balance of trade, and national security cannot be considered separately. There are often hidden costs which are paid by society. We have not advanced to the point of carrying out exact quantitative technology assessments relating to such decisions, but in the interim we must proceed on a qualitative and semiquantitative basis.

## The Importance of Timber as a Resource

It is necessary in considering policies relating to timber to be aware of its importance to the economy. Figure 1 is a graph taken from a publication by Harrison Brown (*8*)[2] in which a comparison is provided between the production of wood and other materials. The data, plotted on a logarithmic scale, show that timber as harvested roundwood is similar in weight to the sum of our production of steel, aluminum, cement, and plastics.

Dwight Hair, in a widely quoted publication (*14*), made estimates of the value added and employment attributed to timber. He then made summations and found that nearly 6 percent of the Nation's gross national product originated in timber-based economic activities, and 1 out of 20 workers were employed in such activities.

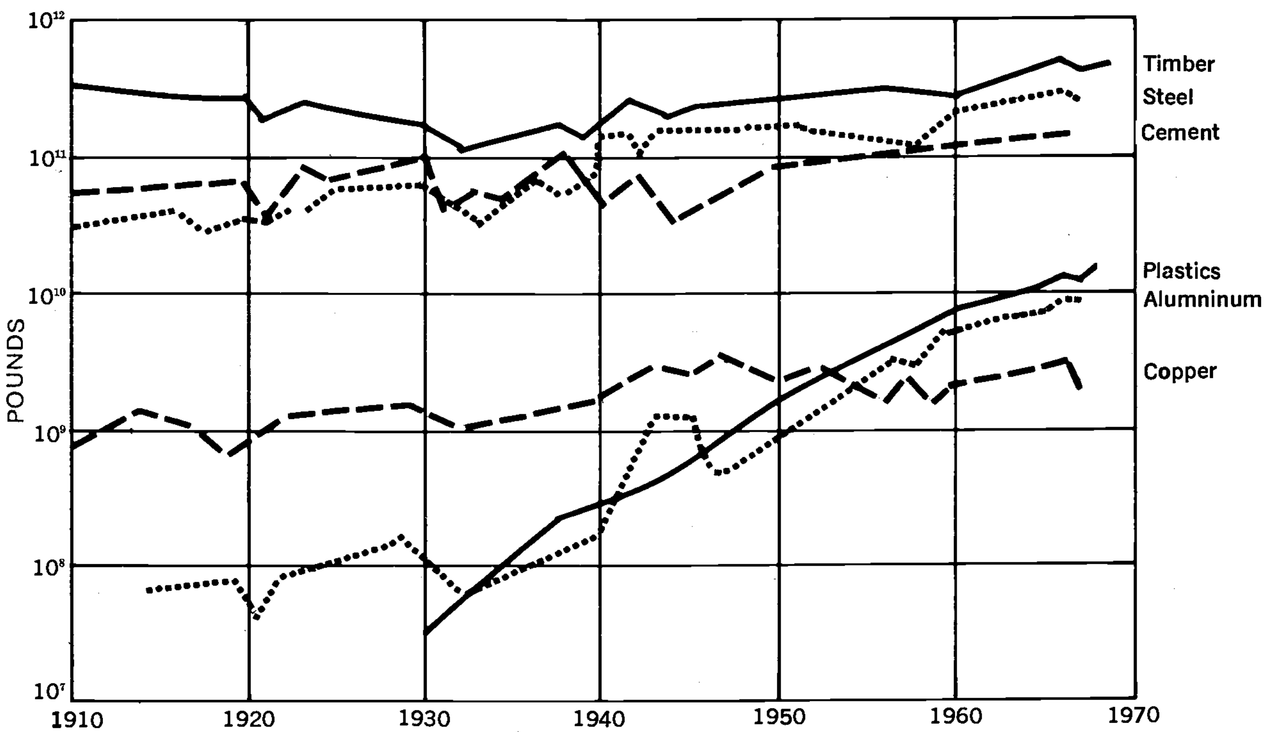
Much of the past importance of wood as a resource was due to the fact that it has been a materials bargain. It offers remarkable properties per pound of material and per dollar of cost. The popularity of wood houses testifies to the fact that no other structural material matches it in these regards. The price of wood has been rising relative to other materials, and this tends to reduce its advantage, as evidenced by the increased use of substitutes. While wood has very favorable properties at a favorable cost, its full potential as a material has not been fully exploited. Realizing and exploiting its full potential will add to the value of the primary resource and improve the competitive position of wood products. This latter is suggested not merely as a goal leading to improved profitability of the wood industry, but as one which also reduces net cost to the consumer and improves the long term outlook for resources and the environment.

[2] Italicized numbers in parentheses refer to literature cited at end of this appendix.

## The Resource and Environment Situation

Concern for resources and the environment in this country has a long history. The first great wave of conservation began at the end of the last century. Much of its early leadership was drawn from the forestry profession, and the preservation and wise use of forests were central issues. In the thirties there was another wave of conservation activity but this was motivated more by social concerns

**FIGURE 1.—Production of Key Materials (U.S.)**




Source: See reference (*8*).

and the need for public works programs during the great depression than by concern for resources and the environment.

World War II, with its unprecedented demand for materials, aroused concern for the strategic importance of resources, and this in due course led to the Paley report (*31*). Though foreseeing little cause for immediate alarm, the authors of this report, published in 1952, raised caution signals concerning the long term outlook. Meanwhile, there was an increasing number of articulate and persuasive people who aroused public interest in resource and environment matters. Active conservation-oriented groups began a period of rapid growth and increasing influence on public opinion. Resources for the future with the support of the Ford Foundation undertook excellent scholarly studies. In 1966, the National Academy of Sciences established its Resources and Man Committee and that group's report, "Resources and Man" (*29*), was published in 1969. The Club of Rome supported work by Forrester and Meadows of MIT. A resulting popularized report, "The Limits to Growth" (*24*), drew extraordinary public attention to its message on the impact of exponential growth on the finite resources of the earth. Growing public and congressional interest and concern led to the Resources Recovery Act of 1970 which created a National Commission on Materials Policy. The Commission's report is expected to offer a comprehensive and balanced summary of our resources situation. Even without such a statement we now know enough about the outlook to arrive at conclusions concerning the future importance of wood as a resource.

Within our Nation we have a growing population with demands outrunning supplies. By about 1985 we will be over 50 percent dependent on imported petroleum. Within the relatively few years to the end of the century we will be over 50 percent dependent on imports for most nonrenewable materials. Looking at the rest of the world we see a more rapidly rising population doubling in size in about 35 years. More importantly we see a still more rapid worldwide increase in per capita demand, and the increasing competition for materials can only become more severe. Environment and pollution problems increase with increasing numbers of people, with increasing energy consumption, and with increasing processing, use, and disposal of materials. Within the United States there is a developing energy shortage which for decades will have a marked effect on industry and consumers. Just how all these developments are viewed depends on the balance between optimism and pessimism in one's soul. Most people, of course, pay little attention to the situation. A few view it with deep alarm, even panic. Rarely, however, does a person examine it seriously and remain complacent.

Increased use of wood alone, of course, will not solve our resource and environment problems. In view of inevitable worldwide developments, every resource must be used and, if possible, reused, with more care and efficiency. Wood in the past has served us very well, and in terms of performance and economy it remains the material of choice for many applications. As far as the future is concerned we are driven to the conclusion that the long-term needs of the people and the Nation will be served better by increased production and improved use of timber than by increased reliance on nonrenewable minerals. Minerals require large amounts of energy for their processing, generally have high environmental impact, and increasingly are drawn from foreign sources. The advantages of timber over alternative industrial raw materials will be developed at greater length in the following portion of this report, and opportunities will be outlined for alleviating the timber supply problem by more efficient utilization.

### Timber—Its Renewability and Domestic Availability

The renewability of wood is its greatest asset in a world threatened with material shortages caused by growing numbers of people and compounded by increasing per capita consumption. Forests occupy one-third of the Nation's land and nearly one-third the land of the world. Forests of the United States now produce hundreds of millions of tons of wood per year. If unharvested and unused, an amount equal to the annual growth would be recycled in the great scheme of nature. Wood is produced and available for use whether we use it or not. Through well-known, long-established management practices, the productivity of our forest land could be doubled. If we choose to do so, the productivity of selected land areas well suited to timber production could be much more than doubled while forest land valued for other purposes is kept out of production. On the average, only a very few percent of forest land need be harvested per year (perhaps 2 percent), and the forest can be quickly reestablished to create a new crop. With further development and application, forest genetics can eventually function as another multiplier in timber production.

The efficient production of timber carried out on suitable land and with sound practices can be continued in perpetuity. The nutrient demands are a very small fraction of those required for food grains and forage. The environmental impact in terms of wind and water erosion and contamination of ground water and waterways is small compared to that characteristic of annual crops. In certain populous areas, annual crops have been grown on the same land for millennia. In Europe, trees have been grown as a crop for many centuries. Both practices, with care, can be continued indefinitely.

## Alternative Materials

In earlier and simpler times, decisions on the use of materials were made primarily on the basis of direct costs. To a very large degree, this remains the case today. Increasingly, however, we will have to pay more attention to the options which are open to us and make choices between alternatives which take into account not only the direct cost but the indirect or hidden costs as well.

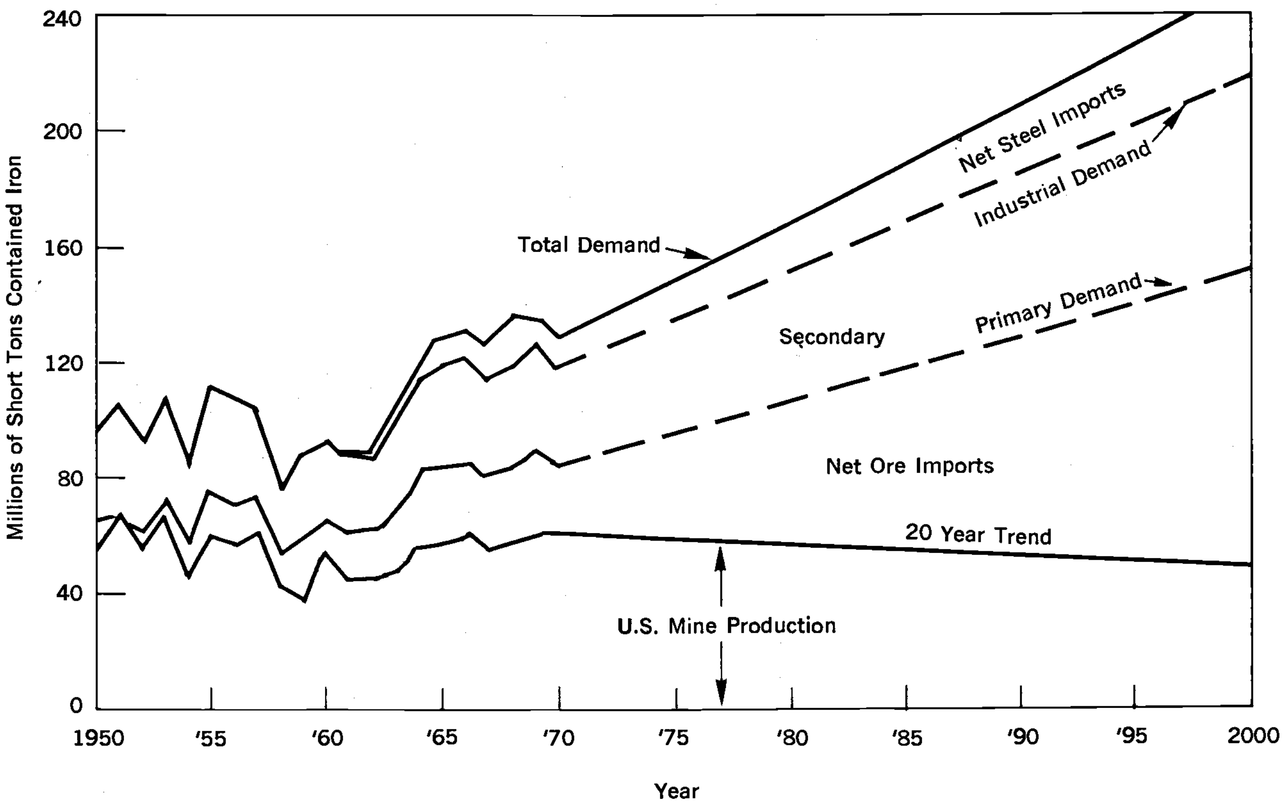
The main alternatives to wood as a structural material are steel, aluminum, brick, and concrete. Plastics serve in smaller volume applications which tolerate higher costs.

The special characteristics of wood, steel, and aluminum are their costs and favorable strength properties in relation to their weight. Lacking the three materials, concrete can be used to make up the deficiency, but it is an alternative to the others only in a limited sense.

### Iron and Steel

Iron and steel supply and demand for the decades ahead is discussed in the interim report of the National Commission on Materials Policy (*27*). Figure 2, taken from that report, shows that U.S. iron mine production will decline to the end of the century. At that time, some 70 percent of new supplies of iron in the form of ore and steel

**FIGURE 2.—U.S. Iron Demand and Supply**




Source: Reference (27).

will be drawn from foreign sources. In regard to iron and steel production, the Interim Report states:

> Environmental problems associated with the production of iron, from the mining of ore to recovery from scrap, are ubiquitous, pervasive, and massive in size. * * * The annual production of almost 60 million tons of iron in ore, requiring the mining or removal of 380 million tons of material creates problems in land use, waste disposal, restoration of the landscape, and transportation of ore to the point of use. Air, water, and waste disposal problems beset the entire process of iron and steelmaking from ore to shipped steel products. Air pollution problems are associated with blast furnace, coke plant and steel melting operations, and captive power plants. Water problems arise from the discharge of large volumes of cooling water and from the disposal of waste products. * * * Solid waste problems include disposal of mine overburden, concentrate tailings, sludges, slags, and dust from air pollution control devices.

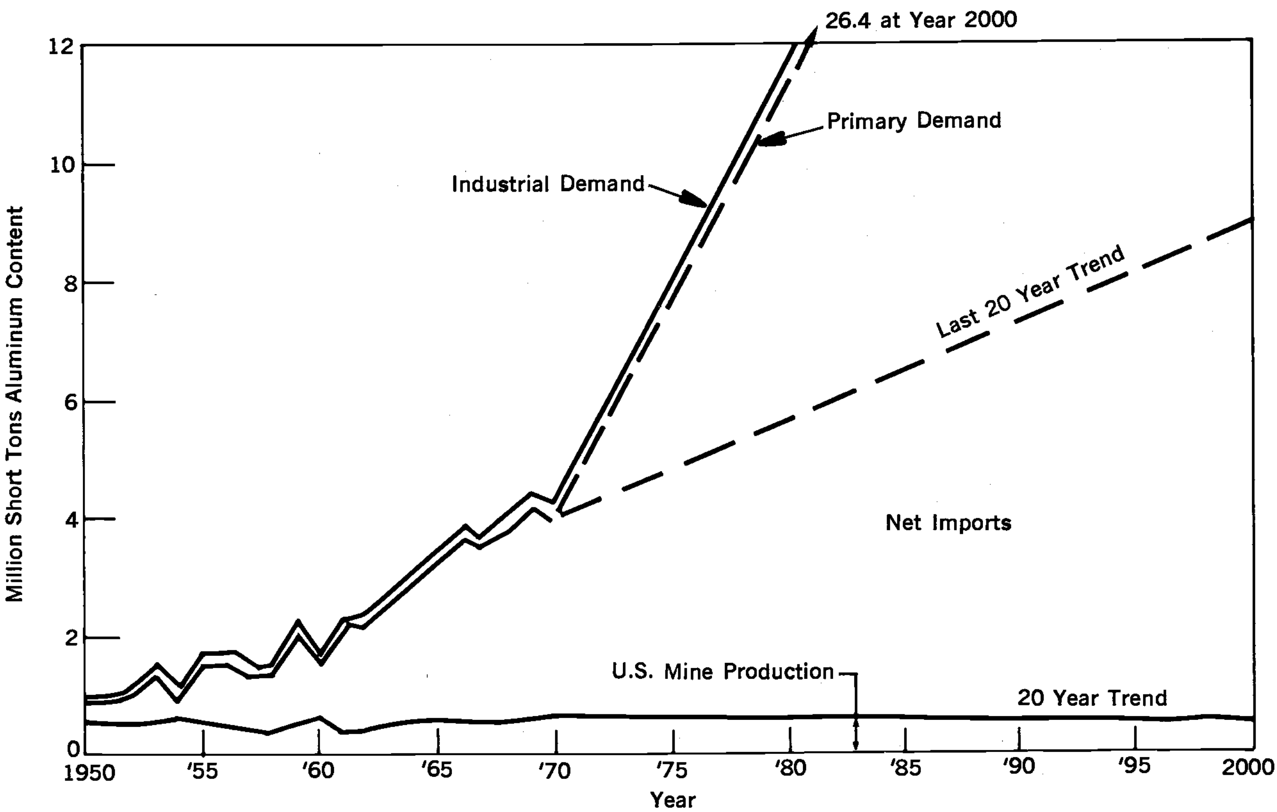
### Aluminum

The production of aluminum starts with the mining of bauxite and coal, with the usual environmental impacts of such operations. Again, quoting the National Commission on Materials Policy (*27*):

> The reduction of aluminum metal from its oxide is a very energy-intensive process and accompanied by all environmental control problems germane to electric power generation. Additional problems can be created by fluorine-containing dust and gases emitted from alumina reduction cells. The disposal of waste red muds from present-day Bayer plants treating bauxite poses a problem that will become more critical with time. However, land use conflicts also would accompany any large-scale employment of domestic clays as a primary source of aluminum.

Figure 3 from the interim report shows anticipated aluminum demand and supply to the end of the century and the small portion likely to be provided by U.S. mines. Aluminum production is low compared to steel and wood, but the anticipated rate at which aluminum use will increase, greatly exceeds that of either of the other two. Anticipated demand for aluminum is expected to rise more than sixfold from 1970 to the year 2000 as a result of aggressive pursuit of markets, prominent among which is housing. Overall demand growth in the

**FIGURES 3.—U.S. Aluminum Demand and Supply**




Source: Reference (27).

rest of the world is expected to be greater than in the United States.

The world bauxite reserves at such rate of growth will be consumed in a few decades. Aluminum, however, is a very abundant element. At a price 30 percent higher than the average 1970 price, the supply of aluminum is virtually unlimited; but with lower grade sources will come greater pollution problems. Aluminum is said to be easily recycled. Its high price should in theory favor salvage and recovery, but in 1970 old scrap took care of only 4 percent of U.S. industrial demand, down from 8 percent in 1951.

The large power requirement for alumina reduction results in a high environmental cost, but now a new problem has arisen. Recent increases in fuel cost in the United States have raised the very real possibility that new aluminum smelter capacity will not be built in the United States (*3*). This means that expanded use of aluminum will require the importation not merely of ore, but also of metal, further increasing our dependence on others and adding to balance-of-trade problems.

## Environmental Considerations

Future limitations on industrial activity might well be set as much by environmental considerations as by the adequacy or availability of resources.

Minerals, as evident from the discussion above, are recovered in mining operations which typically involve the moving of overburden and the disposal of tailings. The smelting operations involve great quantities of heat and electric power, both derived mainly from coal. Coal causes its own serious forms of damage to the land, air, and water, both in its mining and combustion. The damage done to the landscape in much mining lasts indefinitely, and the cumulative, total with the passage of time, is distressing to contemplate. The residues of mining and mineral processing usually represent a great mass compared to the weight of the final product. Such residues usually have no value and often present serious problems.

Timber production involves undeniable environmental impacts. It is most evident and visible in the case of the first harvesting of old-growth timber containing a high percentage of defective trees. Some sensitive areas have been logged which never should have been logged. Some have been logged improperly. In the case of well-managed stands which were properly harvested, the problems are minimal. With increasing use of tree-length logging and other improved practices, utilization can be quite complete and there is little environmental threat other than the appearance of newly logged lands. Unlike the tailings of mines and smelters, wood residues are finding increasing use, and this trend can be accelerated.

Electric power and energy sources generally are considered to carry great hidden costs. These hidden costs include those associated with petroleum and coal production, with sulfur oxides, particulates, and thermal pollution, and with the hazards inherent in nuclear reactors and radioactive wastes. Energy supply problems in the United States will be severe for decades. For the longer term, we can hope that breeder reactors and nuclear fision will close the gap. For a very long time, however, energy costs will rise and create increasing environmental threats.

In a recent paper, Makhijani and Lichtenberg examined the question of energy and well-being (*22*). They estimated the energy and materials consumption according to the goods consumed in the United States. The amount of energy needed to produce unit amounts of basic materials are shown in table 1. The units of energy shown are kilowatt-hours thermal (kWht).

In their Paper, Makhijani and Lichtenberg point out that some 25 percent of the energy consumed in the United States is used in transportation, and some 20 percent for residential use for space heating, lighting, and air-conditioning. The production of materials requires about 13 percent of the energy consumed.

Now that we have become aware of energy as a key factor in environmental quality, means must be considered to reduce its waste in all segments of the economy. Space heating, air-conditioning, lighting, and transportation all offer opportunities for increased economy. When considering the materials segment, the low energy demand for wood is very apparent. According to Makhijani and Lichtenberg's data, the energy consumed per ton of lumber, rolled steel, and rolled aluminum stands in the ratio of 1 to 8.4 to 45. For some applications, steel, aluminum, and wood might substitute one for another on a pound-for-pound basis. A generalized estimate of substitutability, however, is that for beams, utility poles, or stressed-skin composites, the ratio might be of the order of 0.5 to 0.75 parts of steel or aluminum to 1 part of wood. Even at 0.5 to 1, we find that wood structures might require a quarter as much energy as steel, and a 20th as much as aluminum.

**TABLE 1.—Energy Consumption in Basic Materials Processing (22)**

| Material | Total kWht per ton | Number of tons consumed (1968)×10⁶ | Total energy, $10^{10}$ kWh (1968 consumption) |
|---|---|---|---|
| Rolled steel | 12, 600 | 90 | 113 |
| Rolled aluminum | 67, 200 | 4. 07 | 27. 4 |
| Cement | 2, 300 | 74. 0 | 17. 0 |
| Sand and gravel | 21 | 918. 0 | 1. 8 |
| Lumber [1] | 1, 510 | 37. 5 | 5. 7 |

[1] Assuming 1 ton per 1,000 fbm.

With so much of our energy going to space heating and cooling, the thermal insulation properties of wood and the ease with which conventional and innovative wood construction can be insulated takes on new importance, and may be even more significant than energy saved in the use of wood as a material.

Dane (*10*) estimated the hidden environmental cost of alternative materials available for construction. Table 2 taken from his report shows his summation of the new solid materials processed to make 1 ton of product. He then went on to estimate social costs as a function of costs of avoiding environmental impacts from production of steel, aluminum, concrete, and wood. Thus, he estimated the social cost of air pollution from steel production as being equivalent to the cost of preventing such pollution. His estimates placed social cost due to environmental impact of aluminum, concrete ready-mix, and steel at 28, 24, and 9 percent of the 1970 selling price as compared with lumber at 2 percent. Dane carefully pointed out the difficuties and uncertainties in such estimates. Still, it appears that use of wood structural materials involves low net environmental impact. Recently,

**TABLE 2.—Tons of New Solid Materials Involved in the Production of 1 Ton of Product, 1970 (*10*)**

| Structural material | Direct raw materials (tons) | | Direct raw materials plus other materials involved (tons) | |
|---|---|---|---|---|
| Aluminum (primary ingot) | Bauxite | 4. 6 | Bauxite | 4. 6 |
| | | | Overburden | 6. 3 |
| | Coal | . 7 | Coal | . 7 |
| | | | Waste | 2. 9 |
| | Soda ash | . 4 | Soda ash | . 4 |
| | Lime | . 12 | Lime | . 12 |
| | Pitch | . 1 | Pitch | . 1 |
| | Cryolite | . 08 | Cryolite | . 08 |
| | Aluminum fluoride | . 03 | Aluminum fluoride | . 03 |
| | Fluorspar | . 003 | Fluorspar | . 003 |
| | Total | 6. 033 | Total | 15. 233 |
| Concrete block and ready-mix concrete. | Portland cement | . 14 | Portland cement | . 14 |
| | Sand and gravel | . 67 | Sand and gravel | . 67 |
| | Crushed and broken stone | . 19 | Crushed and broken stone | . 19 |
| | Total | 1. 00 | Total | 1. 00 |
| Lumber | Roundwood | 2. 64 | Roundwood | 2. 64 |
| | | | Left in woods | . 75 |
| | | | | 3. 39 |
| Steel | Iron ore | 1. 53 | Iron ore | 1. 53 |
| | | | Mine waste | 2. 50 |
| | | | Benefication waste | 1. 82 |
| | Coal | . 96 | Coal | . 96 |
| | | | Mine waste | 2. 90 |
| | Limestone and other flux | . 25 | Limestone and other flux | . 25 |
| | Total | 2. 74 | Total | 9. 96 |

the National Commision on Materials Policy contracted with the National Academy of Science to make a detailed study of the impact of various construction materials on the environment that should add much to our knowledge of this subject.

In summary, timber is a major industrial raw material in terms both of sheer mass and its effect on the economy. The Nation faces problems which just a few years earlier were scarcely recognized. These have to do with adequacy of resources, energy demands, and environmental quality. When viewed in the light of future needs, and from an ecological standpoint, wood is our most nearly ideal major construction and industrial raw material.

The unusual place of wood among resources has long been recognized. Many countries besides our own have encouraged the growing of timber through technical assistance, incentives, tax concessions, and by other means. This, in retrospect, has been a wise policy and one which is widely considered to have a favorable benefit-to-cost ratio. As time goes on, the hidden costs associated with alternative materials will increase adding to the social advantages of using wood where suitable in industry and construction.

## PART II. EXTENDING THE TIMBER RESOURCE THROUGH IMPROVED UTILIZATION

### The Problem

The President's Advisory Panel on Timber and the Environment was established in response to the rapidly rising prices of structural lumber and plywood. Since the establishment of the Panel, the supply and price problems have accentuated.

This discussion responds to the Panel's request for an estimate of

> * * * the extent to which new research and developments in the use of wood may lead to greater economy and hence enable the Nation to meet its housing goals without running short of timber.

#### Research in the Wood Industry

The wood industry's ranking in the level of research and development during the period 1957–67 is shown in figure 4 (*30*). Expenditures for wood research, low to begin with, over that period showed no growth while expenditures for research by most other industries roughly doubled. Separate data on the wood industry are no longer published, but it is a common impression that research effort in terms of manpower has declined. For many reasons, the wood industry has operated historically at a low level of technology. The highly dispersed nature of the industry makes it difficult to create and maintain effective research programs. Research is the main tool with which industries create and respond to change. To meet the challenge of change, the wood industry, and industry associations need to put more effort into research and the application of established technology. Given the present state of the art, much could be done directly to achieve more efficient and profitable operations. Research can then show the way to still greater gains.

#### Increased Supplies of Softwood Structural Products

The immediate need is to increase supplies of softwood structural products. There are two primary means by which this can be done. One is to grow and harvest additional timber; the other is to increase the yield of products from timber already grown. The effect of the two is similar; any increase in product yield is essentially equivalent to the same percentage increase in timber harvest or timber growth. The two approaches complement one another in that increased product yield can mean a higher price for logs and thus stimulate increased investment in intensity of forest management. This in turn increases long-term resource supply and environmental benefits.

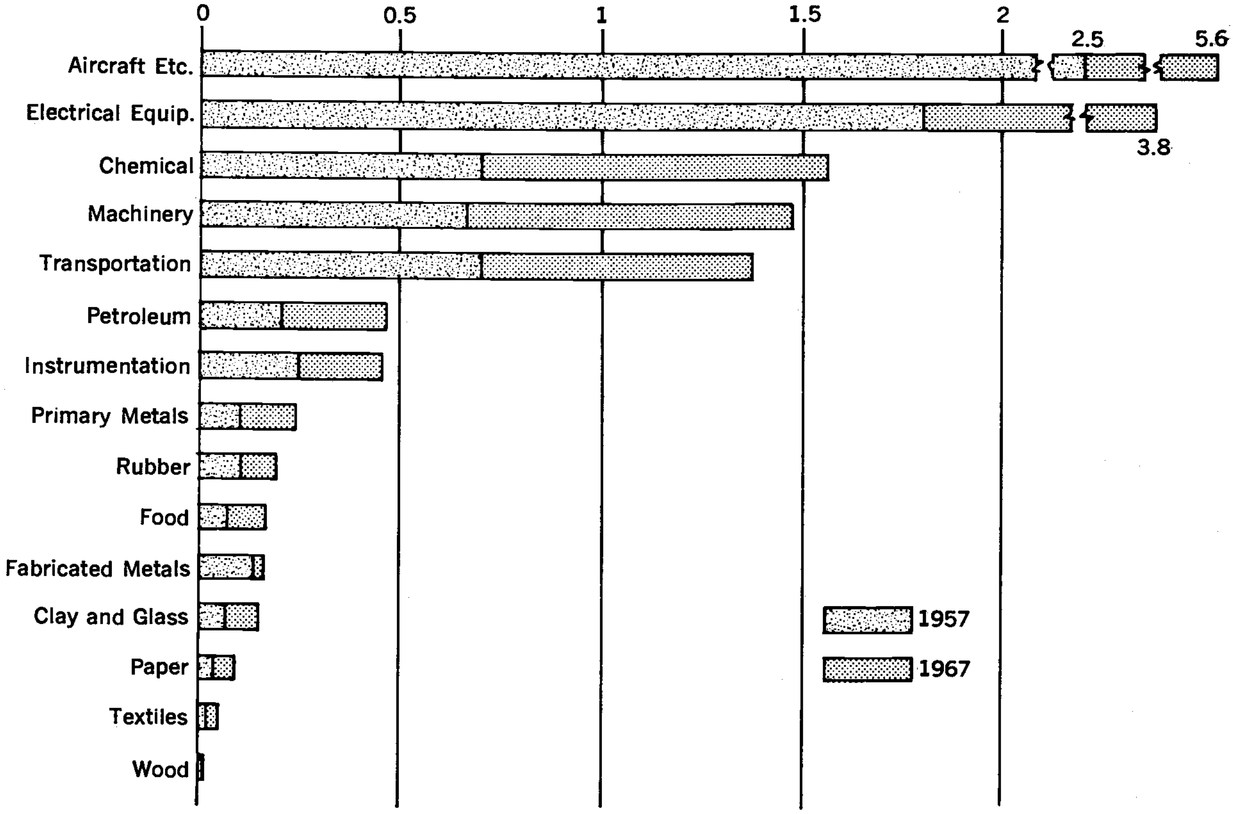
With current and prospective constraints on increasing harvest on Federal lands, improved utilization may offer the best hope for increasing supplies at competitive prices over the next few decades. The advantages of improved processing will continue indefinitely.

#### Advantages of Increasing Supplies by More Efficient Utilization

More efficient utilization of timber promises lower environmental impact per ton of product. High-yield processes draw on less forest acreage and timber for a given output and there is less residue generated. Some new developments promise to make high-performance structural products from presently wasted forest and manufacturing residues, further reducing environmental impact.

The growing of timber involves long-term commitments and considerable risk. The return on investment is highly dependent on site quality.

FIGURE 4.—R & D by Industry ($Billions)




NOTE: Research Performed by Industry, Funded by Industry and Government

Source: NSF Feb. 1969

As we move toward higher total production, we tend to become increasingly dependent on poorer sites.

In general, the financial return from timber growing has not been attractive to private investors. The return on investment has been enhanced by various forms of incentives, favorable tax treatment, and by a historic increase in the price of sawtimber relative to other materials. In spite of great relative price increases over the years, wood remained competitive with other materials, because it started from a low relative price. It has remained a bargain in terms of engineering properties and service purchased per dollar. Further increases in timber price will result in increasing use of substitutes, which has been pointed out, results in economic and environmental disadvantages. Further increases in timber production require additional public and private investment.

Investments in equipment and facilities required to gain an added increment of yield of products from timber typically shows returns much higher than those characteristic of tree growing. This is substantiated by the rapid rate at which a few well-managed companies are investing in more efficient lumber processing systems. Without positive action, however, such advances will spread too slowly through the industry to have a favorable effect on the primary problem being attacked by the Advisory Panel. The anticipated slow rate of adoption of new technology is evident in recent projections of the Forest Service Division of Forest Economics and Market Research. These projections anticipate only a 12-percent gain in yields due to improved utilization by the year 2000. Such gains presume no change in relative prices and they include the apparent gains resulting from a recent change in lumber sizes.

Additional public investment in timber production is required and justified to improve the supply and control prices. Increasing supplies of structural products should be achieved as economically as possible, therefore an appropriate balance should be struck between investment in intensified forest management and more investment in efficient processing. Investment in increased processing efficiency would be expected to show high leverage in its effect. The initial need would be for technical assistance and financing. Necessary loans would be self-liquidating. The new technology introduced would increase profitability and be self-sustaining. Within State and Federal agencies, there are mechanisms for providing any type of help which might be called for.

Returning now to the specific charge from the Panel, we can examine developments in the use of wood which will enable the Nation to meet its housing goals without running short of timber. With this in mind four outstanding opportunities are outlined: (1) Improved efficiency in the conversion of saw logs to lumber; (2) the production of the practical equivalent of lumber and plywood from small trees, residues, and unmerchantable material; (3) increased use of rough wood for pulp production to release some of the 7 billion fbm of saw-timber being used for that purpose; and (4) improved efficiency in the use of wood in housing. These serve to illustrate the total task ahead. Other opportunities, such as improved harvesting, bucking, and log allocation, or other approaches to reconstituted wood products may well have equal or greater potential.

## Improved Efficiency in the Conversion of Saw Logs to Lumber

Lumber is the main solid wood product from timber, amounting to 1½ times the tonnage of all panel and miscellaneous wood products. Nearly half of the Nation's timber is being processed and will continue to be processed in sawmills for many years into the future. The conversion efficiency in most mills leaves much room for improvement. This was pointed out in a conference on "The Future of Wood as a Raw Material." A report of this conference (*2*) tabulated the yield and value of products from a typical sawmill or lumber mill as follows:

| End product | Yield (percent) | Price (dollars per ton) | Value (dollars) |
|---|---|---|---|
| Lumber or plywood | 35 | 100 | 35 |
| Chips | 35 | 18 | 6 |
| Mill waste | 20 | 5 | 1 |
| Bark | 10 | 2 | 0. 2 |

In a paper presented at a meeting of the Forest Products Research Society, McKean discussed the future of softwood dimension lumber, both in its conventional and innovative forms. He suggested that improvements in prospect could have major impact on the supply situation. (*23*).

Highest priority is attached to improvement in the yield of lumber from saw logs. The reasons for giving it this priority are: The importance of lumber for housing; the great volume of wood processed to lumber; and the remarkable improvements in yield which can be achieved by making use of proven technology and available equipment.

There are approximately 600 softwood mills cutting 40,000 fbm or more per shift and these account for 80 percent of the softwood lumber. Approximately 100 companies, some with a number of mills, account for 60 percent of softwood lumber production. There is much variation in mills particularly from one geographic region to the other. Although many use old equipment, improvement is underway through the use of better machinery and quality control. The most urgent need is to accelerate this improvement. The processing efficiency of the industry is usually expressed as the board feet of lumber obtained from a cubic foot of log. This ratio, known as the lumber recovery factor, is abbreviated as LRF. Since finished lumber is less than nominal thickness and width, the maximum hypothetical recovery is not 12, but approximately 16 $fbm/ft^3$.

### Recent Advances in Conventional Sawmill Practice

Important recent developments in equipment and processing are coming into more common practice. These include high-strain bandsaws cutting a very narrow kerf, "clean cut" circular saws, and improved gangsawing systems. Improved setworks are available which allow log positioning with an accuracy of ±0.001 inch, and which can hold sawing variation to ±0.015 inch. It is common practice to cut oversize at least two thirty-seconds of an inch on each face for planing, but with poor mill maintenance or poor equipment, this must be exceeded. It has been demonstrated, however, that if lumber is accurately and smoothly sawn, a very light cut by an abrasive planer is sufficient to produce a finished surface. All these developments serve to improve the yield of lumber from logs.

No one mill is known to encompass all the improvements which tend to raise the yield. Kerbes (*20*), however has shown that at least two mills using narrow kerf saws are obtaining a lumber recovery factor ranging from 8.5 to 9.1 from logs averaging 8.2 and 12.7 inches in diameter.

For a mill to raise its lumber recovery factor from 6.5 to 8.7 fbm/$ft^3$ would be the equivalent of a one-third increase in the log supply or a one-third increase in lumber production. As things stand now, much timber is converted to excessive percentages of low-value residues and waste, thus creating a saw log deficiency. Making up our saw log deficiency requires a large investment. Consideration should be given to changes in timber sale policy, to an incentives program, or to loans for improvement of equipment which now tends to limit the efficiency of sawmills. Effective programs of this sort coupled with State and Federal educational and liaison activities would assuredly exhibit a high benefit-to-cost ratio.

The gains discussed above involved only proven technology. The outlook is further enhanced by new research and development just being brought into practice.

### Computer Control

We are on the threshold of major advances in automated computer-controlled processing in sawmills. Present-day production rates make it impossible for operators to gather information, integrate it, evaluate it, and make correct processing decisions. The answer to this problem lies in automatic, electronic systems. Sawing involves converting cylindrical logs into rectangular lumber of specified sizes. The problem of lumber yield thus basically involves fitting rectangles into a circle. The key is the opening cut, as the resulting face fixes the position of all other faces or saw lines in the same plane. For a given set of conditions, the rough green lumber thicknesses and widths are fixed. The total yield is, of course, the summation of those items which can be fitted in the log diameter being examined. Shifting the saw lines back and forth across the face of the log end results in substantial differences in lumber yield because of the geometrical interrelation involved. Even if one assumes the operator is capable of correctly solving this problem, his inability to operate under production conditions is evident.

To take full advantage of the potential volume of a log, several things are necessary. First, one must know the exact diameter of the log. Secondly, a sawing pattern must be selected that best fits the correct combination of lumber items into the circle of that diameter. This involves the evaluation of a host of complex alternatives and the selection of the best combination. Computer control of sawmills has been initiated in Sweden and in one or two mills in the United States. These commercial mills, however, have not been described in detail.

A recent publication outlined an approach to the computer control of sawmills known as the best opening face (BOF) system (*17*). This utilizes already available electronic and mechanical equipment for its implementation. It is estimated that sawmills can improve their yield by 10 percent through the use of this system. The system is believed suitable for mills of a size class of 40,000 fbm per shift; 80 percent of lumber production comes from mills of such a size or larger. Computer control, in addition to increasing the yield, also increases the rate at which logs are processed. The 10-percent increment in yield is in addition to the yield improvement obtainable by the conventional means described previously.

### Edge Gluing and Finger Jointing

In further elaboration of the best opening face system, it has been proposed that the resulting 2-inch-thick flitches be dried and edged to the greatest width, glued into large panels, scanned by an ultrasonic device to sense and locate defects, then ripped in such a way as to produce dimension lumber of maximum quality. Such an "edge-glue-and-rip" (EGAR) system eliminates the waste presently resulting from the production of dimension lumber in 2-inch-width increments. By minimizing the occurrence of edge defects in the product ripped from the wide panels, there is an effective increase in the usable strength from a given base of raw material. This system is expected to increase yield by 15 percent over conventional sawing.

By the simple expedient of cutting dimension lumber to remove defects, then finger jointing, joists of high quality and any length can be produced. The upgrading of the product and the advantage of being able to cut to specified length represents a marked increase in utilization efficiency.

## Structural Laminated Lumber

In the production of conventional lumber, some of the wood is converted to low-value sawdust, resulting in unavoidable waste. The yield of lumber in current practice is of the order of 40 percent by weight. Naturally occurring defects in lumber, such as knots, cause it to have a high variability, with the result that it is used inefficiently as an engineering material. By converting the log to veneer on a lathe, no sawdust is generated, and with such tangential cutting, all knots are of minimal size. The best wood on the outer part of the log is recovered to a high degree, and the knotty juvenile core containing the pith is put to lower grade use. When dried veneer is glued into a parallel laminated assembly, the defects are dispersed and the resulting product shows higher average strength properties and markedly less variability than sawn lumber. Yields depending on log diameter, are higher than for sawn lumber (*17*). Such products have been under investigation in a number of laboratories (*7, 22, 32*).

A publication of the Forest Products Laboratory describes the production of "press-lam" (*32*) from rotary-cut veneer of ⅙- to ½-inch thickness. The veneer is press-dried under low pressure, and advantage is taken of the high temperature of the material as it leaves the press to cure the adhesive. Fully satisfactory products can be made without jointing the laminae, but finger jointing, particularly in the case of the thicker veneer, offers an advantage in performance at an increased cost. Characteristically, laminated veneer lumber is made in a wide panel of continuous length which subsequently is cut to required sizes. For large-volume applications, members can be tailored to specific length, width, and thickness. This results in material savings over the practice of marketing lumber in 2-foot increments of length, and 2-inch increments of width. It offers additional savings and better performance by making joists available to builders which are long enough to span the entire width rather than have a lap joint on a center beam.

Besides its potential for laminated dimension lumber, thick veneer can be fabricated into large vertically laminated beams with impressive savings in material. Because of the presence of lathe checks, such large members have the advantage of being very easily impregnated with preservatives. Difficultly treated heartwood of Douglas-fir, after assembly into a beam, becomes totally treatable with preservatives. Laminated lumber of premium quality has, for several years, been produced and marketed in the form of fabricated trusses. Plans are underway to expand the operation (*18*). In Canada, a small but seemingly successful enterprise processes one-fourth inch veneer into dimension lumber (*37*). There is rapidly rising interest in this general approach to higher yield and higher performance structural products.

## Practical Lumber Recovery Factor Improvement

The industrywide lumber recovery factor is currently about 6.5. Hallock and Lewis (*16*) evaluated the lumber recovery factor potential of the three systems—best opening face, edge-glue-and-rip, and press-lam. The results are shown in figure 5.

(1) The best opening face technique shows a range in potential lumber recovery factor of 4.9 to 11.6 fbm/ft$^3$ from 5- to 20-inch-diameter logs.

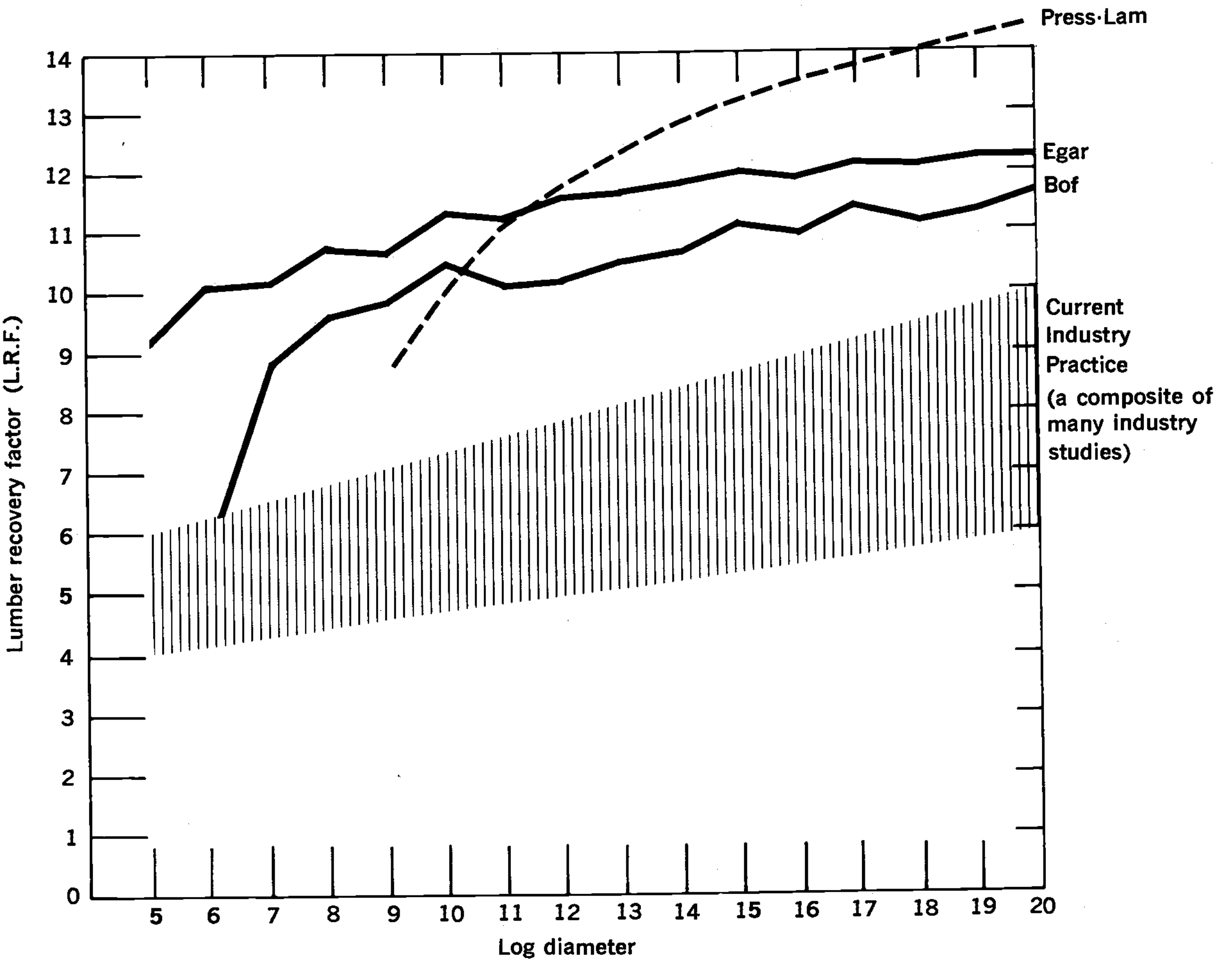
(2) The edge-glue-and-rip process shows a recovery of 9.1 to 12.3 from 5- to 20-inch-diameter logs.

(3) Press-lam potential lumber recovery factor yields ranged from 8.5 to 14.5 from 9- to 20-inch-diameter logs.

Sizing accuracy, kerf, and planing values used in the best opening face and edge-glue-and-rip modeling were the best actually known to exist currently in the sawmilling industry. The values used in the press-lam model were those realized in the Forest Products Laboratory press-lam research program. The veneer thickness assumed was 0.4 inch. Thinner veneer results in higher yield. The assumption was made that the log was peeled to a 7-inch core and this was then sawn into three 2 by 4's, and their volume is included in the lumber recovery factor. Shown also in figure 5 is the range of the lumber recovery factor current in the present sawmilling industry.

The theoretical values of the lumber recovery factor shown in figure 5 for any one of the processes will not be attained under actual operating conditions. For the industry as a whole, there will be mills which for one reason or another will not adopt the high strain band headrigs, the high precision setworks, a computer control system, or the press-lam process. Even these mills can make very simple improvements in their main-

FIGURE 5.—The maximum yield of lumber from conventional and innovative processes.




tenance and sawing practices which will raise their efficiency over present levels by at least 8 to 10 percent.

While a prediction of a lumber recovery factor of 10 is unrealistic for the near future, it is possible for so-called conventional sawmilling operations, within the constraints imposed by actual operating conditions, to reach a lumber recovery factor level of 8 in a very few years. This is more than 20 percent above the probable present-day average.

If the edge-glue-and-rip process proves successful, it should result in a lumber recovery factor under actual operating conditions of at least 8.5.

Very high yields are possible in the production of laminated dimension lumber. Under production conditions a lumber recovery factor of 9 or above could be obtained. Additional advantages of member sizes, better average performance, and decreased variability adds to its attractiveness as a material of construction, and in effect extends the resource still further by reducing the amount of material required to serve a given purpose.

## The Practical Equivalent of Plywood and Lumber From Small Logs and Residues

There is a huge unutilized wood resource in the form of small or low-grade logs and residues. The effective use of this material has powerful implications to the timber, environment, and structural products situation. The amount of residues generated in forestry, logging, and manufacturing operations is poorly known, as is their character and usefulness. This has been recognized and is being given increased attention. The recent report of the Close Timber Utilization Committee of the Forest Service (*13*) surveys the situation and outlines an initial attack on the problem. The amount of un-



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used residues of all types is very large even when measured against predicted wood needs.

The particleboard industry has been growing at the rate of about 20 percent-per-year. Most of the nearly 3 billion $ft^2$ per-year (¾-inch-thick basis) is made from manufacturing residues such as sawdust, planer shavings, and slivers from hogged material. At least 95 percent is used for noncritical interior applications such as floor underlayment or corestock. The properties are adequate for such uses.

A much larger potential market exists for higher performance products which might be referred to as "structural particleboard." Early work on such products dates back more than two decades. Among such studies is work by Turner at the Forest Products Laboratory which was published in 1954 (*36*). This work showed that careful preparation of appropriate flakes makes possible the production of a panel which is the practical equivalent of plywood. Forest residues or small low-grade trees are a preferred starting material for such products, while sawdust and shavings are unsatisfactory. A commercial particleboard made of flakes cut from aspen roundwood is a step in this direction and has been finding increasing acceptance in Canada during the last 10 years (*28*). A similar board will shortly be available from a plant in Minnesota. It was recently shown that comparable properties can be achieved using softwood forest residues including the bark.

Conventional particleboard has properties which stop short of allowing it to be considered a structural product. The presently available flakeboards, however, are finding structural uses. By more advanced technology, superior flakes can be converted to panels which are the practical equivalent of plywood, and by proper alinement they can be converted to the practical equivalent of lumber. The latter two have not been reduced to commercial practice, but we have enough technical data to feel confident of the outcome. We then would have a family of new materials; conventional particleboard, structural particleboard with properties ranging from utilitarian to plywood equivalent or better, and a lumber equivalent or better.

Particleboard products offer the great advantage of showing low variability in properties, permitting their use at a higher level of efficiency than that characteristic for example of conventional lumber. They have good dimensional stability, good weathering properties, good strength- and stiffness-to-weight ratio, and can be fastened without difficulty with nails or adhesives. The raw material requirements are not critical and can be satisfied from many sources in abundant supply. The production process is highly automated with a low labor input. Particleboard can be conveniently modified with preservatives and fire retardants. With additional resin, a high level of dimensional stability can be achieved, and the combination of additional resin and compression results in large increases in stiffness and bending strength (*35*). The particleboard process is a dry process, and yields are at least of the order of 75 to 80 percent; hence, there need be no serious environmental impact of a plant.

Conventional particleboard processes are well known, and capacity is growing at a rate of 20 percent per year. Commercial operations have been established which introduce the structural particleboard concept. The greatest need and the largest market is for high-performance structural products which are the practical equivalent of lumber and plywood. Such products could directly relieve the pressure on softwood sawtimber. Estimates of informed people have it that such products would be available at lower cost than their equivalent in lumber or plywood, they would be produced in twice the yield, and their combinations of properties and low variability would give them net advantages. The overall process economics seem attractive. The missing ingredient is full-scale engineering development to transform sound technical concepts into working hardware and convert available raw materials to marketable items.

Reconstituted wood products are not simple substitutes for currently available products; they are new products, superior in some respects, inferior in others. Parallel with engineering development there is a need for design criteria; so architects, builders, and craftsmen can know their advantages and limitations. A strategy of product introduction must be developed involving regulatory and lending agencies.

A program of this sort takes concerted effort involving public laboratories, equipment developers, and industry cooperators. The impact of such a program on forestry and the building industry would be very great, even revolutionary. The cost would be low compared to the benefits.

## Increased Use of Residues for Pulp Production

In 1971, 64.3 million cords or about 5.7 billion ft$^3$ of wood were used for pulp production. Of the supply, 30 percent consisted of sawmill and veneer plant residues. Such residues are clean, high-quality, bark-free wood and they come at a favorable price.

Of much significance to the impending timber shortage is the fact that over 7 billion fbm of softwood sawtimber is now converted to pulp, a need which could be filled by lower grade raw materials. When examining opportunities to relieve the pressure on softwood supplies, few have greater potential impact than efforts to increase the flow of small-diameter trees, thinnings, and residues to pulpmills and papermills, and hence decrease their use of sawtimber. The prominent use of residues for pulp production began about 20 years ago when sawmills started debarking logs prior to sawing. The bark-free slabs were converted to clean chips which were at least as good as, and probably superior to chips from roundwood. In many mills, particularly on the west coast, such manufacturing residues became the sole wood supply.

### Residue Salvage Storage and Use

If residues are to be used to a greater extent in replacing sawlogs, it is evident that they must come from sources other than sawmills, primarily from forest and logging residues. Keays (*19*) has done a great service by his five-part analysis of the literature on complete tree utilization. Young, too, is known for advocating fuller utilization of the forest resource (see the Keays review). Much effort has gone into mobile equipment capable of reducing trees and other residues to chips. For areas presenting special problems, pipeline transportation of chips is under study. The critical remaining problems have to do with the long-term storage of chipped residues and with problems resulting from the presence of bark.

### Chip Storage

Pulpmills have always found it necessary to keep a large inventory of pulpwood on hand to guard against shutdowns when wood is not available. Woodchips, too, are stockpiled at the pulpmills in the form of large outdoor piles. Equipment has been developed for the transport, storage, and handling of chips in and out of the piles. Handling wood as chips instead of as logs has resulted in manpower savings so great that many mills receive their wood in the form of logs, then debark and chip them immediately on arrival, storing the wood as chips. Although there are obvious advantages to chip storage, there are also problems (*15*). During outdoor storage, pulpchips undergo chemical and physical changes. These reactions result in a loss of pulp yield and quality, increased chemical usage in both pulping and bleaching, and a rapid loss in tall oil, a valuable byproduct. There have been instances of catastrophic fires due to spontaneous combustion in large piles (*4, 9*). The advantages of outdoor chip storage, however, are so great that the industry has tolerated the disadvantages, depending on control of storage time to avoid serious problems (*15*).

Recent studies have identified the underlying causes of chip pile deterioration, and control measures have been devised. These control measures make use of small amounts of inexpensive chemicals to inhibit the respiration of living cells in the chips and to kill or inhibit micro-organisms which attack the wood substance. Both effects control the generation of heat, which in itself results in chip deterioration, and eventually can lead to spontaneous combustion. Laboratory and pilot studies in this area have been successful. Extending the results to larger semicommercial-sized piles has controlled deterioration, but for a shorter time than desired. A continued vigorous attack on this problem is necessary. Residues are generated at an irregular rate, and demand rises and falls. Inexpensive and effective methods for insuring against deterioration are essential if stocks of chips are to be generated, stored, and put into domestic and foreign trade, not only for the production of pulp, but for reconstituted structural products as well. The outlook for ultimate success is very good.

### Bark Chip Separation

In large part, wood salvaged from forest and logging residues cannot be debarked using existing technology. In a recent publication, Erickson (*11*) described various chip debarking methods presently under development which are applicable to such material. Steam heating of the bark chip, then compression debarking followed by an abrasion process was the most successful. Laboratory methods have resulted in about 70 percent removal of the bark for aspen, sugar maple, jack pine, loblolly pine, and slash pine. With refinements it is possible to attain a goal of 1.5 to 3 percent bark in the final chip mix. This work integrates into a system with mobile chipping equipment, using whole-tree harvesters and chip-handling methods.

### Pulping Unbarked Wood Chips

There remains no doubt that the fiber resulting from the whole tree will be acceptable and usable.

Traditionally the pulp industry has maintained high standards for bark removal. This in large measure goes back to days when sulfite digestion was the dominant process, and bark was poorly tolerated. In actual practice, the kraft and neutral sulfite semichemical processes are quite tolerant of bark and in periods of the year when bark removal is difficult, operations have gone on with high bark content. These facts, and the current importance attached to extending wood supplies through the use of residues, caused new attention to be given to the matter of bark tolerances in a well-operated kraft system (*6*). This approach is an alternative to the separation of bark from chips. A variety of wood species with bark contents of 5 to 15 percent were studied, comparing the case in which all bark was removed prior to chipping, and another in which rough wood was chipped. Both clean and rough chips were then subjected to the full pulping process sequence of digestion, washing, screening, centrifugal cleaning, and bleaching. The work established that it is technically feasible to pulp rough wood and eliminate the adverse effects of bark while maintaining pulp quality. The great significance of the work is that it adds to the attractiveness of using low-cost residues from which bark cannot easily be removed.

Other advantages include the elimination of the high-cost debarking and bark disposal system. A favorable yield increase results from the elimination of "white wood" loss during debarking, and to this is added the fiber yield from the bark. Because the bark is solubilized in the pulping process, bark disposal is shifted to the chemical recovery furnace where its heat value is recovered. On the debit side, there is a higher chemical requirement and a larger chemical recovery system.

Trials are now underway, extending this work from the laboratory to actual practice. The merits will finally depend on relative capital and operating costs of the entire system. The outlook is favorable and will become more so with increasing wood costs.

### Wood Fiber Recycling

Of the 58 million tons of paper and paperboard consumed last year in the United States, 11 million tons or 19 percent was recovered, reprocessed, and reused. Some other nations make much more use of recycled fiber. Prior to 1970 U.S. pulpwood consumption rose 4.5 percent annually. Over the past 20 years the tonnage of secondary fiber used has increased from 8 to 10.5 million tons annually. During the same period, however, the percentage of secondary fiber used in paper production dropped from 32 to 19 percent.

There are social pressures and pollution problems favoring increased recycling of fiber products. The recovery and reuse of fiber either in paper products or for the production of panel products has a direct effect on our timber supply problem and should be encouraged through policy actions and through research and development grants.

## Improved Efficiency in the Use of Wood in Housing

Three factors are necessary in providing structurally sound homes while optimizing use of materials. These are the accurate establishment of the properties of the engineering materials, analysis of the loads a structure must support, and correct design and construction methods. Excessive allowances for unknown values of any of these factors results in a waste of the timber resource, adds to costs, and accelerates the trend toward the use of alternatives. The role of the factors is intertwined in the building of homes. Generally an innovation in load analysis or material properties will not find its way into rapid use unless concomitant changes are made in design and construction methods.

### Current Practice

Traditional construction techniques are used for most of the homes being built today. Despite many attempts to depart from traditional practices, they retain their prominence. Also despite a long history of use, such practices can be made more efficient and economical. A major effort to achieve materials and cost savings was undertaken by the National Association of Home Builders under contract with the Department of Housing and Urban Development. As a result of this work there has been published a "Manual of Lumber and Plywood Saving Techniques" (*25*). These techniques have subsequently been incorporated into a demonstration house (*26*). The National Association of Home Builders Research Foundation projects an annual material saving of 1.5 billion fbm of lumber and 600 million $ft^2$ of plywood through adoption of these techniques. All are acceptable for use in housing having HUD–FHA mortgage insurance. Actually achieving such savings requires a large and effective education and extension program that does not presently exist.

The NAHB design demonstrates certain concepts that will increase the efficiency with which wood is used; other ideas for structural elements supported by basic engineering theory and judgment can be equally effective, although they have not yet been incorporated in demonstration houses.

### Roofs

A concerted effort has been made to apply engineering principles to the design of residential roof trusses, and it has paid off well! We now have a 42-percent lumber saving in a 28-foot-wide house, over the ceiling joist-roof rafter system previously used. And the saving is a real one, since roof trusses are almost universally used. Practices have changed in the past, and they can continue to change. Further dramatic efficiencies are possible if we would take advantage of the roof sheathing to strengthen and stiffen the roof trusses. It would only require gluing the trusses and sheathing into a single three-dimensional structural unit. The ceiling, furthermore, can share in carrying the lower chord tension load. To realize fully these potentials, the sheathing and ceiling panels should extend the length of the adjacent framing members. End-jointed plywood panels that could serve this function are now being produced. In the future, structural particleboard panels of adequate size will be regular production items. The techology is now available for the large-volume production of structural particleboard of adequate properties and size for such use. Establishment of the practice would permit economies in the quantity of wood or in the grade of the wood used for the construction of the truss.

### Walls

Current wall framing practice is wasteful of materials. Tradition, rather than structural requirement, dictate stud size, grade, and spacing. Some codes specify stud size and spacing according to story height with no regard for calculated wall loads or stud material properties. Research has shown that material use efficiency could be increased by any of several means.

Lower grade material could be used. Tests at Oregon State University reveal that walls made of utility grade studs (not presently allowed by FHA) support 2.6 times the design load (*12*).

Spacing of 2 by 4 studs could be changed from 16 to 24 inches without sacrifice of structural integrity. This is presently allowed by FHA for single and top stories.

Research at Washington State University shows that 1 by 4 studs on 16-inch centers, glued to ⅜-inch plywood sheathing, perform about as well as 2 by 4 studs at the same spacing acting alone (*1*).

The NAHB manual suggests further wood-saving innovations applicable to conventional construction. Inline construction, where floor joist, stud, and roof truss rests directly over each other, eliminates the need for the double 2 by 4 top plate. Single-layer outer wall covering, effecting significant material savings, has been accepted and is widely used. Preplanned placement of windows and doors so that studs could double as opening framing is an elementary consideration, but it is not widely done.

### Floors

The floor system offers numerous potential material savings. Codes have established design standards for homes, a design floor load of 40 $lb/ft^2$, and a maximum deflection-span ratio of 1 to 360. These may or may not be realistic, and they should receive careful reevaluation for potential savings.

The joists and flooring—always required to be in intimate contact and held in that position by fasteners—should be glued and designed as a composite member. Composite action results in stiffness and strength increases of about 50 and 30 percent, respectively. Recognizing this in design results in wood savings of about 15 percent. Presently HUD–FHA gives credit for the stiffness, but not the strength increase. However, extensive research on floor systems being conducted by Colorado State University may provide the technical justification for code recognition of the strength increase due to composite action. Another wood-saving advantage of the glued system is that it allows the application of floor covering or carpet directly on the structural floor without the need for underlayment. Most floor joists are spliced over a center girder. If they were run full length, thus taking advantage of a continuous two-span design, the floor stiffness would increase about 41 percent. This would result in a theoretical net saving of wood of 11 percent. Long-length joists, 24, 26, and 28 feet, are economically possible with proven end-jointing techniques. This idea, if combined with the code revision just cited, will allow very pronounced wood saving in the floor system.

### The Whole House

The common denominator of many lumber-saving principles is rigidly connecting single elements to form composite assemblies. This extends to the joining of the assemblies to form a space structure, the house. Evaluation of the interaction between house assemblies and the strengthening gained by connecting them together is complex, and will only be determined by carefully controlled tests of complete houses. Only then can the strength of the complete house be recognized in the design of the component assemblies.

### Future Trends

Factory-built components are advantageous principally because of the quality control that can be exercised in fabrication. This is most important in the gluing operation.

Particularly promising are the innovative floor systems possible through factory fabrication techniques. Developed at Washington State University, the T-joist stressed-skin floor panel was placed in research houses in 1965 under the FHA experimental program and has been serving satisfactorily in continuous use since that time (*34*). The panel uses 1 by 4 webs and flanges, stress-rated lumber, and sheathing grade plywood. It is factory-built, glued, and nailed. Total floor material savings over conventional construction is 26.8 percent. Additional savings in wall material result, since the floor is only 4¾ inches thick. The interjoist space is accessible for wiring, heating, and plumbing runs.

A more conventional stressed-skin panel uses plywood skins either just on the top, or on both the top and bottom of the joists. The efficiency of such panels has long been recognized, and design rules have been formulated. However, few factory housing concerns produce and use them.

The ultimate in structural efficiency can be obtained with sandwich construction (*33*). Load-bearing floor, wall, and roof panels can be designed with plywood or wood-based panel facings and foamed plastic or honeycomb paper cores. Such panels can use about 60 percent as much wood as conventional construction.

Sandwich panels with structural particleboard faces and bark cores are feasible. In addition to the advantages of structural efficiency, and favorable acoustic performance, we will benefit by the fact that the panel may be built from residue that is presently used inefficiently or not at all.

Still in the future are the material use efficiencies that can be realized through innovations in structural particleboard. This is a material of extreme flexibility. Strength and stiffness can be varied by changing the resin content, particle size and shape, particle orientation, and processing temperature and pressure. Efficient structural shapes are possible because of the high shearing strength of the product. For example, a 9-inch-deep composite **I**-beam with the best grade 2 by 4 flanges and a half-inch particleboard web exhibits one-third greater stiffness and twice the strength of a No. 2, 2 by 12. Techniques will be devised for molding the particles and resin into shapes so that no further manufacture is required. Research toward this end should be supported and expanded.

### Codes and Standards

The function of codes is to establish rules for design and construction of buildings so that life and property will not be endangered. To this end codes have served well. But the Nation is facing a change, from a period of construction materials abundance to one of scarcity. Building code provisions must be examined for excess allowances for uncertainties in materials properties and performance requirements. We must search out and eliminate those provisions that are not technically justified by today's standards.

Optimization of materials use must be made possible within the framework of the codes. The redraft of the FHA–HUD minimum property standards, volumes 1, 2, 3, and 4 (not yet published), from specification to performance type is a step in the right direction.

All housing standards should be changed from the specification type to the performance type. In addition, the performance stipulated should be that of assemblies, not single structural elements.

What assemblies should be considered? Ideally it should be not less than the whole house, since all individual assemblies provide mutual support when connected into the final assembly. Obviously, this would not be a realistic approach. However, it is important that those interassembly effects be evaluated to furnish realistic requirements for single assembly performance. One can postulate that a floor system, including joists, all flooring, and lower surface ceiling (if present) should make up one assembly. Performance criteria might include sound and heat transmission, fire safety, stiffness, strength, and the fundamental frequency of vibration. These criteria are considerably broader than present codes encompass, yet they would allow innovative design for optimizing materials use.

Great care must be exercised in establishing acceptable levels of performance. They must meet the requirements for assuring health, comfort, and safety, but might also meet certain requirements related to energy conservation and other national concerns.

### Lumber Grading

Among pieces of sawn lumber there is a wide range of strength and stiffness. For efficient marketing and use, pieces must be sorted into classes for which design properties can be safely and efficiently assigned.

The visual stress-grading system, together with traditional design and construction methods, has resulted in wood buildings that are structurally sound. Visual stress-grading is not precise, but the assignment of properties for design values has been conservative. Of particular significance to the panel assignment, present practice results in the use of more wood than necessary, adding to the materials shortage. Mechanical grading is more precise than visual grading, and offers opportunities for resource savings without sacrifice of safety or performance.

Field trials of machine-graded lumber used in conjunction with design improvements have demonstrated a 20-percent savings in house-framing systems (*5*). Such findings did not, however, spark expanded demand for mechanical grading, because they were not translated into clear advantages to the builder, and it is he who usually makes the final decisions on lumber to be used. Thus, the need for a systems approach is evident, in which the entire spectrum of barriers is kept in view.

Great savings are possible in the use of wood in housing, but much effort will be required to modify established practices. The most cost-effective step which can be taken is to supply to code and lending authorities sound technical information on improved practices and innovative systems. A few people in these positions can exert powerful influence on the efficiency with which many others use our dwindling resources.

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appendix L

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# Maintaining Timber Supply in a Sound Environment

## RECOMMENDATIONS TO THE PANEL

1. The growing of timber and its use are more compatible with ecological principles than any other kind of land resource management. The forest is a living and, therefore, renewable resource; the extraction of wood from it can be accomplished without significant reduction in the capacity to produce more. The utilizable production of wood and other forest benefits can be substantially increased by comparatively modest efforts systematically applied over long periods of time. It generally costs less in money and adverse environmental impacts to carry out the processing, use, and ultimate disposition of wood products than of alternative materials derived from nonrenewable resources. In its long-term raw materials policy, the United States must aim toward policies that will take full advantage not only of these attributes of wood but also of a potential capacity for its production that has virtually no equal on Earth.

2. The wise and efficient use of the forest resources of the United States requires the development of National and State policies concerning the use of all land. The growing of timber crops takes so many decades that, of all the forest uses other than wilderness, it is the one most peculiarly dependent on a high degree of stability and continuity of land use. Increased attention should be given to whatever combination of planning, zoning, controls, and incentives will bring more assured stability in the supply of forest land and the multiplicity of benefits available from it. On Federal forest land there should be allocation of the relative priorities accorded different uses, almost acre by acre, to carry out the true and intended meaning of the multiple-use concept.

3. The most important way to reduce any impact of timber harvesting demonstrably harmful to the physical environment is to regulate the construction and maintenance of logging roads. These cause vastly more damage to soil and waters than drastic cutting or fire. The capacity of forest vegetation to regrow and the resilience of forest soils are great enough to resist most significant damage except when organic surface materials are moved long distances sideways by scraping action. Under some circumstances, it may be desirable to regulate such activity in logging, slash disposal, and silvicultural site preparation. Forest waters can be further safeguarded by public regulation of treatment of vegetation on the banks of those kinds of streams that are significant for water supply or desirable aquatic life.

4. Clearcutting has a temporarily adverse effect on the esthetics of the environment. This effect is highly visible in steep country and may be further aggravated by logging debris, the burning thereof, or treatments to prepare the site for establishment of the new crop. Clearcutting, in and of itself, does not harm the physical environment any more than partial cutting, except on unusual sites or under rare sets of circumstances. Since the adverse environmental impact of clearcutting is largely a visual one and the practice often has important countervailing advantages, it seems logical that any restrictions on it apply only where scenery is one of the primary resources under management. Normally these places are the margins of public roads and waters or dis-

tant hillside vistas. On Federal lands, it is sufficient that administrative action be taken to use partial cutting methods in closely visible scenery and to try to blend distantly visible clearcuts with the rest of the landscape. As far as private lands are concerned, it seems generally best to encourage voluntary action of the same sort. Where States deem the scenic resource sufficiently vital, as several have, there may be basis for laws prohibiting clearcutting along public roads and waters. There is better legal precedent for reducing fire hazard by requiring disposal of logging debris in such places; this has the incidental effect of reducing unsightliness. Similar results can be obtained on both public and private land by encouraging closer utilization of wood that might otherwise remain as logging debris.

5. The prompt reestablishment of vegetative cover is the surest safeguard against damage to the physical environment from timber harvesting and similar forest disturbance. In climates where forests can grow, natural revegetation is typically swift and adequately protective even when merely shrub or herbaceous cover that may be otherwise undesirable. This phenomenon renders legal requirements for revegetation, solely for protective purposes, almost pointless. However, severe disturbance of the soil can impede such natural revegetation. It is for this reason that the second recommendation was that consideration be given to legal requirements for the care of roads and other surfaces subjected to scraping action.

6. Where the continued productivity of timber on private land is deemed a matter of public necessity, there is already precedent for requiring that the revegetation after logging include an adequate stocking of commercial timber species. Several States in which timber production is vital to the economy have laws to this effect which have withstood challenge in the courts. National timber requirements appear to be sufficiently critical to justify consideration of the extension of this rather minimal kind of requirement to other States. It is entirely possible that additional incentives to encourage voluntary private action to this end may be more effective and practical. Any programs aimed at this goal should be applied in the light of consistent and comprehensive Federal or State land-use policies designating the kinds of land on which timber production should be a goal.

7. American forest conditions and forestry practices are so greatly variable that the details of any public regulation of practices should be determined by local boards representing adequate professional competence. Any legislation should be confined to the establishment of policy and machinery for its execution.

8. The kinds of regulations proposed for consideration above represent minimal measures designed only to protect the physical environment, basic site productivity, and some features of the esthetic environment. More positive goals beyond such minimal safeguards on private land are best sought by direct or indirect incentives of a financial nature. This is most definitely true of efforts to secure sustained yield of timber which is virtually synonymous with the reservation for future harvests of growing stock in trees now merchantable. Laws requiring the reservation of merchantable growing stock would represent excessive public intrusion into the use of private capital for benefits available only beyond the lifespan of many forest owners.

9. Considerations of environmental protection, preservation of site productivity, timber supply, and principles of applied ecology cannot be encompassed by sweeping generalizations about clearcutting or any other silvicultural technique. The choice of such treatments is best made on the ground on the basis of professional judgment within the constraints of ownership objectives, legal safeguards, and the circumstances of the time. The following observations are pertinent but subject to reservations about the validity of generalizations:

Clearcutting or any other pattern of timber harvesting really has little to do with questions of whether site productivity or physical environment is damaged. The degree of any such damage depends mainly on road construction or other mechanical treatment of the soil, although severe fire and unwise use of herbicides can be harmful. The immediate effect of almost all timber harvesting and silvicultural treatment is unsightly and clearcutting is more unsightly than most others. However, the appearance of the new forest under construction is no worse than that of buildings under construction and the true environmental consequences are less harmful.

There are several basic methods of harvest or regeneration cutting and many variants of each. No one of these is universally applicable or desirable even for the culture of a given tree species. Clearcutting, like all cutting methods, is nearly mandatory in some cases, unsuccessful in others, and one of several options in many. It has led to failure of desirable restocking in circumstances where the kind of seedlings wanted were not ecologically adapted to exposure.

Clearcutting is most advantageous in replacing stands that are old and decrepit or badly degraded by opportunistic cutting in the past. Such stands contain few trees that are capable of growing much more or even enduring if left in partial cuttings. American forests presently have many such stands and means of establishing new ones have become generally dependable. Consequently, clearcutting has become common in current forestry practice.

Options for various methods of partial cutting are greater in vigorous stands of good quality, especially if they have been thinned and otherwise intensively managed from their beginning. Thinning of immature stands increases the actual wood yield by putting to use trees that would otherwise be crowded out. It also increases sawtimber yield by speeding the growth of residual trees to larger diameters and is often essential to economic production of sawtimber. The process also makes trees grow strong and secure enough to enable use of shelterwood and other partial cutting methods during the replacement period. Nevertheless clearcutting of such stands at maturity has important operational advantages, especially where the new stand is to be planted on prepared ground. Shelterwood cutting, under appropriate circumstances, allows better manipulation of growing stock and provides for establishment of regeneration before the old stand is entirely removed; because of this it is also superior esthetically to clearcutting. However, like other methods, it has enough drawbacks that it is not suited to universal application.

Even-aged management, if properly administered and associated with assured establishment of desirable new crops, is the simplest and most dependable way of assuring sustained yield. The basic principle of this mode of regulating timber harvests is exemplified by the annual replacement of stands on one-sixtieth of the area of a forest in which stands are grown on a 60-year rotation. Clearcutting is one, but not the only one, of the methods of regeneration cutting involved in even-aged management. Even-aged stands appropriate to this approach to sustained-yield management are also created by shelterwood, seed-tree, and sprout-coppice cutting. Uneven-aged management is associated with selection cutting and requires careful manipulation of an inventory of intermingled trees of differing size and age. It is a less dependable pathway to sustained yield because it involves mathematical and administrative procedures of high complexity and discouragingly low reliability. Clearcutting is not the antithesis of sustained-yield forestry even though it was once associated with forest liquidation.

Natural fires, windstorms, and insect kills have produced far too many even-aged stands to allow credence to be given to the view that uneven-aged stands are the norm of nature. Where uneven-aged stands do not already exist, it takes many decades of partial cutting with nearly single-minded purpose to create them, often at the expense of other important considerations. The methods of selection cutting designed to create them have many pitfalls. Attempts to employ this method on a large scale in American forestry in 1930–50 produced some bitter experiences that have in part led to two decades of widespread application of clearcutting.

Place for true selection cutting does, however, exist where it is of paramount importance to maintain stands that always have large trees. This is true of stands managed primarily for scenery, streambank protection, or avalanche barriers. The method has a greater role in handling stands of good quality that are already uneven aged. However, in this connection it is worth noting that stands consisting of mixtures of species may be even aged in spite of the fact that the trees of differing species may vary so greatly in size that it may seem impossible that they could all be of the same age.

10. Logical silvicultural practice varies not only as to technique but also in intensity of application. For economic reasons alone, it is necessary that the most intensive practices such as clearcutting and planting, be reserved for sites which are high both in productivity and responsiveness to treatment. In American forestry and particularly on public forests there appears to be too much tendency to try to apply the same intensity of practice across all sites used for timber production. The most promising sites are often not managed with sufficient intensity and the poor with too much.

11. Efficient silvicultural practice is a peculiarly local talent best acquired by years of experience with the same kind of forest. National forest silvi-

cultural personnel should not be transferred so frequently that they are prevented from acquiring such experience. Policies against inplace promotion should be relaxed as far as such personnel are concerned. Efforts should also be intensified to train suitable professional personnel to prescribe appropriate practices and subprofessional staff to insure proper execution of these practices. While the interdisciplinary approach to such problems is vital, it is, in the last analysis, applied more efficiently by competent individuals than by teams or committees.

12. It is probable that future timber yields from national forests can be increased by consistent, intensified silviculture on the better and more responsive sites. Any dependable increases in future sawtimber yield can be reflected, under sustained yield, in increases in present rates of harvest. However, such increases in present cutting rates cannot be justified under sustained yield unless there is guaranteed financial support for the necessary intensification, both now and in decades hence.

13. The Knutson-Vandenberg Act of 1930 would, if appropriately amended, provide means of the necessary financing. This act enables the use of funds reserved from stumpage receipts for establishment of new stands to replace those harvested. However, the intensification of silvicultural practice recommended in this report would go beyond the replacement of stands to include their subsequent treatment. The act now stipulates that the funds be expended within the specific sale areas on which they were collected and within a limited period of time. It would be more advantageous if these moneys could be invested in any timber-management operations within geographical units no smaller than a national forest. The amounts reserved from stumpage receipts might logically be fixed amounts per acre equal to the anticipated cost of growing timber on an average acre through one rotation within the management unit where the funds are expended. Excessive impact on payments in lieu of taxes to local government would be avoided if the 25-percent allocations for this purpose were made from gross sales receipts rather than, as is now the case, from the net receipts remaining after deduction of the Knutson-Vandenberg funds.

14. The harmful impact of logging roads on the physical environment can be mitigated by design standards that specify the narrowest possible widths, fit locations to the topography, and both minimize and balance cuts and fills. On public lands, road networks should be administered so that the extent of actively used roads is held to the lowest level that will meet demonstrable needs. Roads which are temporarily or permanently out of use should be revegetated and provided with fail-safe drainage systems; they should also be actively barred against casual use.

15. There should be public participation in the research and development of improved logging systems, especially skidding machinery, that will reduce damage to soil and to residual trees. Machinery that will increase effective yarding distances and, therefore, reduce the density of truck-road networks is generally desirable. Cable-yarding equipment suitable for partial cutting in steep terrain will be increasingly essential. The same is true of tractive skidding machines for more gentle terrain; in this instance it would be desirable to develop machines that combined the speed of rubber-tired skidders with the favorable load distribution of crawler tractors. Developmental efforts should include consideration of entirely new techniques and not be limited to modifications of existing machinery.

16. The use of pesticides has not and should not play a major role in the growing of forest crops. Both economic and environmental constraints militate against the frequent, heavy and routine use of pesticides associated with intensive agriculture. Existing regulations now largely preclude the use, in forests, of persistent pesticides or those which are dangerously toxic to warm-blooded animals. Insecticides less persistent than those exemplified by DDT are in use, but research to develop even more suitable ones is needed. Few problems have arisen with use of herbicides in forestry. However, current uncertainties about the possibility of contamination of 2, 4, 5–T herbicide with a highly toxic dioxin compound in manufacture need to be resolved.

A more concerted effort should also be made to develop integrated management of forest pests by the judicious combinations of biological, genetic, silvicultural, and chemical control which have long been a goal of forestry practice. Within such combinations, the use of chemical controls must continue to be viewed as the weapon of last resort rather than first line of defense. One problem of increasing concern is the fact that pesticides have been used so little in forestry that chemical manufacturers have not found it a market that would repay much special effort in research and development. Most of the forestry pesticides have had to be borrowed from agriculture. Research and development leading to sophisticated third generation pesticides that are target-specific, or otherwise more suitable than those now in use, will probably have to be federally financed efforts.

17. Projected shortages of softwood sawtimber two and three decades hence cannot be met from new stands created in the present decade regardless of how efficient production from such stands might be in the longer term. Additional emphasis must be placed on the silvicultural treatment of existing immature stands and other measures which will increase production during the remainder of this century. Improved utilization in logging and manufacture is obviously the quickest part of the solution because it does not require waiting for trees to grow. Too much pulp comes from saw log-sized material and not enough from what is now left in the woods as logging debris. Greater use of hardwood for pulp and particleboard would reduce pressure on the softwood resource. Furthermore, it would accelerate the growth of softwood sawtimber in middle-aged hardwood-softwood stands and of hardwood sawtimber in hardwood stands.

More generally, any sort of stand improvement cutting in middle-aged stands with a softwood component will help offset the anticipated deficit. Greater use of shelterwood cutting and other kinds of partial cutting, aimed at prolonging sawtimber growth in stands approaching maturity will also increase harvests during the period of the projected deficit. The greatest gains from such tactics can be made on private nonindustrial land in the South and North. But in the middle term and beyond, the greatest opportunity for major increases in softwood production lies in conversion of hardwood stands to softwoods on this same category of land. There are many sites in both South and North where softwoods would grow well but existing stands of the more demanding hardwoods grow poorly.

## INTERPRETATION OF ECOLOGICAL AND ECONOMIC OBJECTIVES

Of all the land resources that man uses, the forest comes closest to being one that can be used in perpetuity with the least harmful effect on the total environment. The flow of goods and benefits from forests as well as the processes that resist the natural and artificial degradation of them result from the growth, life, and death of plants and animals. Like all other living resources, the forest is a renewable resource, perhaps the most perfectly renewable of all.

Forests can be managed so that the goods and benefits which they provide can be used without removing very much material or energy that is not replaced by solar energy, return of water and gases through atmospheric cycles, and release of chemical nutrients from rock weathering. Wood products, the primary but not exclusive concern of this report, provide the most important example of this.

The wood of tree stems is derived almost entirely from solar energy, water, carbon dioxide, and small amounts of nitrogen, all of which come to the trees directly from atmosphere or Sun or indirectly from atmosphere through the soil. The amounts of mineral material in stem wood are very small when compared with those in leaves, twigs, and rootlets that are typically left behind in wood harvesting. The mineral substance removed in the wood is ordinarily somewhat more or somewhat less than the amount fed into the living system from rock decomposition during the time it took to grow the wood. In this respect, wood, made almost entirely from air and water, is incomparably less damaging to the chemical fertility of the soil than most agricultural crops.

Wood products are also highly advantageous from the environmental standpoint when compared with alternative materials derived from nonrenewable resources. Comparatively little energy or fossil fuel is needed to convert wood to use. The greatest likelihood of environmental damage associated with use of wood comes from transportation out of the forest, notably the effects of logging roads, and pollution by manufacturing waste, mostly those involved in pulping. Wood products are naturally biodegradable, so that when their use ceases, the materials resulting from decomposition or destruction, mainly water and carbon dioxide, return to the atmosphere and the ecological cycles that take them back to the forest.

The forest system is naturally resilient enough that the fundamental productive capacity can be preserved for posterity by perpetual observance of some rather simple precautions to protect soil and streams. The treatments necessary to make the forest and its products more useful to man than they would be if left to unmodified nature are mostly those which simply redirect natural production. Some of the treatments may cause unacceptable damage to environment or long-term productivity and deserve both continuing scrutiny and care in application.

Farsighted and consistent management policy is most crucially necessary for maintenance of a sustained yield of the benefits that depend on the growing of trees. If it takes 70 years to grow a sizable pine sawtimber, the trees from which it must come in 2043 must start in 1973. If there is to be a perfectly evenly flowing sustained yield, there must now be stands of approximately equal area for every single-year age class from age 1 to age 70. This distribution of growing stock must be protected from loss and temptations to make the final harvests prematurely. While many trees may be thinned out along the way, the trees for the final 70-year harvest must remain the full term or rotation, but be replaced promptly at the end. Often release cuttings and other treatments must be applied during the rotation so that the final crop trees reach a certain size in 70 years rather than the 85 years that might be required in a less intensively managed stand. If the sustained yield program is geared to the 70-year rotation and the necessary treatments are sometimes omitted, the whole program will lapse in the direction of either a longer rotation or reduction in final tree size; in either case, the average sawtimber yield in board feet will decline.

It takes stubborn and persistent effort over many decades to put a forest on a sustained-yield basis even approximating those described. Since the whole proposition is actually much more complicated, it is difficult to assess the status of a forest with respect to sustained yield or even to decide what level and kind of sustained yield could or should be sought. Much of it comes down to balancing the wants of the 20th century against those of the 21st.

The environment that is to be protected has a variety of different dimensions and interpretations. It lies within and beyond the forest; it affects the forest and the forest affects it. The environment is such an all-embracing web that it is not readily separated into parts. However, present issues cannot approach resolution without an attempt to do so.

### The Physical Environment

The physical environment can be measured and analyzed just well enough to make objective assessment of any important damage within grasp. It involves such things as the physical and chemical properties of the forest soil and the waters that flow from it, the nature of the gases and particulate matter escaping into the atmosphere, and the temperature of air and water in the forest.

The causes of virtually all of the least debatable and overt kinds of damage to the human environment can be assessed in physical and chemical terms. The degree of pollution of air and water can be determined by chemical analyses; erosion and stream siltation can also be measured quantitatively. Such measurements can, in turn, be related to human health, soil productivity, aquatic life, and similar considerations that are obviously of high social importance.

### The Biotic Environment

The biotic environment, however, has many more parts and is more difficult to interpret and assess. Actually it is almost inextricably interwoven with the physical environment but it can be damaged in ways that are not necessarily measurable in conventional physical and chemical terms. The biotic environment of the forest consists of all the plants and animals within it as well as those outside that are influenced by the forest or affect it themselves. These complex interrelationships, in which everything affects everything else, are considered in a subsequent section, "The Forest Ecosystem." It is to the partial domestication of this system that the practice of forestry is addressed.

### The Social Environment

One of the axioms of forestry is that forests should be managed for people and not as ends in themselves. Because of this forestry would inevitably conflict with any extremely pure naturalistic viewpoint, except where it was agreed that certain forests were to be left to nature in response to popular demand.

Social requirements are imposed on the forest and forestry mostly by economic and political processes. Conventional economics has such a short-term outlook that forestry, especially that aimed at timber production with its rotations of many decades, collides with this kind of economics more violently than it does with the extreme naturalistic viewpoint. The idea of developing a sustained yield of wood in perpetuity is ludicrous when viewed in the short term. One of the arguments commonly raised against sustained yield of wood is that technology will develop substitutes. Since the known mineral substitutes require profligate use of energy and nonrenewable resources, this argument is one of diminishing credence in the ecological dimension which society is gradually mastering.

The countervailing force lies in the political sphere. While posterity neither votes nor spends money, its influence is more likely to be felt at the ballot box than in the marketplace. However, people place more demands than they know upon the forest and its resources. The roots of present discord about the use of forests lie partly in the human tendency to want more than is necessarily available. For example, an increasingly mobile and urbanized population tends to regard forests as esthetic and recreation resources and to overlook their status as the source of the raw material which the Nation needs and uses in great amount.

The social environment, in other words, is a living environment as complex as the other one identified as biotic. The basic objective of forestry is to make man a compatible part of the environment of forests that are passed to posterity with unimpaired productivity.

## THE FOREST ECOSYSTEM

An ecosystem is an interacting combination of the assemblage of living organisms that inhabit a site and the physical factors which support their existence but are also influenced by them. Tansley (1935) first applied the term "ecosystem," although the concept had existed much earlier (Odum, 1971). The interpretation is sometimes enlarged geographically to the view that an ecosystem is, or should be, large enough to produce a system rendered stable by the exchange of materials following cycles or circular paths between living and nonliving parts. Such an ecosystem would be one in which nothing was taken away without being replaced within the unit involved.

This enlargement of the idea has a powerful appeal but it has implied requirements that cannot be fulfilled in anything smaller than the biosphere, which is the whole Earth ecosystem. Since the energy comes from the Sun and is ultimately lost to outer space, not even the biosphere can be perfectly balanced internally. The cycles of carbon, oxygen, nitrogen, and water are completed through the atmospheric circulation which operates on at least a hemispheric basis. The materials lost to the oceans through purely natural erosion do not return to land until or unless the ocean bottom is cast up as land.

In practice, the concept does not become operationally useful unless it is modified to look upon lakes or whole forests as nearly complete ecosystems with the view that as many as possible of the cycles be closed within the smallest feasible span of time and distance. While the basic concept is obviously desirable, there is much room for disagreement about what is possible and feasible.

In this section, the forest ecosystem is considered as something which might or might not be managed. While much of what might go on in either case is confined within a forest or even one of its component stands, there are also important materials that move far beyond a forest or stand. More would move outside in a forest ecosystem managed for timber production than one which was not, but attention must be given to the possibility of ultimate closing of cycles even when the wood in a house is part of a cycle.

An ecosystem can also be viewed, in part, as including chains of living organisms which participate in sequences of transfer and transformation of energy. These chains can lead from synthesizers to herbivores to carnivores to decomposers. Green plants are the synthesizers which first collect the energy on which the subsequent members of the chain directly or indirectly subsist through their feeding activities. It falls to the decomposers to dispose of any remaining energy that the other organisms or fire have not already released as heat. The understanding of these steps is essential if man is to play his role in the managed ecosystem wisely.

The tree is, as are all other green plants, fundamentally a natural device designed to capture life-supporting energy from the Sun. The sugar produced in the leaves is both the energy-storing material and also the basic building material from which most of the living structures in the forest are formed. Of course, some of the vital structural substances are also the water and chemical nutrients taken from the soil, but the energy comes only from green leaves. All of the animals of the forest derive all of their energy and nearly all of their body-building substances by feeding either on the plant materials or on other animals that directly or indirectly did so.

While there is more to the forest ecosystem than the trees and other plants, the green-leaved plants govern the animals, large and small, far more than the animals govern the plants. This point is one of the fundamental principles of the management of wild and domestic animals.

The nature of forests themselves is controlled largely by the climate and geological influences operating through the soils. However, given enough tens of thousands of years of freedom from geologic upheaval, the soils become essentially a manifestation of climate rather than of geology. Most silvicultural manipulation of the forest vegetation is basically accomplished by what are, in a certain sense, deliberate modifications of climate and soil on a scale which is microscopic by comparison to powerful natural influences. Clearcutting, for example, creates a microenvironment favorable to seedlings of species that require abundant light, water, and chemical nutrients. Various forms of partial cutting favor those which do not require such abundance of growth factors and may even require shade. Tree cover and its silvicultural manipulation can greatly modify the microlimate within the stand. However, the effect of the forest on rainfall and the regional climate is negligible (Holzman, 1937; Penman, 1963); this kind of climate governs the nature of the forest and not the reverse.

Trees have both advantages and disadvantages from their status as perennial plants with woody stems. The strong stems enable them to grow tall and display large areas of sugar-producing leaf-surface in depth for comparatively efficient use of solar energy. This attribute makes a forest nearly as effective in producing raw organic matter as intensively managed fields of sugarcane or corn. If so much of what the trees produced did not go into humanly indigestible wood, forests would be looked upon as massive food producers. Since the tree stems must be strongly built to support the heavy crowns and withstand severe wind loads, the load-bearing wood has instead become, historically and currently, the most important structural material used by man.

This high capacity to store energy and grow organic matter cannot, however, be achieved without maintaining large amounts of living tissue distributed in substantial depth above ground. To grow effectively, trees are committed to a mad race for the sky which makes these living tissues increasingly exposed to all sorts of damage and dangers. Although they have many adaptations, such as seasonal leaf shedding, to enable them to lapse into protective dormancy, the otherwise advantageous perennial habit does not allow them to become as completely dormant as herbaceous plants. Therefore, trees cannot stand shortages of water resulting from low precipitation or immobilization of water by cold as well as grasses and other plants of less impressive stature.

Because of this, forests occur only on that all too modest proportion of the world's land surface where unfrozen water is available for substantial portions of each year. Much of the water that flows seasonally or continuously in streams comes from forests. However, this is because trees occur where there is a good water supply and not because they somehow produce it.

Actually trees are quite wasteful of water, the water that flows out of forests is that which the trees were incapable of returning directly into the atmosphere by transpiration. Forests are the best sources of water because their beneficial effects on the quality and the distribution of water outweigh the reduction in quantity of water (see app. M by Earl L. Stone). The earthworms and other soil organisms that feed on the dead organic matter produced by the forest churn the mineral and organic material into a porous mixture that is the soil. The amount of organic matter is so great that normal forest soils are more porous and readily infiltrated by water than most other kinds of soil. Water which sinks into the soil does not erode and can emerge again in clear-water springs. Water which flows over the surface can remove soil materials and thus erode and cause streams to be turbid.

Forest soils remain highly porous as long as the leaf fall from vegetation renews the supply of organic matter that covers the ground and is pulled into the soil by the organisms that feed on it. One kind of forest vegetation is about as good as another in this respect. Prompt natural revegetation can be depended upon after most kinds of forest disturbance short of very hot fires or scraping action which exposes raw mineral material. The revegetation is not necessarily of plants desirable for other purposes but it does protect the soil. Compaction by the hooves of high density of domestic grazing animals or heavy machinery can



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also impair soil porosity even though plant cover remains.

The forest soil is also inhabited by fungi and bacteria which are essential to the continued life of the system. They complete the breakdown of organic matter and thus release for reuse the chemical nutrients previously taken from the soil by green plants. They also produce substances that chemically decompose rock materials thus feeding new chemical nutrients into the living system; this contributes to the replacement of nutrients lost to the local forest system through streamflow, timber harvests, and feeding by mobile animals.

Some of the bacteria are absolutely essential to capturing nitrogen from the atmosphere and converting it into forms that plants can use for protein manufacture. Other organisms and processes are continually converting nitrogen compounds back into forms that can escape not only into moving waters but also and more importantly into the atmosphere. Nitrogen is one of the most vital chemical elements and is different from the others in that it is of nonmineral origin and its upward mobility allows it to escape from the system more readily. The most intimate relationship between trees and root-inhabiting fungi is one in which the trees commonly feed the fungi sugar and the fungi capture soil nutrients more efficiently than the tree roots themselves can.

The animal life of the forest includes such lowly organisms as insects, nematodes, and mice as well as deer, songbirds, and foxes. The kind of forest governs the animals very much more than they affect it, although there can be episodes and stages in forest development at which the reverse influence can be powerful. As indicated in the report by William L. Webb, the influence of the vegetation operates through the kind of food and cover which it provides.

The herbivorous animals get their food by feeding directly on the vegetation, but others, the carnivores, derive energy from plants by feeding on the herbivores. The transfer of energy from one level to another is quite inefficient; it is usually estimated that only about one-tenth is transferred from one stage to another. This means that a carnivore could capture roughly one-hundredth of the energy fixed by the green plants and a secondary carnivore, only one-thousandth. It is because of this that the plants are the basic ruling influence and also that rapacious carnivores actually live a precarious existence.

The animals do not depend upon the forest for food alone but are also controlled by the kind of cover that is available against climatic elements and attack by carnivores. It is the relative balance between food and cover as well as the amount of both that usually determine the abundance and health of a particular animal species.

The feedback from the animals to the forest vegetation can be exemplified in many ways. Insects, along with parasitic fungi, are a major cause of mortality among trees of all ages. They can sometimes terminate the life of whole stands and commonly kill trees that have become debilitated for any reason. Tree species that are especially palatable to particular species of browsing animals can be nearly extirpated from young stands. On the other hand, some of the heavy-seeded trees species that grow from nuts or acorns could scarcely be dispersed or germinate but for the rodents that bury the seeds and fail to eat all of them later.

Even the green plants of forests seldom consist of trees alone. Shrubs and herbaceous plants are usually present beneath the trees. They may be temporarily absent beneath dense stands of sapling trees that have usurped the productive site factors for a limited period of time but were usually present at an earlier stage and will return in later ones. These lesser plants subsist on light, water, and nutrients which the trees are unable to utilize. The subordinate plants thus resist tendencies for any of these productive factors to escape from the system. Many of them are adapted to use very temporary seasonal surpluses. The colorful spring flora of many forests, which blooms before the new tree leaves develop and dwindles as they expand, is an example of this.

All of these phenomena point to the conclusion that the forest ecosystem is dominated by living organisms that have physical and chemical means of seizing solar energy, water, carbon dioxide, nitrogen and soil nutrients from their environment for their own life support. If one species is not adapted to take advantage of a supportive factor or a vacancy in the growing space, another will. The more favorable the collective physical and chemical factors of the life-support system, the greater the potentiality for complexity in plant and animal life.

## Role of Cutting in Applied Forest Ecology

Vegetation tends to grow to occupy all the available growing space, that is, to use all the life-supporting factors available to it. Some light, water, carbon dioxide, or nutrients escape being used and are thus unavailable only because deficiency in the supply of one limits capacity of plants to use others. Since they live year after year, trees have an especially high capacity to fill the available growing space; in combination with the other forest vegetation they swiftly occupy any vacant space left by lethal disturbances. It is partly because of this ability for rapid and full reoccupancy of vacant growing space that forest ecosystems, managed or natural, tend to retain chemical nutrients, especially those in short supply.

If the forest vegetation fully occupies the growing space, new trees cannot become established and grow significantly unless vacancies are created in this growing space by the death of at least some of the occupants. Similarly many trees must die during the life of a stand as others prosper and expand into newly vacant growing space. These processes by which death and destruction lead to birth or constructive growth go on in nature; the natural vegetation has evolved to include plants capable of responding to any kind of natural disturbance to which it has been exposed. If, as is commonly the case, there have been natural fires, windstorms, or lethal pest attacks in a locality, then there are species adapted to take advantage of the destruction.

The branch of applied ecology called silviculture is based upon use of these response mechanisms. The objective is usually to redirect the productive capacity of the forest into new trees or the better growth of existing ones, depending upon what sort of human benefit is desired. Since the growing space is nearly full, nothing can be added without removing some or all of the plants by killing or harvesting them. The methods of doing this are designed to simulate or accelerate the kinds of seemingly destructive natural disturbance that have produced the kind of vegetation desired.

The most economical way to kill trees is to harvest them and put their wood to use, although this is not the only way. If wood were useless and it were desirable to replace or modify forest vegetation for reasons of esthetics, recreation, wildlife, water, or grazing, it would be impossible to do so without killing trees, unless natural processes happened to lead in desired directions.

### Natural Succession

Forest ecosystems are dynamic and constantly changing rather than static or changeless. One of the most important processes of change is that in which successions of different assemblages of species replace one another in sequence after significant disturbance (Oosting, 1956; Daubenmire, 1968). The longest plant successions are primary ones which start with the colonization by plants of raw earth exposed by geologic upheaval. Those involved in most forests and forestry are secondary successions in which the earliest rebeginning would be on bare soil which already contained organic matter.

The earliest possible reinitiation of secondary forest succession starts with so-called pioneer stages arising after lethal fires, true clearcutting, or such similar disturbance as agricultural cultivation. Most, but not all, pioneer species are characterized by dissemination over long distances, resistance to exposure, rapid but not prolonged growth, short life, and inability to endure shade.

A high proportion of the tree species that live long and grow to the greatest sizes are those adapted to natural circumstances in which disturbances such as fire are rather severe but come at long intervals. If fires come only at intervals of a century or more, any species adapted to replace itself only after such fires must also be adapted to live and bear seed at substantial age. Among the species that most nearly fit this category are west coast Douglas-fir, yellow-poplar, redwood, the white pines, and most of the southern pines. Not only must they live for many decades but they must also develop bark thick enough that at least some seed-producing trees will survive the fires.

Pioneer vegetation, if not renewed by major disturbance, is replaced by other species adapted to become established beneath and survive the shade of the earlier stages. Often there is a series of discrete stages in which one species or group of species replaces another. In general, the later a species comes in succession the greater is its capacity to endure shade and to respond with vigorous growth when released from domination by the trees of the previous stage. Replacement of one stage by another does require some lethal disturbance of slight or moderate intensity. In nature, this usually takes the form of windthrow or killing by insects and fungi (Spurr, 1964). Fire or any disturbance that kills the so-called advance growth beneath old stands usually sets back the natural succession.

If the successional sequence proceeds for a long enough period, usually several centuries, without major disturbance, a relatively stable end-stage called the climax vegetation will develop. Prominent within it will be species usually characterized by high capacity to endure shade, low resistance to exposure, and slow growth in the seedling stages, large capacity to respond to release, rapid growth in middle age, and intermediate longevity. Since these species can reestablish themselves almost continuously without significant disturbance, they have not become adapted to survive to the great ages and sizes associated with species adapted to respond to major but infrequent disturbances.

It might seem plausible that the climax stage should consist of pure stands of the one most shade-tolerant species but this seldom happens. In reality, the climax vegetation usually exhibits great diversity of species and various processes interact to produce a high stability in the vegetation (Odum, 1971). This condition tends to persist so long as there is no major disturbance. However, maintenance of the diversity probably depends on the fact that disturbances of small areal extent, such as small windthrow patches, are severe enough in localized spots to renew species of earlier successional stages. The stability that exists is typically one of modest fluctuations around an average condition in a dynamic equilibrium rather than one of a static, changeless equilibrium. The most extreme pioneers are usually incapable of surviving in the climax vegetation.

There are some well-nigh insoluble philosophical questions about whether the final stages of succession are superior to the earlier ones. The diversity of vegetation and other conditions in the climax stage does tend to buffer the system against drastic change as by diluting the effects of pests of single species. It is sometimes argued that the progress of natural succession is progress indeed and directed toward successively higher stages in some grand design of nature. Some ecologists and foresters are sufficiently impressed with the approximation of stable equilibrium in the climax vegetation as to imply that ecology exists or at least can really be understood only in this condition. Others, particularly foresters (Lutz, 1963), favor the view that any stage is an equally valid part of any grand design of nature. There is also evidence (Reiners et al., 1971) that the process of natural succession includes features that could be regarded as degradation. Advocates of the maintenance of earlier successional stages are inclined to point to the fact that in some regions and on some sites fire, other natural disturbance, or poor soil conditions have almost permanently prevented real climax stages from developing. In any event, the stable climax forest in which growth is balanced by decay, as postulated by Odum (1971), could not be one that yielded wood for human use.

## Combining Ecological Principles and Social Objectives in Silviculture

In silvicultural practice, the general tendency is to determine which stage of succession is socially and economically most desirable and then simulate the kind of natural disturbance pattern necessary to maintain it. This policy may seize opportunistically upon the rapid juvenile growth of true pioneer stages, the large tree sizes and long-sustained growth of species of the intermediate stages, or the stability and gentle disturbance associated with the final stages of succession. Circumstances of nature and human requirements change enough in both time and place that observers can easily become bewildered over the seeming inconsistencies of variations in silvicultural practice and ecological ideas. It is the basic premise of this report that there cannot be one consistently best way to manage all forests.

Even an urban parking lot is part of some ecosystem; since it interacts with its environment it is an ecological phenomenon. It contributes to a very unnatural balance in its ecosystem, partly because what life it has must derive its sustenance from outside. At the other extreme, the sustained-yield forest, managed for timber production, probably comes as close to the internally balanced ecosystem as any of the works of man.

It differs from the entirely natural forest mainly in that wood is removed and ultimately decomposes outside rather than inside the forest. In either case, carbon dioxide and water, the chief decomposition products, return by way of long atmospheric cycles. In fact, if an amount of carbon equivalent to that in all the fossil fuels ever burned were currently locked up in the existing wooden structures of man, it could be said that the building of wooden homes had, by itself, kept the world atmospheric balance of carbon dioxide and oxygen at the precivilization level. Such a state of affairs does not exist, although wooden housing is hardly the only means of balancing the account. However, given the fact that modern man burns much fossil fuel, the illustration provides part of the reason for the view that forests which are managed and used contribute more to the balance of a modern human ecosystem than man-free and purely natural forests could.

The goal of forest management, with its concepts of sustained yield and multiple use, is basically to maintain, on a broad scale, an ecosystem which is balanced in terms not only of natural factors but also of the anticipated requirements that human society places on the forest. Forestry is historically the first kind of resource management that started to proceed on ecological principles and on time horizons measured in decades and centuries. James W. Toumey (1928), one of America's first ecologists and first foresters, stated that plant ecology was an outgrowth of scientific silviculture rather than the reverse. He pointed out that when Haeckel coined the term "oecology" in 1866 and "biologists took their investigations of the relation of plants to the environment from the laboratory to the field, they found the silviculturist already there with the accumulated facts of a century of fieldwork." The chronic debate about the ecological validity of silvicultural procedures is mainly evidence of the complexity of ecosystems and the problems of balancing present human wants against those of posterity.

The agricultural cropfield is an ecosystem also but a far more artificial one than the managed forest. In agriculture, there is an attempt to offset the degradation resulting from human use of the land resource, by artificial inputs typified by fertilization and plowing. In forestry, most efforts at combating degradation are directed at maintaining a system that is as nearly balanced as possible internally by taking advantage of natural processes.

The forestry profession has traditionally been torn by debate about how closely it can safely emulate agriculture at one extreme or the degree to which it should simulate the man-free natural forest at the other. Many ecologists and some foresters incline, at least subconsciously, to the view that the only ecologically sound kind of forest is that which would develop in nature after centuries of freedom from severe disturbance or human use. For anyone who adhered to this view there would be few forms of timber production or forest use, if any, which would not be an infringement upon the environment. As Lutz (1963) stated in a review of this general question, it is doubtful that any scientific ecologist or forester ever went quite so far as to equate the purely natural state with the perfect one. Neither have they stated that the best way to treat a forest is not to manage or use it at all. Nevertheless the idea is plausible enough that it has continually commanded some credence in lay circles.

The most common defense of clearcutting and other seemingly drastic forestry practices is also a naturalistic one. As Spurr (1964) pointed out in a work on forest ecology, there is ample evidence that even the purely natural forest was not only subject to catastrophic fires, blowdown, and similarly severe disturbances but was also adapted to respond to them. If a kind of forest and forest site has shown a humanly desirable response to severe natural disturbance, it is reasoned that there is precedent for simulating the disturbance. It is prudent to observe that, regardless of whether natural disturbance be slight or severe, the idea that nature does not impair its own environment is hypothesis rather than proven fact. Environment also has a human dimension the criteria of which are not necessarily the same as those of man-free nature. While they are not safeguards that can be depended upon to operate automatically or swiftly, long-term economic considerations ultimately defeat timber-growing practices that are ecologically unsound. The trees live so long and are so difficult to protect that nature ultimately exacts a costly toll from unwise alterations of the biotic environment.

The biotic environment can unquestionably be impaired by excessively wide and artificial departures from nature. However, the natural forests and the processes within them are so flexible and variable that they do not provide simple criteria of what is or is not damage to the biotic environment. While natural precedent is one useful criterion, it must be supplemented and modified by those of human objectives as well as the more simply measured ones of the physical environment.

### The Effects of Leaving Forests Alone

While this report is concerned largely with the effects of active intervention in the development of forests, it is well to consider what happens if forests are left alone as in wilderness areas.

The truly wild forest would yield slightly less water in stream runoff than one in which there was occasional cutting; reductions would be greatest during the growing season when streams are normally the lowest. Flood and other runoff peaks would generally be slightly lower downstream, although much would depend on the relative importance of snow storage on the land and whether sun or warm rain caused the melting. Snow drifting would be less in the wild forest so that there would be less opportunity for snow storage in the delayed melting of deep deposits. The general quality of the water would be the highest naturally obtainable because there would be only natural erosion and the natural deposition of organic matter in streams to impair it. Water temperatures would be, on an average, the lowest that could be obtained without artificial measures designed to make streams deeper. This would be favorable to most game fish of streams except to the extent that windfallen trees impaired other favorable characteristics of streams.

Because of the presence of flammable dead standing trees or snags the number of lightning fires would increase. Because of reduced access by man the number of man-caused fires would be reduced but the fires would tend to be more extensive in area regardless of whether or not effort was made to suppress them. The question of how hot the fires would burn would depend on how much fuel had accumulated in the form of dead trees and litter. Where climate and soil favored swift decomposition of such fuel, any fires would normally be less severe on a given unit of area than in forests where such debris periodically accumulated after cutting. The opening of the forest canopy causes wider fluctuations in fuel moisture than in the undisturbed forest so the dry periods are dryer and the wet periods wetter. While the average severity of fires would generally be less in the wild forest, it must be noted that the most severe fires now tend to occur in areas of unsalvaged blowdown and insect kills of the sort that would be associated with the wild forest.

If a forest were left deliberately alone it is obvious that many of the trees would get older. However, not even trees live forever; all would ultimately succumb and the processes of forest development are such that many trees would die along the way long before the last of their contemporaries did. The characteristics of the forest that would ultimately and gradually develop would depend greatly on the kind and degree of disturbance that they suffered, or were permitted to suffer.

If the disturbances that renew the forest were small and gradual, species of trees capable of tolerating shade and typically starting under other trees would gradually take over in the process of natural succession. If the disturbances were in the nature of moderate or severe fires, blowdowns which churned the soil, or major insect kills, there would be more opportunity for the natural succession to reverse and for shade-intolerant species to maintain themselves. Since they go with the early or middle stages of succession, the grandest species of the forest would become less common in the absence of at least moderate disturbance. In other words, in the absence of major disturbance such species as Douglas-fir, redwood, yellow-poplar, and the white pines would diminish greatly in abundance. The inevitable minor disturbances would favor those such as the true firs, hemlock, and the maples; while the resulting forest would be less magnificent it would have greater variety.

Nevertheless the forest left alone would attain an average age substantially greater than one subjected to silvicultural manipulation on economic rotations. Most of its ailments would be those of old trees and stands rather than young ones. While young forests definitely have their maladies, old forests have more if only because the trees must pass through the vicissitudes of youth before they can become subject to those of age. Heart rots are more common in old trees than young ones. There are also certain kinds of insects, such as *Dendroctonous* bark beetles and the many forms of the conifer defoliator misnamed the spruce budworm, that generally get started only on elderly trees. The result is that one would have to say that the forest that was left alone would be less healthy than one under sound silvicultural management. Imprudent silvicultural management might create unhealthy stands.

Because the trees attain considerable height and are likely to remain for long periods after full height growth is attained, the wild forest is more subject to severe wind damage than those managed on economic rotations.

Animal populations are ultimately controlled by the vegetation on which they must directly or indirectly feed. The larger herbivorous mammals and birds which include most game species thrive best feeding on low vegetation. Therefore, low, young forests actually have far more game than tall, old, and magnificent ones. This observation is sometimes extended to statements that old forests are biological deserts, but it might be more correct to call them game deserts. Old forests probably support as much or more animal life as young ones but there may be a higher proportion of small birds, squirrels, insects, and other organisms that inhabit the high foliage canopy or the soil. The old forest usually has a more diverse fauna than the young; thus, it is more intriguing for the bird-watcher but less so for the hunter.

From the foregoing it can doubtless be inferred that the characteristics of the forest that is left alone depend heavily on the kind, severity, extent, and frequency of natural disturbances that occur it it. There is great natural variation in such disturbances both regionally and locally.

There are very hard questions about the extent to which society is really ready to leave any forest strictly alone, particularly when it comes to questions about control of fire and other damaging agencies. As late as 1950 it was a matter of either policy or parsimony that fires were not controlled on the vast areas of public domain in the Alaskan interior which represented a kind of defacto wilderness area; several million acres burned each summer and the smoke from these fires and similar ones in Canada occasionally darkened the skies across the continent. Serious questions have also arisen about unnaturally large fuel accumulations and similar problems that have arisen from attempts to exclude fire and hunting on national parks and the questions have no simple answers. The management of wilderness areas or similarly untouched areas must at the very least include decisions about the sort of disturbances that will be tolerated.

If a forest is deliberately left alone as a matter of policy, opportunities for human use both are and must be very limited. It is an illusion to believe that any forms of recreation use other than the very lightest are compatible with maintenance of undisturbed forests. Intensive recreation wears the soil and vegetation as hard or harder than sporadic timber harvesting and forests used for this purpose require correspondingly intensive silvicultural treatment. The more extensive kinds of recreation, such as hunting and hiking, are in practice more available and feasible in accessible, managed forests than in roadless wilderness.

There is ample reason to reserve undisturbed wilderness areas and smaller natural areas for primitive experience, inspiration, and scientific values but these should not be confused with major recreational objectives. The concern about large, remote wilderness areas should not obscure the desirability of setting aside more small, undisturbed natural areas in old-growth timber on good sites in the West (Moir, 1972). Likewise, where there are no longer virgin forests as in the East, advantage may be taken of the fact that forests do not take many decades to revert to essentially undisturbed condition if they are left alone. There is no doubt, if there ever was, that wilderness and natural areas should be reserved and left undisturbed; the only questions are about their extent and location.

## FOREST PRACTICE STANDARDS AND THEIR ATTAINMENT

Any consideration of public policy about forestry practice must proceed from identification of the social benefits sought and the public dangers that might be averted by sound practice. On public lands, it is possible to proceed quite directly. The same society that reaps the benefits pays the costs and can, through its legislators and administrators, set high standards and cause them to be attained. As far as the vast area of private forests is concerned, however, the lines of authority and responsibility are tangled and some of the issues are cloudy.

Damaging influences that may be induced on the land of one owner and spread to inflict harm beyond his boundaries fall in the category here called public dangers. The most important of these are taken to be fire, spreading biotic pests, injuries during log transportation, and erosional effects moving downstream. There seems ample precedent for laws and regulations to curb actions of one party that may cause these demonstrable kinds of damage that may spread to harm the interests of others. Nevertheless there is the knotty question of whether the owner or logger of forest lands owes a greater duty to prevent damage to the environment than do such industries as agriculture and construction. This particular point is critical with respect to watershed damage.

While government may logically take action to prevent harm, it is questionable how far it should go in requiring private forest owners to provide public benefits. Such benefits as wildlife, attractive scenery, and continuing timber supply may be more valuable to immortal society than they are worth to a private owner who pays the cost of providing them. Voluntary action provides some of these benefits and there is some precedent for enforcing rather minimal standards by law. However, public action to increase such benefits from private land logically depends more on providing incentives, mainly of a financial nature, than on legal coercion.

## Prevention of Injury to Public Interests

### Fire

Fire is the classic example of a public danger with harmful influences that may spread across property boundaries. There are already plenty of laws about fire in forests and there can never be enough action in forest-fire control. Some of the laws requiring disposal of slash (logging residues), especially in the West, may even lead to undesirable environmental consequences.

Policies requiring slash burning have already collided with equally laudable ones aimed at cleaning the air. The evidence available indicates the burning forest fuels harm the air by adding dirty particulate matter rather than significant amounts of noxious gases (Fritschen et al., 1970; Dieterich, 1971; Hall, 1972). Nevertheless visibility restrictions and the amount of relatively inert dirt can be large enough to cause real concern. Not a little of the clearcutting decried in some circles is the direct result of slash-disposal requirements, since slash disposal, especially by burning, is most effective after clearcutting. Conversely existing restrictions on burning have also led to dangerous accumulations of fuel in some forests and the failure of desirable fire-following plants to regenerate themselves adequately in other places. The circumstances surrounding the use and control of fire in forests vary so widely from State to State that one can do no more than suggest that laws and policies be kept under constant objective and analytical review.

Laws about fires are not the only manifestation of the exercise of public responsibility in the control of damaging agencies that are capable of spreading through forests. Bitter experience has shown that forest-fire control cannot be effective unless it is a function administered, coordinated, and largely performed by governmental units of substantial geographical extent. Fires, insects, and other spreading sources of damage do not respect the property boundaries that may subdivide forests and it is for this reason that their control has so commonly become a public function rather than one of individual ownerships.

### Erosional Phenomena

While they are only seldom a source of as much public danger as fires, various kinds of erosion can also endanger public interests. Erosion harms twice; first, it damages the land that is eroded and second, the land or bodies of water where the eroded materials are deposited. The second kind of harm can be great enough to be cause for public regulation of forestry practice because it falls within the category of damage which may start on one ownership and spread to others. As is stated in a companion report by Earl L. Stone, virtually all of the erosional damage caused by forestry operations comes from road construction or other actions involving wholesale scraping or compaction of the soil. Cutting of trees and fire, in themselves, cause little or none. If erosion starts, it is usually because the porous surface soil, rich in organic matter, has been pushed aside or is severely compacted. Such damage can start not only from log skidding and road construction but also from the use of bulldozer-like machinery for certain silvicultural operations. It is often an act of misplaced concern for the soil to use such machinery rather than fire or herbicides for preparing sites for regeneration, controlling undesirable vegetation, or slash disposal. The rolling brushcutter, which chops living and dead organic materials but leaves them in place, is a welcome departure from scraping devices which may seem to do a neater and cleaner job.

The most important step that can now be taken to reduce environmental damage from forestry operations is to extend stringent regulation of soil-damaging activities to all States. Such regulations should include standards for the construction of forest roads and their maintenance while in use, provision for the revegetation and drainage of abandoned roads, and control of operations that result in the scraping of the forest floor.

The damage reduced would be that from siltation of watercourses, burial of good soils by poor, spreading of waters from clogged stream channels, destruction of habitat of acquatic life, accelerated eutrophication of waters by excessive amounts of chemical nutrients, and impairment of water quality (Federal Water Pollution Control Administration, 1970). In some extreme situations, it is essential that forestry practice be regulated to prevent avalanches of snow or rock debris, the most spectacularly dangerous kind of erosion.

It should not be inferred from this that existing timber-harvesting practice, even at its poorest, is a major source of damage to downstream interests. Practices that are taken as routine in agriculture, public road construction, waste disposal, and building in suburban and urban areas actually cause very much more of the kind of damage under discussion. It may be fairly asked whether regulations applying to forest land should be more stringent than any others. The public has traditionally expected and is probably entitled to expect that the waters flowing from forests will be of the highest quality. Such a goal is closer to attainment on forested watersheds than on any others; high standards can also be maintained with less effort and expense than with most other kinds of land use. More stringent regulation of logging roads and similar works in the forest must be based on this kind of philosophy rather than any idea that all forms of land use should conform to the same standard. If that were the only goal, forestry would be more nearly the last than the first activity to regulate.

Soil compaction by dense populations of grazing animals in the forest is probably potentially capable of causing more erosion than anything done in conjunction with timber-production forestry. On public lands there are the legal means of attempting to keep the situation under control. The regulation of grazing on private lands would be a hopeless cause. Fortunately the use of forests for grazing is decreasing for economic reasons, so it is easy to rationalize restricting activity to educational efforts designed to diminish the practice.

#### Pests

Some, but not all, forest pests are capable of spreading through whole forests irrespective of boundaries in much the same way as fires. As far as public action is concerned, the chief weapon against them is coordinated public control or management of these pests. In the case of exotic pests that have been or might be introduced, quarantine laws or regulations exist to reduce the rate of spread or risk of entry. It is important to note that introduced pests include undesirable green plants and higher animals as well as fungi and insects. Existing legislation is generally adequate, although public action programs are uneven in effectiveness.

#### Logging

The felling of tall trees and the transportation of heavy, bulky logs make logging an inherently dangerous operation. The hazards spread along the transportation network and people spreading onto logging areas are also exposed to these dangers. The greatest risks are to persons directly engaged in the work and the safety record of the logging industry is poor. In general, the laws, regulations, and actions that would safeguard the workers are the same as those that would protect the general public from injury. The Occupational Health and Safety Act of 1970 and its enforcement programs should aid as much as legal action can in improving the situation. Educational activities have helped and can help more in making logging safer.

As is so often the case, desirable objectives can conflict. Much of the danger from logging to the general public goes with forest roads. If it is logical from the standpoint of watershed protection that logging roads be narrower, it must be recognized that their use will be more dangerous. One solution to this dilemma may be greater readiness to close such roads to public entry during periods of logging use or sometimes permanently. Such action would often need to be reinforced by law and by gates.

### Attainment of Public Benefits

While it is clear that a private owner may not inflict harm, the extent to which he may be required to produce public benefit is debatable. Our sociopolitical system has evolved to the point where it is no longer a question of whether he should produce such benefit but rather of how much and in what ways the public should share the burden with him.

#### Fish

Fish and other wildlife, being mobile, spread across property boundaries and are thus generally treated as public rather than private property. The management of fish populations for public benefit is obviously closely linked with that of watercourses. Appropriate precautions are already common, but not universal, in logging. The regulation of road systems and soil disturbance previously recommended for control of erosion and damage to streams finds much of its justification in safeguarding fish.

Additional measures are necessary to maintain proper conditions for fish, notably trout and salmon. In addition to controlling siltation, it is important to maintain low water temperatures and to prevent streams from being blocked by or overloaded with organic debris (Lantz, 1971). High water temperatures reduce the solubility of oxygen in water and excessive amounts of decomposing organic matter deplete the oxygen supply. Fallen trees and other organic debris impede passage of fish which must travel along streams to complete their life cycles.

The retention of streambank vegetation for shade is effective enough in preventing overheating of water that it should be a legal requirement. The shading effect is so localized that retention of typical understory streambank vegetation within a few feet of a stream is ordinarily sufficient. However, the wider the stream the taller is the vegetation required. Strips of such vegetation can also help trap any eroded materials that escape from more distant points. It is not always necessary or desirable to require the reservation of sizeable trees. The amount of shade that they cast is not often sufficiently crucial. Furthermore, the reservation of narrow strips of tall trees is often an invitation to stream-clogging blowdowns.

Any sort of deposition of organic debris in streams during logging operations should be prohibited. There should also be standards regarding bridges and culverts as well as regulations about the use of heavy machinery in their construction.

Any such regulations must be based on clear and enforceable definitions of the treatments and the characteristics of waters that are to be protected.

### Terrestrial Animals

Animals do not live by food alone but have other habitat needs as well. Protective cover, such as that which some species find in tall forests, is often a critical factor. The middle of a 500-acre circular clearcut would have plenty of browse for deer, but might be too far from protective cover for them to use. This phenomenon might, of itself, argue for setting limits on the maximum average width of clearcuttings, provided that it is concluded that private owners owe any duty to the State in fostering its population of large game animals.

The preservation of rare or endangered species of animal life is a matter of high public concern. This is manifested by the numerous laws enacted against the killing of such animals. The recent issuance of regulations designed to eliminate the inadvertent killing of such animals through the indiscriminate use of poison baits to control pest mammals is another practical manifestation of this concern. Further safeguards normally depend on maintaining the habitat of such animals. Where it is essential that existing habitat be left undisturbed or that vegetation be managed for the primary purpose of favoring such animals, it is best that the land be in public ownership. There are, however, instances where the right kinds of silvicultural disturbance or such actions as creation of den or nesting-trees will help rebuild the population of a rare or endangered species. In such cases there is ample evidence that most private forest owners will undertake appropriate action voluntarily if the need and the means are made clear to them.

### Forest Productivity

Over a period of some decades, American public policy regarding the productivity of forests has gradually evolved from a time when there was total lack of concern; the present status can be most soberly described as one of slight to moderate concern. The rate of evolution has not been uniform geographically nor has it been either steady or always progressive. The Panel is explicitly charged with responsibility seeking ways of maintaining supplies of timber in perpetuity and, implicitly, at high levels. Therefore, it is logical to analyze the role which public regulation might play in ensuring that wood, like other forest benefits, continues to flow into the national economy from private lands.

The fundamental source of forest production is the combination of factors collectively called the site. So long as solar radiation, carbon dioxide, and water can be depended upon to come from above, the part of the site that needs to be passed on undamaged to posterity is the soil. The measures necessary to protect the soil are generally the same as those previously described as means of forestalling clear and apparent damage to public waters. The waters are more sensitive than the soils; what saves damage to water will ordinarily protect the soil. The most important exception to this statement has to do with the effects of very hot fires and fires on organic soils, but there is already ample legal control of the use of fire. Furthermore, the chief protection of the forest soil is the vigorous and prompt revegetation that typically follows disturbance of the forest.

As far as timber production is concerned, the next level of consideration is the kind of vegetation. For many forest uses other than timber production it does not, in the last analysis, matter very much what kind of vegetation clothes the ground. In timber production, on the other hand, it is necessary that there not only be trees in the vegetation but also that they be of potentially useful species and quality. Because of this, some States have enacted requirements that productive forest lands, that are to remain in forest, be naturally or artificially restocked after timber harvests. The requirements are usually stated in terms of viable seedlings of plausibly commercial species attaining specified minimum numbers per acre within a stated number of years after timber harvests. The standards logically differ from one locality to another even within States. This kind of performance standard obviates need for regulating details of procedure and is ordinarily sufficient to guarantee maintenance of at least minimal levels of timber productivity. It is significant that the principle of such requirements has satisfactorily withstood challege in the courts.

In this country, society has been unready to proceed beyond this point. In fact, only a few States have gone even this far. Those which have are ones in which timber is important to the local economy; they are often ones where, as in parts of the West, indiscriminate treatment could cause large areas of forest to degenerate to shrub cover. There are many States, especially in well-watered parts of the East, where the kind of minimal restocking typically envisioned would follow almost any sort of forest treatment.

Reluctance to proceed beyond this point in public regulation of timber-production forestry is based mostly on doubts about the wisdom or legality of dictating to private owners how they invest their capital. A number of additional measures would be necessary to approach optimum yield. Owners would have to be required to follow rotations that were neither so short nor so long as to waste production through premature or tardy harvests. No sort of continuity of efficient timber production from a given property or locality, even that far short of perpetual sustained yield, can be insured without requiring that some capital be left in presently merchantable growing stock in the woods.

Basic requirements for restocking do insure some degree of continuing productivity because forest owners can generally be depended upon to leave trees standing until they grow to the threshold of merchantability. However, as far as optimum social benefit is concerned, many trees become merchantable some years before they are economically mature. This kind of problem affects sawtimber production more than that of pulpwood. Furthermore, some commercial species of trees are more useful or productive than others; to cite the most crucial example, most softwood species are more productive than most hardwood species. Efficient timber production often requires some out-of-pocket investment in addition to those for restocking, especially if economic sawtimber production is the goal.

The situation is analogous to requirements about savings accounts. Society is sometimes willing to require that the forest owner maintain a minimum balance in the form of land reasonably well covered with potentially useful timber trees. However, it is quite another thing to specify a higher balance in the form of a required level of merchantable growing stock, to require further investments in the form of cultural treatments, or to force principal to be left in the account for a stated number of decades. There are countries, notably in Western Europe, where timber has long been in such short supply that many such details of forestry and land use are regulated. However, even there the system is coupled with many direct and indirect subsidies. In this country, at least for the time being, it is probably most logical to employ such subsidies rather than to go beyond minimal restocking requirements in maintaining timber production. The capital gains treatment of returns from timber growing is presently the most important single, beneficial, and indirect subsidy.

Where there is direct subsidy to private timber growing, it seems thoroughly logical that the public which provides the subsidy should dictate such matters as rotation length, and other details that involve use of capital.

Restrictions on land use potentially offer another indirect means of safeguarding future timber production and the flow of other forest benefits. If land is zoned such that it must be kept in forest cover, conscious timber production represents the chief means of recapturing the costs of ownership. Such action would be in keeping with the development of sound state and national land use policies. However, any such steps would be confiscatory of private rights unless adequately compensated financially by measures including, but not necessarily limited to, reduction of general property taxes.

#### Esthetic Resources

There seems little question that most of the present public concern about timber cutting practices is over their visual impact. Forests are beautiful and the immediate effect of most harvesting and silvicultural treatment is not. Many members of the traveling public see a cutting area only once and the fact that it may, after several years, again be beautiful is not visibly demonstrable to them. The same logging debris which will return vital chemical nutrients to the soil is typically viewed as an untidy mess that ought to be removed.

It is further presumed that what looks bad must be bad. Therefore, the reaction to the visual affront is the assumption that tree cutting must also be an insult to the environment. This assumption is not supported by the evidence that forest scientists have accumulated during the last century.

Any basis for public regulation of visual quality would have to be found in holding scenery to be a public resource and visible debris a public evil. The practical means of improving appearances are hiding what can be hidden, cleaning up or dispersing what cannot be hidden from closeup view, and artfully naturalizing the boundaries of clearcuttings on distant but visible slopes.

A combination of new and old New Hampshire laws exemplifies legislation that can be employed to deal with esthetic considerations. Only half of the merchantable timber may be cut in any one operation within 200 feet of public waters and highways. Older laws require disposal of logging debris within stated distances of those public ways as well as railroads and buildings. The newer law does not specify the pattern in which half the timber may be harvested but logically leaves latitude for the complete removal in small patches that is usually necessary for regeneration.

Outright prohibitions of cutting in roadside forests are ultimately self-defeating because trees do not live forever. There must be means of providing for cutting and replacement if there are to be sizeable trees along roads in perpetuity.

## FOREST PRACTICES TO PROTECT MULTIPLE-USE VALUES

In 1971, the Council on Environmental Quality commissioned the deans of five major forestry schools, well distributed geographically, to make independent studies of existing knowledge about clearcutting and other forestry practices in their respective regions. While these reports have not been published in their entirety, they have been available to the Panel. A summary of them, prepared by the Congressional Resarch Service in the Library of Congress, has been published in the Congressional Record of March 1, 1972, and also as part of a committee print of the Senate Committee on Interior and Insular Affairs, second session, 92d Congress, entitled "An Analysis of Forestry Issues in the First Session of the 92d Congress." These reports included recommendations about changes that might be made in forestry policies and practices, especially on Federal lands, to improve environmental quality.

The interpretations of fact, conclusions, and recommendations contained in this report on silvicultural matters are essentially the same as those advanced by the five deans and their associates. All five reports and this sixth one were prepared independently.

### Synopsis of Effects of Silvicultural Practice

The truth about timber cutting and other silvicultural practices often varies substantially from intuitive impressions about what this truth seemingly should be. Early American foresters started with many of the same misconceptions that now command popular credence. It has taken generations of experimentation both here and abroad to cure some of these misconceptions. While it is dangerous to generalize, it is astonishing how often systematic, quantitative observation has shown the truth to be nearly the opposite of what hasty application of intuition would suggest that it was.

The cutting of trees does not cause springs and streams to run dry; it actually increases the yield of water and the heavier the cutting the greater the increase. Even the burning of slash after cutting does not greatly modify the quality of runoff waters. Any significant damage to watersheds associated with cutting, in fact, typically over 95 percent of such damage, results from the roads and the nature of the cutting has almost nothing to do with it (Megahan, 1972). The primeval forest did not abound with game animals; since large animals feed on small plants, cutover lands are, at least for a time, vastly more productive of game than most mature or overmature forests could be. The atmospheric processes that control weather and climate operate on such a grand continental or hemispheric scale that the effect of any sort of forest treatment on them is miniscule; cutting has a powerful constructive or destructive effect on the microclimate of the treated stand but no measureable effect on the climate of a State or county. Clearcutting may seem to be the antithesis of sustained yield yet, if properly managed, it actually represents the pathway to the simplest and surest methods of insuring systematic replacement of old stands by new ones for attainment of sustained yield in perpetuity.

Most of the misconceptions about effects of timber-cutting operations arise from the fact that they all look bad; some, such as clearcutting, just look worse than others. The forester can see in his mind's eye the new stand of trees that will follow if sucessful regeneration measures are undertaken. However, to the casual onlooker, who may be convinced that trees exist but do not grow, any such vision seems more like a mirage. The notion that there could again be a fine or finer forest to follow can seem a dream, but such dreams are the mark of the long perspective which is the very stuff of true conservation. The forest is life, life is renewable, and life is the tireless engine which drives the endless cycles which support more life.

There are few if any ecosystems which man may manage that have more perpetual renewability than forests. Wood itself is among the most perfectly renewable of material resources. It consists of little more than substances derived from water, carbon dioxide, and incorporated energy from the Sun. Since forest vegetation tends to live up to the limit of the available growing space in the soil, few chemical nutrients escape the hungry grasp of the roots. Most of these soon move to the leaves which later fall off and decompose so that the nutrients return to the soil to start the circuit over again. One could extol the productive virtues of the forest enough to make it seem like a paradise.

Every paradise has a catch, however. The catch in the forest is that most new life is born only in death. Because the forest vegetation fills all the available growing space, there is no room in which new life may develop unless nature or man kills or removes some of that vegetation. If man had purpose in altering forest vegetation but no use for wood, he would be condemned simply to killing trees without the advantage of the useful wooden byproduct of his efforts.

The trees and other plants of the forest were designed long before man to adapt to the circumstances of nature. The life-renewing fatalities of nature were caused chiefly by such disturbances as fire, windstorms, and attacks of insects and fungi, although destruction by ice, floods, landslides, mammals, and other physical and biotic agencies was sometimes involved. The long process of evolution fitted the forest vegetation of any locality with plants capable of claiming any remotely hospitable vacancy that might come to exist in the growing space. Some new plants might appear only after destructive disturbance but others are adapted to a more subtle strategy in which they become established before the disturbance and lie in wait to burgeon after the right one comes along. The fact that decades or even centuries may elapse between appropriate destructive disturbances makes it difficult for even long-lived men to perceive that they occur at all or even to divine what their nature might be.

It is nevertheless on this knowledge of the effects of disturbance and in something like the time perspective of nature that silviculture, the art of planned disturbance of the forest, is built. In this, the most ancient form of applied ecology, it is seen that forests can be built as well as destroyed by fire and the ax. The objectives are to identify the kind of natural disturbance that has called forth the desired kind of vegetation and then to simulate this disturbance with the optimum balance between human benefit and harmful side effects. All the tools are double edged and can cut both ways.

## Magnitude and Variability of American Forests

The forests of the United States are so vast and bewilderingly diverse that generalizations about their nature and treatment must be made and used with extreme caution. The commercial forest area of 500 million acres exceeds that of all other nations except the Soviet Union, Brazil, and Canada. Furthermore, this vast American forest exists in a natural and social climate sufficiently favorable that it has a higher practical productive potential than that of any nation on Earth. The magnificent forest management of West Germany is, for example, conducted on 16 million acres for a population of 58 million people. It is, in fact, the shortage of land left over for forestry from other purposes that makes German forestry so efficient. Ohio, Pennsylvania, New York, New Jersey, and southern New England have, in combination, as many people, 2½ times as much commercial forest land of at least equal natural diversity, and a net timber deficit like that of West Germany.

Except for the fact that it extends only to the fringes of the tropics, the American forest has a diversity equal to that of Eurasia. By comparison it is more compressed from east to west and thus has a smaller treeless interior. In terms of forest conditions, the span from Maine to California equals that from the Japanese island of Hokkaido to Portugal and that from Puerto Rico (or Hawaii) to Alaska is comparable to the distance from Luzon to Lapland.

In the light of such immense geography and diversity it is prudent to anticipate that logical kinds of forestry practice will vary tremendously and that sweeping generalizations are treacherous. Not only are conditions of nature awesomely diverse but the social demands placed on the forest also change in both space and time.

## Silvicultural Practices and Terminology

Silvicultural treatments are far more numerous and varied than the simplified terminology applied to them might imply (Smith, 1962; Ford-Robertson, 1971).

One basic category of operations involves cutting or other treatments aimed at regeneration, that is, the replacement of old trees by new ones. In the second basic category are intermediate cuttings or tending operations which alter existing, immature stands but do not make way for new trees. The most important kinds of intermediate cuttings are thinnings and release operations. Thinnings are designed mainly to utilize surplus trees and stimulate the growth of remaining ones. Release operations usually have the purpose of freeing desirable species from undesirable ones that overtop them.

The regeneration operations are the most crucial and the final-harvest cuttings that make way for them are conducted in a wide variety of spatial and temporal patterns that determine the form of the new stands. The most important variations in stand architecture are those of the ages and species of the constituent trees. Pure stands are composed of trees of a single species, while mixed stands have more than one. Even-aged stands consist of trees of essentially the same age. Uneven-aged stands are defined as having three or more age classes so intermingled with one another that they are managed as single stands.

The new trees can arise from a variety of different sources and it is crucial to distinguish between them. Artificial regeneration involves the planting of nursery-grown seedlings or the direct sowing of seed in the forest. Natural regeneration can arise from seed or, with some species, as vegetative sprouts from the stumps or roots of the previous stand. Any natural supply of seed may be dispersed from adjacent uncut stands or be that produced by the previous stand before it was removed. Another important natural source may be the so-called advanced growth already established beneath the old stand before it was cut.

Cutting that leads to regeneration by vegetative sprouting is called coppice cutting. However, the more important methods of regeneration cutting are those in which reliance is placed on natural or artificial seeding, planting, or advance growth.

There are three basic methods of cutting that lead to stands adaptable to the relatively uncomplicated administrative techniques of even-aged management (Davis, 1966). These are clearcutting, seed-tree cutting, and shelterwood cutting. The cuttings that are aimed at the creation of maintenance of truly uneven-aged stands are all called selection cutting. The complex form of such stands is associated with elaborate techniques of uneven-aged management.

Clearcutting, in its narrow, technical meaning, involves the removal of virtually all preexisting vegetation to make way for the new crop. Seed-tree cutting differs only in that a limited number of trees are left as a source of natural seed. In shelterwood cutting many more trees are left as a seed source, to protect the new crop, or for additional growth; the new crop usually arises as an induced kind of advance growth beneath the old stand which is removed in stages. Under all three of these methods, as well as in most coppice cutting, the transition from the old stand to the new one is accomplished in a short enough period of time that then new stands are essentially even-aged.

Selection cutting is usually conducted by opening up small holes or patches in the forest periodically so that new age classes are continually recruited to maintain the uneven-aged condition.

The term "clearcutting" is unfortunately used rather loosely to refer to any heavy cutting or simply to the removal of all of those trees in a stand which happen to be merchantable. However, the present controversy about clearcutting does not result from this semantic problem; true clearcutting attracts as much popular criticism as pseudoclearcutting.

The term "selection cutting" and the seemingly similar one, "selective cutting," are also subject to loose and confusing usage. Any partial cutting, regardless of intent, which does not lead to the uneven-aged condition by successful establishment of new, free-growing age-classes is simply not selection cutting. Partial cutting which does not lead to regeneration is usually thinning; that which creates even-aged stands is shelterwood cutting. The terms "selective cutting" has become so thoroughly corrupted that it is now only a popularized term covering a wide variety of kinds of partial cutting.

The establishment of new crops often requires more than just cutting. It may be necessary to employ prescribed burning, herbicides, or mechanical treatment of the forest floor for site preparation. The purposes of such treatments include the reduction of debris and competitive residual vegetation as well as the creation of receptive seedbeds, all to make way for the new crop of trees.

There are many combinations and permutations of all the kinds of cutting operations and treatments that have been briefly reviewed here. There is also wide variation in the details of each technique and this subtle variation can be crucial to success. The ecosystems that are manipulated are responsive enough that no set of silvicultural techniques represents the only possible solution for a given situation. On the other hand, the limitations imposed by nature are powerful enough that it would be fallacious to assume that any silvicultural technique could be effectively applied in any set of circumstances.

## Implications of Various Methods of Regeneration Cutting

### Clearcutting

The practice of clearcutting has purposes which are easily misunderstood and effects that are prone to intuitive misinterpretation. The very nature of the operation is such that it makes cutting areas plainly visible. Any cutting area, including those created in partial cutting, looks bad until the new vegetation grows tall enough to be readily visible. The same appearances that are partly screened from casual view in partially cut areas are all too visible after clearcutting.

*Clearcutting and guilt by association*

It is not at all surprising that the dismal appearance of clearcut areas should lead to the assumption that the practice causes all kinds of damage to the forest and the environment. Early foresters were so convinced of this that they conducted a number of experiments for the scientifically dubious purpose of proving that clearcutting caused real damage to the physical environment. As indicated in the associated report by Earl L. Stone, these experiments showed that almost all such damage resulted from road construction and had very little to do with the pattern of cutting itself. Until the results of these experiments became available, American foresters generally looked upon clearcutting as unsound. The general public can hardly be faulted for resurrecting illusions which the forestry profession was once convinced were true.

Clearcutting carries an ill-deserved and heavy burden of guilt by association. Its silvicultural application is known by the same word and bears a superficial resemblance to what went on during the period when the American forest resource was being most rapidly mined and devastated. That era started around 1870 with the adaptation of the steam engine to logging. The stationary engines involved were difficult to move and the temporary nature of costly networks of logging railroads made the whole system a cumbersome one. The associated financial logic led to cutting everything merchantable over large areas in short periods of time. The land policies of the time envisioned agricultural use of most of the land so that any remaining trees were more of an impediment than an asset.

As far as heavy old-growth timber was concerned, this era did not end until the development, about 1930, of powerful but highly mobile trucks and tractors. This departure broke the unhappy interrelationship between old-growth logging, clearcutting, and the ponderous steam engine. To the limited extent that they were able to control cutting practice, the foresters of the time seized the new opportunity as a means of getting as far as possible from the real and imaginary evils of clearcutting. As will be described later in this report, some of this new departure proved to be unwise overreaction.

The consequences of the very heavy cuttings of 1870–1930 were disastrous enough that it was easy to ascribe them to the clearcutting. However, in most such instances, the forests might well have replaced themselves naturally but for the repeated fires that followed the clearcutting. Sometimes the clearcut areas were too large for adequate dispersal of seed from adjoining uncut stands, if this kind of seeding was necessary for natural restocking. The appreciation of this point did, in fact, lead to some of the early State laws requiring reservation of seed trees during logging. However, the prevailing attitude was that any sort of reforestation was hopeless, unnecessary, or even undesirable.

Forest fire control was practically nonexistent. Many States enacted laws requiring the burning of logging debris in an effort to reduce the threat of wildfires to farms and towns. Such laws sometimes had the effect of requiring the destruction of any residual trees and thus the forest. Regardless of whether the fires were legally required or accidental, they commonly occurred. Often they had the effect of substituting even more flammable grass, brush, or herbaceous growth for forest vegetation.

The result was the destruction of literally tens of millions of acres of softwood forest. Vast areas of the famous pineries of the Lake States reverted to aspen, much of it worthless. Most of the longleaf pine forest of the South was, after clearcutting, replaced by grass because of annual burning to improve grazing and the appetite of razorback hogs for longleaf pine seedlings. Longleaf pine has a remarkable affinity for fire but not for regular annual burning. Until fires were brought under control, most clearcut areas in the west coast Douglas-fir region were on their way to replacement by bracken fern which thrives on repeated burning.

The deforestation came not from the clearcutting but from what happened afterwards. The same is true of even more alarming cases in Eurasia which are more widely known than correctly interpreted. The deforestation and hydrologic damage which has impaired Mediterranean civilization may have started with clearcutting of forests but browsing by goats and repeated burning was primarily responsible for the destruction of forests and soil. Similar practices associated mainly with grazing deforested most of the British Isles. In some populous parts of the Far East, the pernicious practice of removing the litter of the forest floor for fuel and fodder adds to the damage. Any practice that has so many evil historical associations and is also unsightly is certain to be regarded as destructive.

Actually many kinds of forests are the natural vegetation resulting from major fires or other destructive disturbances taking place at relatively long intervals. Clearcutting merely mimics such disturbances. Some tree species even require such disturbance for their perpetuation. On the other hand, most tree species are not ecologically adapted to what amounts to annual or frequently repeated vegetative removal by fire or browsing animals. Grasses and shrubs are the chief kinds of vegetation maintained by such frequent destruction.

Clearcutting has been viewed with so much suspicion both here and abroad that it has commonly been prematurely blamed for problems caused by something else. In addition to the effects of fire, animal browsing, and nutrient depletion by litter removal, these other harmful influences have sometimes resulted from effects of previous agricultural use of the land, replanting with ill-adapted species or strains thereof, or the use of scraping devices in site preparation.

The relative merits of various methods of regeneration cutting are a chronic subject of dispute, often excessively doctrinaire, among foresters. Nevertheless there are times and places where certain views and practices have commanded majority support. Many American foresters were enchanted with selection cutting and uneven-aged management until the two decades from roughly 1930 to about 1950 brought them their first real opportunity to practice them. During those two decades, selection cutting came close to being the ruling silvicultural doctrine of the U.S. Forest Service and many other public and private forestry organizations.

A classic case was the effort to apply selection cutting in old-growth stands in the Pacific Northwest. One publication (Kirkland and Brandstrom, 1936) described what seemed to be the high promise of the technique; another, by Isaac (1956), recounted the ignominious consequences. Disenchantment set in during the late 1940's and again produced overreaction, this time in favor of clearcutting. The decades from about 1950 to the present have been ones during which clearcutting started an ascent to the level of ruling doctrine. It remains to be seen whether this trend is reversed and, if it is, whether yet another overreaction results.

*Advantages and disadvantages of clearcutting*

There have been many good reasons why clearcutting has been restored to respectability in silviculture throughout the world. Its application has been very far from universal but there are many circumstances, some temporary and some permanent, that make it an effective and advantageous technique (Shaw, 1970; Barney and Dils, 1972).

Clearcutting enables all the operations necessary for removal of an old stand and its replacement to be accomplished with a minimum of impediment from residual trees. There are few problems with such steps as the sideward shifting of the cable-yarding systems necessary for safe logging in steep terrain. In any kind of terrain, the harvesting operations are so concentrated that the length of road network used at any one time is held to an absolute minimum. Since roads and their use are the main source of environmental damage, this means that clearcutting may paradoxically cause less of such damage than removal of the same amount of timber in partial cutting.

Any measures for slash disposal or other fuel reduction, control of undesirable residual vegetation, site preparation, and planting or other regeneration operations can be done more cheaply and thoroughly than when there is no need to protect residual vegetation. If regeneration is successful, the new stands are uniform and all aspects of their subsequent administration, protection, and treatment are as simple and straightforward as possible.

Clearcutting has become common in American silviculture in recent years because there are still so many overmature stands of old-growth timber, especially in the West, and so many stands, mainly in the East and South, that were repeatedly mined of good trees in earlier, more reckless times. There can be benefits in prolonging the lives of such stands by partial cutting, but these can seldom be based on the prospect of useful economic return on the growth of residual trees. Clearcutting is commonly the most expeditious way of effecting prompt replacement of such stands by new and productive ones. Recent decades have also produced the technology and financial means to replace such stands, sometimes by planting. It is this ability to replace a large backlog of economically derelict stands that has produced two decades of professional enthusiasm for clearcutting.

The simplicity of administering clearcut logging and the new stands to which it leads is an important advantage. It can be pursued to excess, especially in the common situation in which a forest management organization is financed solely for administration of operations which are actually conducted and financed by others. It is distinctly simpler and less costly to check adherence to performance standards on clearcut areas and in simple, uniform stands than it is in those which are partially cut or are of heterogeneous structure.

The mathematical techniques of regulating the rate of cutting to achieve sustained yield are much simpler and far more dependable in forests of even-aged stands than they are for those of uneven-aged stands. Clearcutting is the most expeditious way of creating even-aged stands but not the only one; seed-tree, shelterwood, and simple coppice cutting do so as well. The shelterwood method is, among other things, a means of combining the advantages of partial cutting with those of even-aged management.

True clearcutting is seldom the cheapest form of logging. Ordinarily the most economical form of logging is the high grading of everything merchantable from a stand. An additional cost is often required to complete the cleacrutting by eliminating the unmerchantable trees. As far as silvicultural treatments are concerned, there is scarcely any regeneration technique with a higher immediate cost than the combination of clearcutting, site preparation, and planting. In other words, it would be incorrect to conclude that clearcutting was merely a shoddy expedient designed to minimize harvesting and silvicultural costs.



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On the other hand, if the clearcutting method has been adopted or if clearcut areas are made large primarily to economize on purely administrative costs, it is logical to suspect misplaced emphasis. The costs of forest administration may loom large in the budgets of many forestry agencies, but they are much smaller than those of harvesting activities and often small in comparison with the costs and benefits of silvicultural treatment.

Logging costs can come close to absolutely dictating clearcutting in situations where road costs are high there is need for moving heavy quasi-stationary machinery. This set of circumstances is typified by the logging of old-growth timber with overhead cable systems in mountainous terrain in the West. The high, fixed costs involved are chargeable to the acre that is logged and are difficult to meet without spreading the cost over the largest volume of timber that can be cut from a single road or yarding point.

There are many kinds of logging machinery that are more compatible with clearcutting than with partial cutting. This has always been true of cable-skidding machinery used in the West, although there is a rapidly increasing tendency to modify it so that it can be used for partial cutting in second-growth stands. The self-powered skidding machinery used mainly in the East has, in contrast, shown a steady tendency to become more powerful and cumbersome. It is thus less suited to partial cutting than the lighter equipment and animals once used for skidding. Unless more attention is given to the development of skidding machinery suitable for partial cutting, it may be anticipated that clearcutting will increase.

Aside from esthetic considerations, the most general objection that can be raised against clearcutting is actually an economic one. Even the most uniform-appearing stand consists of individuals of differing size, quality, and rate of current of prospective growth. These variations are the result of the natural, random variation and relentless competition between individuals that is a basic characteristic of stands of perennial plants. It creates a situation in which some trees become financially mature before others. Unless the stand is so old that all the trees are overmature, clearcutting removes some trees either before or after they are mature.

There may be other financial considerations, such as the high cost of setting up logging operations in difficult terrain which override the economic advantages of harvesting a stand in two or more partial cuttings. Nevertheless, the economic logic of partial cutting will presumably become more prominent as an increasing number of good, vigorous stands approach maturity on favorable terrain. More use of sequences of thinning and shelterwood cutting may be anticipated in even-aged stands now being created after clearcutting.

*Success and failure in application of clearcutting*

One of the most important reasons for recent resurgence in clearcutting has been the arrival of the time when public and private interests were ready to make outright investments in the replacement of poor stands with good ones. In many instances, especially in the South, this has logically involved clearcutting of degraded stands, intensive site preparation, and planting. Efforts to create the best possible stands have resulted in rapidly increasing use of genetically improved stock which must be nursery grown. There are many factors which make planting and genetic improvement go hand in hand with clearcutting.

The general result is that the pursuit of logical goals, separately or collectively, has led to increasing use of clearcutting. Among these goals are genetic improvement, planting of uniform stands, mechanization of logging, intensive site preparaton, reduction of fire hazard by broadcast burning of slash, and simplification of forest administration. Sometimes the means to useful ends become ends in themselves. When any of these practices, including clearcutting itself, become unquestioned ends in themselves, it becomes logical to doubt whether there is sufficient analysis of alternatives. Silvicultural treatments are better chosen by conscious decision than by blind adherence to standard operating procedures.

Clearcutting is often associted with site preparation by use of fire, herbicides, or mechanical methods leading to the planting of pure stands or monocultures. These techniques, singly and collectively, have the kind of guilt by association alluded to earlier. Whether the guilt is deserved or not depends on the circumstances and details of application. The technology that cannot be used to cause damage as well as to promote good growth has yet to be invented. Both this report and that of Earl L. Stone set forth the general view that scientfic evidence shows that the damage from such techniques is commonly overestimated yet the potential for severe damage under certain conditions exists.

Some of the points are covered elsewhere in these reports.

Planting, especially in combination with genetic selections by man, confers not only benefit but also the opportunity to make mistakes that would not be possible with natural seeding. The same is true of any powerful technique of intervention into natural processes. The long history of silviculture in Europe has shown that some of the greatest successes and worst mistakes have come with clearcutting and planting. The mistakes have been mainly from putting species or strains thereof on sites to which they were not adapted. Nevertheless the remarkable and longstanding success with pure stands of climatically adapted North American softwoods introduced into western Europe and the Southern Hemisphere suggests that natural precedent should not be entirely ruling.

The culture of southern pines on the vast Southeastern Coastal Plain provide an important and excellent illustration of some of the basic considerations. The kinds of pine stands being planted are essentially the same as those that had been maintained for millennia by relatively frequent lightning fires on the dry, sandy uplands. In nature and in practice, these fires check the hardwoods which creep in continually and threaten to succeed the pine; incidentally, they supplement the pine vegetation enough to create doubt as to the applicability of the term "monoculture." Whatever is good or bad about such stands can be known from both nature and the similar stands that have colonized abandoned agricultural lands. The widespread substitution of slash and loblolly pine for longleaf pine on the deepest and driest sands is a source of apprehension but on most sites the problems seem few and tolerable.

The natural and artificial simplicity of these pine forests results partly from the fact that rapid water loss from transpiration of the trees induces summer drought. The pines are better adapted to this than the hardwoods. Within the same region are the bottom lands of the broad river floodplains. Most of these sites are so well watered and nonrestrictive that they support some of the most complex mixtures of hardwood species found outside the tropical rain forest. Here it is technically feasible to create stands of single species, including those of slash or loblolly pines which grow very well. However, such departures from the natural vegetation are debatable on grounds of ecological principle; the bottomland vegetation is also so vigorous that the maintenance of pure stands can be excessively expensive.

Pure stands of single species of softwoods generally go with seasonal drought and the same has been true of the natural fires that renewed them. Clearcutting, with or without planting, is the primary silvicultural method of imitating many kinds of forest-renewing fires. However, true clearcutting with intensive site preparation seldom fits as well in mixed forests on nonrestrictive sites where the vegetation is naturally more adapted to disturbance by such forces as windstorms and insect attack.

There are circumstances in which natural factors render clearcutting practically mandatory for regeneration of satisfactory stands. Sometimes trees have become so weak or are so badly exposed that they too are easily overthrown by windstorms after partial cuttings. Many stands in the interior of the West are badly infected with the debilitating dwarf-mistletoe, a parasitic seed plant which cannot be controlled without the clearcutting of its host trees. Some pioneer tree species, such as jack and lodgepole pine, paper birch, red alder, and cottonwood, are ecologically adapted to regenerate only after natural disturbances which can be imitated mainly by clearcutting and subsequent treatment to reduce the natural litter.

Except for the true pioneer species and not always even these, it cannot be said that any tree species has ecological requirements that necessitate clearcutting for natural or artificial regeneration. Many are capable of enduring the exposed conditions that result from clearcutting, often because of the very localized protection of bits of logging debris or of low vegetation that endures the cutting or comes up afterwards. At the other extreme, many of the true firs, spruces, maples, and a few other species will not start in the extremely exposed conditions created by true, complete clearcutting.

However, the relationship between methods of cutting and regeneration is as much a matter of local environment as it is of species. For example, Douglas-fir often regenerates well from natural seeding after true clearcutting at low and middle elevations in western Washington and northwestern Oregon. Nevertheless there are kinds of soils and slopes in southwestern Oregon where the prolonged rainless summers create conditions in which even planting of Douglas-fir typically fails.

There are other situations in which true clearcutting has led to the establishment of shrubs, grassy vegetation, or unwanted species of trees rather than those desired. Most of these cases appear to be similar in that the desired species, in the kind of environment involved, was naturally adapted only to start as advance growth under prexisting stands.

The most serious problems have arisen in the droughty forests of the Southwest and the interior of the West. Sometimes the rainless periods are so long that, even in nature, new trees have become established only in years when rain fortutiously fell in periods which are normally rainless. Under such circumstances, there has sometimes been a tendency to clearcut to facilitate the destruction of competing vegetation that might otherwise rob planted trees of water during crucial drought periods. Often this works but sometimes the new trees are so exposed to heat injury, frost, or excessive water loss that they succumb. The problem is often aggravated by animal browsing. Clearcutting does not always cause failure in these unfavorable circumstances, but there are instances in which protection from heat, frost, or high transpiration tips the balance in a favorable direction.

In many parts of the West this problem is aggravated at high elevations even where the 2- to 3-month snow-free period is so short that soil moisture probably does not limit the growth of established trees. Some of the difficulty here probably arises because the atmosphere above the sites is so thin and, in the summer, so dry that there is little to block incoming or outgoing radiation. At least in the strata close to the soil surface, temperatures become very high by day during the summer yet nighttime frost is also common. If true firs or Engelmann spruce are the desirable species at these elevations, as they commonly are, failure can result from clearcutting because these species are really adapted to start as advance growth beneath existing stands and not in the open. Lodgepole pine can stand the exposure but the spruce and the firs generally cannot.

There is limited evidence to suggest that small seedlings of the balsam fir of the eastern spruce-fir forests are as lacking in resistance to exposure as many of the high elevation true firs of the West. Operations approaching true clearcutting have only recently started in a few places in the eastern spruce-fir forest, so it is too early to determine how much difficulty it might cause there. Most of what has passed for clearcutting in that forest type in the past has, at its most severe, involved leaving many balsam fir saplings 5–25 feet tall. This could be a case in which sloppy semantics could lead to mistakes.

A problem of just such an origin has already recently arisen on the Alleghany National Forest in northwestern Pennsylvania. This lies within the optimum range of the valuable black cherry. Thrifty, fast-growing stands of this species had arisen from very heavy cuttings of mixed forests for wood distillation plants early in the present century, before the land was purchased for the national forest. Since the early cuttings were not closely observed, it was not illogically presumed that the black cherry had arisen from seeds germinating after true clearcutting.

Clearcuttings were recently instituted with the intention of maintaining black cherry through natural regeneration. In some instances, the black cherry did not materialize. Preliminary investigations have shown that cutting akin to clearcutting produces new black cherry stands only if advance growth more than several inches tall is already present before the cutting. However, the browsing of an inordinately high deer population accentuates the problem and also complicates precise diagnosis. Where adequate advance growth of black cherry and other species already exists, heavy, "one-cut" shelterwood cutting leads to development of good, new stands, usually in spite of the deer. Where it does not exist, the deer assist in insuring the predominance of grasses, sedges, ferns, and shrubs.

Clearcutting can cause the "swamping" of poorly drained forests by reducing the transpiration of water. The drastic reduction in the amount of transpiring foliage can cause the water level to rise enough in these areas to make them temporarily too wet for reestablishment of desirable trees. Shrubs, undesirable tree species, or other unwanted vegetation may become so thoroughly established as to preclude the growth of desirable trees for long periods. The phenomenon is common in certain kinds of northern bog forests. Many of the elaborate forest drainage projects being undertaken on industrial holdings in the South are on lands which may have swamped after clearcutting aggravated by repeated dry season fires.

*Certain episodes involving clearcutting on National forests*

National forests clearcutting, or practices associated with it, have attracted much public attention in four recent, famous cases. These involve the replacement of decrepit or diseased stands in the Bitterroot, Tongass, and Monongahela National Forests and those in northwestern Wyoming.

It is significant that, except for some instances in the Wyoming forests, the practices called into question involved successful regeneration rather than failures of the kind discussed in the previous section. Aside from the all too common erosional problems associated with roads, none of them appear to have involved impairment of soil productive capacity. What these cases all have in common is the concern about esthetics and what appear to be basic questions revolving around land use policy. A silviculturist who wanted to develop general, technical arguments against clearcutting would not start with these cases.

On the Bitterroot National Forest in western Montana, primary objection has been raised against the practice of preparing clearcut areas for planting by bulldozing terraces along contours on steep slopes. The purpose of this practice, now abandoned, was to eliminate competition with grass by plowing it aside and to create level strips wide enough for tractor-drawn tree planting machines. As was found by an investigating team (U.S. Forest Service Task Force, 1970), the practice was more successful in terms of establishment of new trees and the cost of doing so than any other planting method that had been tested in the locality. Presumably because of the rapid infiltration of water on the highly porous soils, there has been little or no erosion from this drastic treatment of the soil. The main problem is that the unnatural terraces on the steep slopes look bad and are visible for long distances, especially before the planted trees grow up and hide them. There are also doubts not easy of resolution about the wisdom and cost of such intensive regeneration measures or even of harvesting timber at all where the sites are as low in productivity as they are. The wisdom of spending $50 per acre to plant stands that will grow only 250 bf per acre annually on a 100-year rotation is debatable.

Spot killing of the competing grasses with herbicides and various methods of hand planting would avoid the unsightly terracing but would not be any cheaper. On the other hand, the idea of "mining" the old-growth timber from such areas once and then abandoning timber production, as has been advocated by one group of observers (Select Committee, University of Montana, 1970) is probably not a policy which could be justified to a group of critical observers a decade hence. It would seem better to refrain from cutting some of the areas at all and, on others, to embark on the less intensive, less costly, less productive, and less disruptive silviculture elsewhere advocated in this report for unresponsive timber sites. The basic decisions are matters of administrative and land use policy; in the light of heavy and conflicting demands on a resource of limited productivity, it is very clear that the best set of decisions is that which will leave all interests equally happy.

The cases involving the Wyoming national forests are known to the writer only from an evidently objective investigation reported by the Wyoming Forest Study Team (1971) of the Forest Service. As is commonly the case, many problems revolve around roads and esthetics. However, some regeneration failures have resulted from inadequate perception of the variation in seed dispersal habits of lodgepole pine and of the shortcomings of true clearcutting in reestablishing Engelmann spruce. While the climatic circumstances make regeneration difficult, better results could probably have been obtained by application of existing knowledge.

Both the Tongass National Forest in southeastern Alaska and the Monogahela in West Virginia involve forests and climates in which desirable natural regeneration after clearcutting is virtually certain. The only important questions relate to the size of clearcut areas. In both cases there are important relationships between the size of clearcuttings and considerations of esthetics, wildlife management, and watershed protection that need to be weighed in arriving at decisions. From the watershed standpoint, there are at least intuitive grounds for being skeptical about clearcutting whole watersheds at once although hard evidence about the effect of such a practice on flash runoff during floods is scanty.

In the Appalachian hardwood forest involved on the Monongahela National Forest most of the new forest dependably comes from various forms of advance growth or seed already on the ground at the time of cutting. In fact, what is termed "clearcutting" is not technically clearcutting at all but, because of preestablished advance growth, really a simple variant of shelterwood cutting. The primary advantage in removing all the old trees in patches, large or small, is that the new trees grow straighter in even-aged aggregations. Whether the stands have been carefully tended during a series of constructive partial cuttings or degraded by shortsighted high grading in the distant past, there are important reasons for employing something akin to clearcutting when they are replaced. One of the considerations in the West Virginia case is that of maintaining an adequate representation of stands old enough to provide acorns and cover for wild turkeys. However, this is not difficult to do in a sustained-yield forest in which there is always a representation of stands approaching maturity.

The Sitka spruce and western hemlock of the forest of southeastern Alaska regenerate remarkably well from natural seeding after clearcutting. There is even an extreme case in which such regeneration took place on a mile-square clearcutting (James and Gregory, 1959). Nevertheless much of the necessary seed supply must blow on the wind from adjacent uncut stands. This kind of dissemination cannot take place over indefinitely large distances and there are just enough cases of inadequate dispersal to make it unwise to be complacent. The geologically youthful terrain of southeastern Alaska is also plagued, in places, with problems of steep, unstable soils. However, control of landslips is more a matter of road construction than of questions about cutting patterns. The protection of streams and fisheries depends far more on special measures undertaken close to the streams than on the general pattern of cutting. The main problem seems clearly an esthetic one aggravated by the anguish involved in replacing old stands by ones which will not again have such magnificently large trees.

*Senate guidelines and CEQ proposal*

At this point it is logical to summarize more detailed commentary earlier made to the Panel about certain recommendations which two other governmental bodies have made regarding clearcutting on Federal lands. One set is the harvesting guidelines recommended by the Senate Subcommitte on Public Lands in March 1972, submitted to the Committee on Interior and Insular Affairs, and published in a report entitled, "Clearcutting on Federal Timberlands." The other set was prepared separately by the Council on Environmental Quality and proposed, but not issued, as an Executive Order in January 1972.

Both sets of recommendations are quite similar and reflect careful and thoughtful composition. Both focus attention almost exclusively on clearcutting; the intent of reducing environmental damage would more effectively be directed at forestry and timber-harvesting practices in general. Each carries the implication that clearcutting on "fragile" sites is somehow more likely to cause erosion and watershed damage than partial cutting methods. As indicated elsewhere in this report and that of Earl L. Stone, this is true only on sites even more exceptional than those which should be thought of as "fragile." The roads and soil disturbance that can be associated with timber harvesting cause fully as much erosion and watershed damage with partial cutting as they do with clearcutting. The obvious and logical intent of both sets of recommendations would be more effectively fulfilled if there were more attention to soil disturbance than to the pattern of cutting.

The other general recommendations about considerations of esthetics, multiple use, and degree of concern about financial matters in relation to clearcutting seem amply sound. However, the recommendation of the Council on Environmental Quality about the maintenance of diversity could prove unrealistic if interpreted too literally.

Both sets of recommendations underscore the desirability of mitigating the visual impact of clearcutting. This can, as previously indicated, be accomplished by screening closeup views from traveled ways as well as by shaping distantly visible clearcutting areas so that they blend with the topography. Much of the solution of this problem lies in active acceptance of the fact that it exists. Public acceptance of clearcutting will probably increase when it becomes more patently obvious that new stands do, in fact, grow where the technique has been used.

The intent of these proposals would best be fulfilled if decisions about details of silvicultural practice were made on the ground by competent and experienced individuals. The factors that must be weighed are too complicated and variable to be anticipated by Executive orders or national agency directives. Furthermore, the decisions should be within the competence of individuals and ought not to need the routine attention of expensive multidisciplinary committees.

### Seed-Tree Cutting

The preservation of scattered seed trees as sources of natural regeneration is closely akin to clearcutting. Such trees are typically too scattered to offer useful protection to the new seedlings or to add enough growth per acre to provide economically significant additional growth. Nowadays they are usually removed after the new even-aged stand is established.

The method was first adopted in this country in the era of large-scale clearcutting with railroad logging when there began to be concern about regenerating forests. Some States enacted laws specifying the numbers of such trees to be reserved. These laws represent the main American example of legislative prescription of silvicultural details. The technique usually worked when coupled with voluntary efforts by owners to carry out site preparation and control competing vegetation. Where owners merely followed the letter rather than the intent of the laws, the results were generally poor.

The seed-tree method came to be commonly used in combination with proper accessory measures for regenerating the southern pines during the early 1950's. While it remains in use there and elsewhere under certain circumstances, it has tended to be displaced by other methods as forestry practice becomes more intensive. If thorough site preparation is necessary to make the method work, it is often deemed better to regenerate artificially than to lose time and run the risk of brush invasion while awaiting the sporadic seed crops of nature. Clearcutting and planting of genetically selected pines has recently been the common alternative. Where the object is still to get new even-aged stands from natural seeding, the more attractive method is shelterwood cutting.

### Shelterwood Cutting

Shelterwood cutting is a technique with a wide range of variants. As the name implies, the residual trees are left in sufficient numbers that they shade and literally shelter the new seedlings. This can be disadvantageous for some light-demanding species, although the severity of cutting can ordinarily be varied enough to allow establishment of most desirable species. The seed supply is abundant, sometimes too much so, but natural seed crops do not necessarily come in the year of need. In shelterwood cutting, however, the overwood remains at least until suitable crops of seed occur, so timing of cutting and regeneration is not crucial. When the new crop is established the older trees are removed in one or more stages leaving a new, essentially even-aged stand (Erye and Zehngraff, 1948).

In both shelterwood and seed-tree cutting the new stand is present and usually visibly so before the last remnants of the old stand are removed. As a result, the cutting areas do not have the devastated and barren appearance of true clearcuttings. Shelterwood cuttings can be as attractive as any method of cutting can be, although all methods leave some logging debris. The esthetic advantages of shelterwood cutting are greatest if many trees are reserved in the initial cutting and the new stand is not fully released until it consists of large saplings.

With shelterwood cutting the growing space is nearly continuously occupied with vegetation so there is virtually no risk of loss of nutrients or soil material, except along the roads. Less wood production is lost during the transition from the old to the young stand than is with clearcutting or the seed-tree method.

Those trees that are growing well can still be reserved to continue valuable production and the space not utilized by them is devoted to giving the new stand a headstart on the next rotation. This essentially economic advantage is, in fact, one of the greatest incentives for use of the method, especially if the reserved trees are numerous enough and grow well enough to make their subsequent removal a highly attractive harvesting operation. In other words, the shelterwood method is as much a technique of economic manipulation of growing stock as one of providing seed and shelter for a new crop.

The theoretical advantages of shelterwood cutting are so great that it is not necessarily easy to perceive why the method is not more commonly used. The main barrier to application is that shelterwood cutting is best suited to stands that are approaching maturity in good, vigorous condition. Most American forests are either decrepit old growth or the residue of low-quality trees left after previous high-grading operations. Neither of these kinds of stands have many trees that clearly are worth reserving for continued growth. They may be too old to grow well, too insecure to resist blowdown, or too malformed or rotten to be able to add new wood of much value. Sometimes trees of this sort are reserved in shelterwood cutting when it is absolutely essential that the new seedlings be sheltered, but many of the other reasons for shelterwood cutting are not operative under such circumstances.

Shelterwood cutting would not necessarily be applicable in all well-managed even-aged stands that were to be replaced by natural seeding. Where cable logging systems are employed, the removal of a stand in several stages can be unacceptably expensive. The use of roads in steep terrain could also be unduly prolonged. The presence of residual trees can sometimes inordinately hamper slash disposal and site preparation.

The possible range of difference among shelterwood cuttings is very wide; a variant that is successful in one situation may fail in another. The range of possibilities covers nearly everything from the severe exposure of clearcutting to the environmental conditions associated with the lightest selection cuttings under uneven-aged management. The advantage of such cutting, especially in the opportunity for discrimination in the economic timeliness of removal of individual trees, will probably become more compelling as the number of good stands increases. Shelterwood cutting has many advantages and the reaction against clearcutting is already causing increased use of the method. However, neither this method of cutting nor any other is so widely applicable that it deserves the status of a universal panacea.

### Selection Cutting

All of the methods of cutting which create or maintain truly uneven-aged stands by regeneration from seedlings fall in the highly variable category of operations called selection cutting. The components of differing age are ordinarily segregated horizontally into small substands which might actually be regarded as little even-aged stands if the forest vegetation were mapped in fine detail.

The new constituent substands are created by cutting trees in small patches or as large, old individuals and thus leaving vacancies large enough that new trees can become established and grow well enough to remain exposed to the sky. The removal of trees in patches is called group-selection cutting as distinct from the self-defining single-tree selection cutting.

There is a tendency to call almost any kind of partial cutting selection cutting even when the ultimate results do not meet the test of getting new substands established and free to grow. It so happens that those vacancies created in attempts at single-tree selection cutting are frequently too small to meet this test; the surrounding residual trees often close the gaps unless some of them are removed in subsequent cuttings.

The uneven-aged selection stand is the kind in which both large and small trees coexist perpetually. For this reason, the selection method of cutting is the best for the maintenance of stands along roadside or in other situations where esthetic objectives are a ruling consideration. The method is likewise useful where it is desirable to maintain stands which always have some large trees to protect streambanks or to defend against landslides and avalanches.

Where uneven-aged stands do not already exist it is not possible to create them easily or quickly. Even-aged stands are common and they can be converted to the uneven-aged only by cutting holes in them periodically and consistently over many decades. The task cannot be completed without either cutting some trees before they are mature or else carrying some until they are distinctly overmature.

On the other hand if an uneven-aged stand already exists, it cannot be converted to the even-aged condition without cutting some trees when they are either immature or overmature. However that kind of conversion can be accomplished all at once if it be desirable. In any event, the alteration of the age-class of a stand is not a casual undertaking.

The uneven-aged stand has not only an esthetic appeal but also a conformity to an idealized concept of forests which is traditionally popular among many ecologists and sporadically so with forestsers (Koestler, 1956). In both ecology and the perpetual management of the renewable forest it is ultimately essential that there be balance between birth and death, growth and decay, gain and loss, input and output. Nature's books ultimately balance; the only questions are about about the level at which they balance and the expanses of space and time within which they balance. If a forest stand included an equal representation of all age classes from seedlings to old trees which continually died or were cut to give place to new, most parts of the account would balance within the stand. If it is also reasoned that the purely natural state must ipso facto be an ideal one, it is easy to conclude that anything other than a perfectly balance selection forest represents a departure from both nature and the technologically desirable condition.

This interpretation of nature as always benign actually verges on the transcendental. If new trees can arise only after lethal disturbance, this ideal condition could arise and persist only if small disturbances of equal areal extent took place at short, equal intervals of time. Natural disturbances are quite variable in extent and frequency; they can certainly create irregular, nonuniform forests but not balanced ones. If a balanced, all-aged stand could ever come into being, it would have to be an artificial creation built by rigidly systematic cuttings conducted over a period which could not be much shorter than a century. If this interpretation is correct, it must be concluded that such stands exist only in such works as textbooks of ecology and silviculture. There is no undebatable evidence that balanced, all-aged stands have been created within small areas either by nature or by silvicultural practice.

During the 1930's and 1940's the selection system was viewed with great favor in American forestry. The basic objective was to obtain the theoretical ecological balance simultaneously with even, perpetual, sustained yield in each forest stand. The magnificence of hindsight shows this noble goal to have been far too ambitious. It was seldom in keeping with the ecological realities of the forests involved. Furthermore, sustained yield is difficult enough to achieve by putting stands of differing age together into whole forests that meet the goal collectively. Efforts to make each stand a sustained-yield unit are practically hopeless.

It must be said that this episode had opportunistic features not in keeping with the principles of true selection cutting. In selection cutting in a truly uneven-aged stand, large trees are cut leaving smaller and presumably younger trees to grow. The depressed lumber markets of the 1930's made this attribute of the selection system more attractive than it rightly should have been from the standpoint of sound long-term management. Where stands were more nearly even-aged than uneven-aged, as was frequently the case, the procedure really amounted to highgrading, that is, cutting the good and leaving the poor. In these instances the smaller trees that were reserved were just as old as the larger ones and were not thrifty, young recruits but were smaller simply because they were already declining in vigor.

This kind of partial cutting was, at least subconsciously, a way of postponing the regeneration of stands in a time when the technology and especially the financing for such regeneration was sorely lacking. It was hoped that the light cuttings involved would foster establishment of natural regeneration. However, in many instances it soon became apparent that many of the most desirable species of trees were not sufficiently tolerant of shade to become established in the small openings created.

Sometimes the method worked, especially where the treated stands were truly unevenaged by groups of trees which could be removed in group-selection cutting. Under such circumstances use of the method has often continued. However, in most instances, especially where single-tree selection cutting was attempted, the results were dismal enough to produce disenchantment and revulsion against the approach.

Some of the poorest results came in ancient old-growth stands in the West and in stands, common in the East, which had already deteriorated under the effects of previous high grading. Degradation was generally accelerated rather than halted. Many of the stands that had been so hopefully treated in this manner have had to be cut clear and replaced.

### Necessity of Deliberate Variation of Silvicultural Treatment

The forests of the United States are too vast and too varied, both in their natural characteristics and in the demands that society puts upon them, to justify stereotyped silvicultural procedures. These variations are too intricate to allow anyone to generalize about optimum procedures even for a species or a management unit the size of a national forest ranger district.

The highest degree of uniformity prevails on the broad, level Atlantic and Gulf Coastal Plains, even though these are not as uniform as the terrain would seem to indicate; at the other extreme are the steep mountains of the West where the differences that exist within a few thousand feet of elevation and a few miles of horizontal distance might ideally call for almost as much variation in treatment as would seem logical for the whole country.

Logical treatment varies in time as well as in space. Technology and socioeconomic requirements change and this affects practice. While natural conditions do not change, knowledge of them increases and practice should, therefore, improve as well.

The pattern of natural variability is intricate enough that it takes essentially intuitive judgment to decide which variations are important enough that practice should be adjusted to fit them.

American silvicultural practice in general and that on Federal lands in particular is too stereotyped. Some of this has arisen because of insufficiency of creative imagination and analytical thought on the part of the forestry profession. Too many ideas and practices have been carried from places where they fitted to ones where they did not; others tend to linger beyond their time.

The variability is great enough that decisions about silvicultural treatment are best made by competent practitioners on the ground. Generalized guidelines and policies can be established from a distance but they lead to mistakes if they are too specific.

### Intensity of Silviculture

Part of the desirable increase of variation in treatment should come from greater deliberate variation in the intensity of the silviculture practiced. This kind of intensity can be measured, although imperfectly, by the amount of money invested in a stand through an entire rotation.

The most common place for silviculture of high intensity is on responsive sites where trees grow so well that timber production, as a primary use, is most rewarding. Actually the most highly intensive silviculture should be practiced in the very limited areas subject to concentrated recreational use; any incidental utilization of the trees is primarily a way of recovering some of the treatment cost.

Even where timber production is a primary objective there is no reason why measures representing the same intensity of practice should be spread uniformly from the best sites to the poorest or from the most accessible to the least. Money for long-term silvicultural investment is inevitably and always in short supply. Therefore, it is best to invest most of it on good, responsive or accessible sites. On poor, unresponsive, or remote sites it is best to spend little more than what goes with skillfully patient guidance of natural developments.

The various methods of regeneration cutting, such as clearcutting, shelterwood cutting, and selection cutting, do not denote differing intensities of practice. All of these cutting methods can be associated with the whole range of intensity of application. In fact, clearcutting and cutting akin to crude selection have such an ancient history of association with outright timber mining or other degradational processes that each method has, at various times, been totally condemned for defects not inherent in either method.

The less intensive kinds of silviculture have a common, but not inherent or essential, compatibility with the use of forest land for a multiplicity of purposes. As a prime example the less intensive the regeneration measures the slower will be the development of solid tree cover; this prolongs the period of browsing for many game animals, that of increased stream runoff, and that in which beautiful flowering herbaceous plants flourish.

If the variation in intensity of silvicultural practice is intentionally accentuated, standards of accomplishment must be correspondingly varied. Extensive silviculture would normally be associated with lower yield and lower stumpage returns, although there would be instances in which lower cost might increase ultimate net financial return. Regeneration might be slower, less complete, or of less than ideal species composition, than if intensive practices were successfully applied.

This is not a proposal that society invest less in silviculture or be resigned to a lesser flow of goods and benefits from the forest. It is instead proposed that more deliberate variation of practice is one of the ways of investing more funds with greater wisdom and increased benefit. In general, the greatest increases in timber production and other benefits can be achieved with the least risk of environmental harm on the responsive sites which also yield the best returns on investments.

### Relationship to Land Characteristics

Many Federal forest lands pose problems about land use policy and silviculture that are unusually difficult to resolve. Most of the national forests, especially in the West, were set aside after the most productive and accessible forest lands had passed into private ownership. The national timber supply did not shrink to the point where Federal lands became important contributors to the harvests until after World War II. The agencies have attempted to carry the new burden and to maintain high silvicultural standards in replacing what is cut. The result is that they are attempting silviculture of high quality on lands where climate, soils, terrain, economics, and conflicting social demands often make the task very difficult.

The most serious dilemmas are faced where the terrain is steep and growth is poor yet trees have lived long enough to become large and valuable. Roads in such steep terrain are costly to build and maintain yet the risk that they will cause erosion or mass movement of soil is often serious. The unfavorable conditions also make the costs of regeneration, slash disposal, and similar measures high and the risk of failure is also large. Steep slopes and esthetically repulsive kinds of silvicultural measures conducted on them are often visible for long distances.

It should not be inferred that all steep slopes are of low productivity. Paradoxically some of the most productive forest land in the Nation or even in the world is on terrain, often very steep, in the narrow belt that extends along the Pacific coastal mountains from the redwood region of northern California to the Sitka spruce-hemlock forests of southeastern Alaska. Highly productive land also exists on steep slopes with deep soils and plenty of winter snowfall in the Cascade Range of Washington and Oregon and the Sierra Nevada of California. Such high productivity can easily justify intensive silviculture and special precautions in roadbuilding on such terrain, although the prospects become debatable where the terrain is highly susceptible to landslides. The main problems at issue involved those lands where productivity is low and the terrain steep and difficult.

Certain policies, each the result of noble intentions, have often operated, in such conditions, to encourage silviculture excessively ambitious for the situation or sometimes to cause timber to be cut where it might better be left. Pressure for public timber and the demand that the Forest Service be optimistic about the allowable cut and its future silvicultural prowess have led to overestimates of the commercial forest land base and probably of the practical productive capacity of some of the poorer commercial forest land.

Sometimes the definition of commercial forest land as that capable of sustained production of 20 $ft^3$ of mean annual increment per acre has been taken too literally. This criterion may be acceptable or even too restrictive on easy terrain but not where roads cost $40,000 per mile and may still cause landslides. In recognition of such considerations, the Forest Service has already begun to eliminate some land from the allowable cut base; even more detailed examination of its vast domain is more likely to produce more subtraction than addition to this base.

The inclusion of unpromising areas in the land base of the allowable cut has induced an extension of recent timber-harvesting operations into tracts that are only slightly less promising for future production. This action in and of itself is thoroughly logical because, in a sound sustained-yield program, it is necessary that the cut be spread over both good and poor areas insofar as the transportation system can be made to allow. However, when timber harvests are made anywhere there is a certain inflexible rectitude in the silvicultural policies of the Forest Service that is apt to call forth actions that are of debatable wisdom on marginal areas.

Where harvest cuttings are made it normally appears to be accepted as axiomatic that regeneration be accomplished swiftly and that no effort be spared to create new uniform stands that will be as thrifty, healthy, and productive of timber as the site will permit. Slash disposal is also often pursued as an end in itself rather than as a calculated action designed to reduce fire hazard, improve the appearance of visible areas, foster regeneration or control pests. Where centuries of slow growth have allowed the accretion of stands of high monetary value, provisions of existing fiscal policy tend to encourage the conduct of treatments with scant regard for cost or the value of future timber benefits. The costs of slash disposal are traditionally charged against the value of the harvested timber. The otherwise laudable purposes of the Knutson-Vandenberg Act of 1930 enable all or nearly all of the costs of establishing new stand on the site to be charged against the value of the timber harvested.

The net result of this combination of policies is that amounts of the order of $100 or $200 per acre are sometimes invested in regenerating stands on sites where the conventional but draconian analyses of the value of future timber harvests would justify investments of less than $10 per acre. In fact, the amounts invested where natural conditions make regeneration easier and future production greater are often lower.

Clearcutting and planting has sometimes been done because it is the only means of assuring compliance with such arbitrary standards as "full restocking within 5 years after harvest." Such a requirement is logical and sometimes even rather lenient if clearcutting is indeed employed. However, when applied as a uniform requirement to all modes of cutting for regeneration, it distinctly discourages partial cutting aimed at securing natural regeneration. Furthermore, it can and has led to clearcutting and planting on sites where such practice is questionable on purely economic grounds. If partial cutting leaves a thrifty residual stand in some approximation of full occupancy of the growing space, as in shelterwood cutting, one can often afford to wait some years for natural regeneration. There should be goals for the extent and timing of regeneration, but they should be set on the ground in terms of what is economically realistic and biologically attainable in each case.

Criteria for restocking sometimes require, or are construed as requiring, that only new stands of a single species are acceptable. This is logical in some places; in others, as in some kinds of mixed conifer stands in the West, it can be wiser economically and ecologically to accept mixed stands. This is especially true if market preferences for particular species are becoming less restrictive.

While it should not be inferred that partial cutting and low-intensity silviculture are synonymous, many of these sites are places for various schemes of partial cutting with heavy but not necessarily total reliance on natural regeneration. Much of such operation would resemble high grading since it could involve skimming off a major portion of the merchantable volume at infrequent intervals. However, there are subtle ways of stopping short of outright high grading, usually by adoption of some of the principles of shelterwood cutting in which individual trees of high productive potential are reserved.

It seems neither biologically necessary nor socially desirable for the Forest Service to embark upon the deliberate "mining" of old-growth timber on poor sites as proposed by the Select Committee of the University of Montana (1970). The idea of harvesting the timber once but not attempting to replace it has a certain economic plausibility. However, where nature grew trees once it will grow them again; protection and limited silvicultural assistance will make them grow a little better. The rotations may be long and the production low but there seems no need for abandoning the principle of sustained yield in these cases.

Extensive silviculture has a larger component of opportunism than the intensive kind. For example, if it involves partial cutting, there can be substantial advantage in planting trees on strips or patches where competing vegetation has unintentionally been eliminated during logging. It is often better to do this than to adopt arbitrary policies that there would be no planting or that regeneration in 15 years would suffice. In such places slavish adherence to such arbitrary policies would often guarantee long-term dominance by shrubby brush and the loss of a brief but useful opportunity. Likewise market conditions fluctuate enough that there are sometimes limited periods of opportunity for constructive action of sorts unfeasible at most times. The main essential is that the practitioners of extensive silviculture have the imagination and administrative flexibility to recognize and use favorable opportunities to the maximum.

Extensive silviculture requires less monetary investment in treatment than the intensive but it may require more skill to be successful. It does not take as much of such skill to spend a lot of money on clearcutting, site preparation, and planting as it does to accomplish useful results without such large investments.

Accentuating the extremes of intensity of silvicultural practice will not necessarily reduce the overall allowable cut based on prospective future harvests of timber. Substantial increases from more intensive silviculture on more promising sites, not necesarily just on the best, might well more than make up for reductions on the least promising.

Nevertheless consideration must be given to the fact that major increases in timber production in Federal lands in one locality will not entirely compensate for reductions in those where production is decreased. There would be serious dislocations in less favored localities where the labor force and mill capacity are adjusted to a faster rate of cutting than would be sustained in the future (Johnson, 1972). The impact of this readjustment can be blunted by accomplishing reduction of harvest rates gradually and making the change in policy well known.

The effect can also be muted by refraining from withdrawing land from timber production solely because of concern for the visual impact of clearcutting on distant slopes. Nonintensive applications of partial cutting or the artistic shaping of edges of clearcut areas represent the best way of meeting scenic considerations. There are other good reasons for withdrawing land from timber production, but most esthetic objectives can be ultimately met most easily if timber harvest remains a tool for doing so.

*Land classification*

Desirable adjustments in the intensity of silvicultural practice must be based on mapped determinations of (1) the priority accorded various uses, (2) the capacity of sites to produce wood and endure timber harvests, and (3) present and prospective accessibility. Decisions about use of land are, of course, the first and ruling consideration. The present land classification schemes of the Forest Service include some, but not all, categorizations that would be necessary to guide such variation in intensity of practice. Timber cutting is not involved on reserved lands (notably wilderness areas), noncommercial and nonforest areas, although some silvicultural work not directed at timber production could be involved on some of these areas.

Areas where timber production is contemplated are now separated into three categories: Standard, special, and marginal. The "standard" category includes all areas in which there are no major impediments to growing timber and such use is compatible with others to which the areas are put. The "special" category includes areas where timber production must be reduced to accommodate higher priorities accorded to such purposes as recreation, stream protection, and scenic considerations. "Marginal" areas are chiefly those where risks of damage associated with such activities as roadbuilding are so great that cutting is deferred until technological development has made such operations safe and feasible.

This classification is very useful for management purposes but should not be confused with classification according to capacity to produce timber or variations in logical intensity of silviculture. Each category might actually include the full range of site productivity classes down to the poorest that could produce 20 $ft^3$ per acre annually and thus meet the minimum criterion of commercial forest land. There is still need, especially within the broad "standard" category, for classification according to productivity and the matching of intensity of silviculture to productivity and the constraints of other uses. There is presently an excessive tendency to manage all standard acres at the same intensity, according to the same performance standards, and on the same rotation.

Current conflicts over allocations to wilderness and the need for low intensity silviculture on some areas combine to underscore the desirability of land use classification intermediate between wilderness areas and the standard timber-management category. The concept of the "back-country zone" that is developing in national forest management is a logical approach to the problem. It involves land, often in narrow stringers on ridgetops, that is not easy of access and often of low productivity. Such land is often too useful for wilderness and too close to better land to remain unprotected. Almost always it can be administered for hiking and other forms of dispersed recreation more effectively than true wilderness areas. In fact, much of what passes for the "wilderness experience," especially in the East, takes place on such lands which may have been logged in the past. The possibilities for a multiplicity of compatible uses, including low-intensity timber management, on such areas are substantial.

Under any circumstances, it is crucial to recognize that use classification should change in time as well as in space. This provides valuable ways of integrating timber production with other uses. For example, hunting usually goes with young timber stands and must logically be shifted to new, young stands as the ones previously suitable for hunting become older. Conversely, hiking often goes best with old stands, so it is equally logical that the trails be shifted around as the ages of stands are changed.

Nevertheless, judgments about land use should not be confused with those about intensity of timber production. The decisions about land use come first; those about the kind of silviculture must be secondary ones fitted into the framework of use.

## Personnel Policy and Silvicultural Practice in the Forest Service

Success in the prescription and execution of silvicultural practices depends almost entirely on the ability and performance of the people who do the work in the field. Most of whatever shortcomings can be found in timber management practices on the national forests result from poor work by private parties doing the logging or from inadequacies of inexperienced Forest Service personnel. Ways must be found to develop greater silvicultural expertise in the Forest Service, which has personnel as conscientious as are likely to be found anywhere in the Government service.

The most astute silvicultural practice is now found on the best-managed industrial holdings. This is partly because the most easily managed forest sites are mainly in private ownership and partly because industrial forest managers get more chance to understand the forests with which they work.

The best field practitioners are those who have had a chance to work for some years in the same forest and on the ground. Good silvicultural practice is such a local art that it is also well to be skeptical about its centralized control at any national or even regional level. The standards of silvicultural practice in the U.S. Forest Service often appear to have suffered because of frequent transfers of personnel. These transfers have militated so strongly against the development of localized expertise that there has been a tendency to take refuge in overcentalized direction and to follow practices deemed acceptable in the higher echelons whether they fit the circumstances on the ground or not.

The situation is epitomized by the fact that current personnel on many ranger districts tend to regard anything that was done there 10 years previously as the ancient history of anonymous predecessors. Since the details of what was done in specific stands are obscure, it is difficult for the current personnel to determine why measures previously applied succeeded or failed. Even 10 years is too short a time perspective to allow the development of the requisite local background for successful culture of crops that require most of a century to mature.

While there are other and better reasons for use of the practice, the widespread use of clearcutting and planting seems to have developed partly from the anxiety of personnel lacking in the assurance that comes from localized experience. The technique is simple; it is also the manifestation of positive and forthright action; in the vast majority of instances it works well; where it doesn't, the person who applies the procedure can hardly be called to account for inactivity. The higher echelons that are tempted to produce guidelines tend to have a corresponding partiality to procedures that have a high assurance of sucess; at these levels there is not only lack of knowledge of local circumstances but also the gnawing feeling of responsibility for field personnel suspected of being equally lacking.

The personnel policies of the U.S. Forest Service, long admired in circles of public and personnel administration, have been so successful that criticism should be made only with deliberation. The frequent transfers and tendency to avoid inplace promotions have important advantages. It is primarily in the case of silviculture personnel that otherwise sound policy seems to have been pursued to excess. However, in devising new personnel policy for such people, there are other dangers to be avoided. Long-distance transfer, especially of young personnel, is definitely desirable in combatting the provincialism often apparent in even the best silviculturists. Therefore, it would be best if they were transferred several times at the beginnings of their careers and then caused to strike root and advance in a single place during the remainder.

Responsibility for silvicultural practice should not be relegated to the lowest rungs on the professional ladder. A forester who is a good silviculturist should be able to continue the practice of his art without detriment to his advancement at least to the middle-management level. The Forest Service appears to be moving in this direction by assigning specifically designated silviculturists at district, forest, and regional levels.

Some of the recent shortcomings of Forest Service silvicultural practice are traceable to a tendency to make the preparation of timber sales a responsibility and end in itself. This was the result of pressure, starting in the 1950's, from the timber industry to meet the allowable-cut goals. Timber sales officers were rated on their ability to get the allowable cut onto the market, but the creation of new stands after the sales was often left to beginners. Silvicultural expertise was more likely to be consulted after, rather than before, problems arose, for example, after the second planting failure rather than before the initial cutting.

The development of appropriate silvicultural expertise depends partly on better use of a reservoir of existing personnel with adequate silvicultural competence. However, some must come from more positive efforts at training of personnel both inservice and in the universities. In recent decades, forestry has been so heavily concerned with people problems that those in nature have been slighted enough that they have now become another kind of people problem.

The silvicultural personnel problems of the Forest Service and of forestry organizations in general are not exclusively internal. American forest management, for otherwise sound reasons, usually operates on a basis under which logging and long-term forest management are separate responsibilities. The shortrun economic outlook of timber harvesting and the vastly longer one of forest management inevitably collide during logging operations. The impact can be softened by patient efforts at mutual understanding and cooperation, especially among experienced personnel knowledgeable of each other's problems.

There are some problems of dealing with poor logging practice that result from but are hardly unique to public forests. Since it is clearly desirable that public property, in this case timber, be sold on competitive bidding and to the highest bidder, the public forest management agency has less control over the qualifications of the buyer than the private owner who can be more discriminating. The situation is further complicated by the fact that buyers of public timber may and commonly do engage independent contractors to do the logging, so responsibility for what happens is distributed among at least three parties rather than two. An inordinate amount of time of timber-sales personnel goes into efforts, not always successful, to control a few shoddy operators, who may reappear on sale after sale. One result is the development of increasingly detailed timber-sale contracts which tend to inflict maddening restrictions on the many for the sake of controlling the few.

It has been suggested by another of the Panel's consultants, Carl A. Newport, that this problem might occasionally be attacked on Federal lands by separating the functions of logging from those of timber purchase. Under the present system, a timber purchaser is usually in the position of contracting to buy timber, harvest it, and build roads. In an era of increasing specialization and heavy investment in equipment, he may not be in a position to discharge all functions equally well. There are undoubtedly situations in which superior results would be achieved if Federal forestry agencies dealt directly with specialized, experienced, and properly equipped contractors for each function. This could give the agencies tighter control over the logging and roadbuilding that go on in and affect the forest environment. However, such a system would also put the Government in the position of selling logs at roadside rather than stumpage in trees standing in the forest. It would represent a major departure in present administration practice, but the time appears ripe for its consideration.

### Financing of Forestry Practice on Federal Lands

Long-term programs such as those implicit in sustained yield and the growing of trees as a renewable timber crop cannot be conducted without some degree of stability in long-term financing. The setting of allowable cuts under sustained yield depends among other things on predictions of future yields and of the support that will be available in the future to maintain useful productivity above purely natural levels.

If the allowable cut for 1973–83 is set at a level consistent with the view that all harvested stands will be replaced by planting, it is not enough that there be money to replant all stands harvested in the next decade. The horizon of dependability must extend for at least as many years into the future as the proposed rotation is long. If the rotation is 70 years long, there must be assurance of money for the planting in each year for the next 70 years. In 1973 the horizon year is 2043 but in 1974 it becomes 2044. The principle involved is, of course, subject to the modifying proviso that plans with century-long horizons be revised at intervals of a decade or so.

Forest vegetation, like the tide, waits for no man. Many of the things that must be done to make a forest stand highly productive must be done when the time is ripe or the opportunity is lost. This is most true of the regeneration stage; the latitude for flexibility in timing does increase as the trees grow older but it can then decrease again as the risks and ailments of age begin to increase. If regeneration measures are not undertaken promptly when growing space has been made vacant by timber harvests, the empty spots may fill up with nature's contribution of unwanted kinds of vegetation; this must be eliminated later at additional expense if the desired vegetation is to be established. At this stage, delays beyond the start of a single growing season can be disastrous.

These regeneration measures must also be planned in advance. If it takes several years to grow seedlings for planting, nursery production should be geared to the anticipated requirements of harvest cuttings a corresponding period of time in advance. If the seedlings are ready and the areas have been cut, but funds are not available for planting, the seedlings may literally have to be plowed under; money is thus wasted and the brush may conquer.

While the need for timely treatment is most crucial in the regeneration phase, there are other treatments which must often be conducted later in the lives of stands if any ambitious production goals are to be attained. Young stands may need to be weeded and thinned like crops of carrots lest too much of nature's bountiful production go to weeds or into too many desirable trees that remain runts. Among the many other operations that enhance useful production are fertilization, pest control, and pruning. The nature of forest production is such that much useful material goes to waste long before stands are ready for replacement if it is not removed in commercial thinnings or the salvage of moribund trees. Even though commercial thinnings and similar intermediate cuttings usually yield net revenue to the Treasury, there must be funds for the personnel to administer the cuttings. While many of these operations need not be done in a given stand precisely in a given year, the opportunities are generally lost if they are not done in a given decade or 5-year period. In practice, if such operations are not kept on a steady and reasonably timely basis, large backlogs of needed work accumulate and the opportunity to catch up typically never comes.

It was in recognition of such problems, although notably that of the need for reestablishing harvested stands, that the Knutson-Vandenberg Act was passed by Congress in 1930. This provides that national forests may, at their administrative discretion, withhold some of the gross receipts from specific timber sales and expend them on various regeneration measures within the sale areas whence they came. These so-called K–V funds and moneys from regular congressional appropriations finance the silvicultural work of the Forest Service.

While it is hard to fault the principle of the Act, it has imperfections and unanticipated consequences. Payments in lieu of taxes to local government are 25 percent of the sale revenue left after the K–V funds have been deducted. Since the K–V funds thus reduce payments in lieu of taxes, there is often unhappiness in impoverished rural counties if deduction for regeneration expenses become large. As a result, the K–V deductions are sometimes smaller than optimum. This particular problem would be eliminated if the act were amended to provide that payments in lieu of taxes be based on gross stumpage receipts rather than the net remaining after deduction of K–V funds.

The present requirement that K–V funds be expended only for regeneration measures within the sale area where collected is too limiting in time, space, and purpose. When the act was passed in 1930, silvicultural practice was so nonintensive that the replacement of harvested stands was deemed a sufficient goal. The subsequent treatment of established stands, which is essential to the more intensive silviculture now contemplated, was presumably viewed as desirable but beyond prospect of early attainment.

The requirement that K–V funds be expended within the sale area where they were collected means that they are not necessarily invested where the money would do the most good. Sometimes they are used for regeneration measures too intensive to be economically or ecologically appropriate to the sites involved. The funds could be used far more effectively if they could be invested in any timber-production measures within the national forest or Forest Service region in which they were collected. Such measures would logically include not only stand reestablishment but also such activities as precommercial thinning, fertilization, pruning, and administration of timber sales.

If the Knutson-Vandenburg Act were thus amended, it would be necessary to establish some criterion for determining how much should be reserved from sales receipts for the intended purposes. It is proposed that these sums be fixed amounts per acre equal to the anticipated cost of growing timber on an average acre through one rotation within the management unit where the funds are collected and expended. In the case of partial cuttings, the amounts collected would have to be prorated in accordance with the proportion of the production of one rotation harvested in a given sale. While the procedure might have the effect of transferring funds from poor sites to good, it would keep the accounting from becoming unwieldy. If the management unit were kept on a sustained-yield basis, the funds would be continually equal to the support of whatever timber-management program was planned and in operation.

### Roads and Forest Management Policy

Roads constitute the chief source of environmental damage associated with forestry; they can be discouragingly costly to build and maintain properly; they are indispensible for most forms of management and use of forests (Pearce and Stenzel, 1972). While their management must be under constant examination in any kind of forest ownership, the quandry about roads is especially acute on most Federal forest ownerships. Past land policies have created a situation in which these ownerships were set aside in the most remote and difficult terrain. Even though decades of effort and investment have been expended on Federal forest roads, these forests remain the least accessible in the country. This problem is most acute in mountainous terrain where roads are very expensive and are most likely to give rise to erosional problems.

The situation is one that aggravates other problems. In fact, it is no accident that most of the present forestry controversy revolves around mountainous lands. Almost everything goes far more smoothly on flat or rolling terrain, whether public or private forests are involved. The considerations interrelated with this problem are numerous and the magnitude of problems seems to grow in geometric proportion to the steepness of the terrain.

From the standpoint of sustained timber yield, it would be ideal if all the area in any large timber-management unit could be completely roaded before any cutting was done. It would then be possible to spread the cut of any year evenly among the good and the poor, the easy logging and the difficult, winter and summer ground, and to apply optimum silvicultural treatment to each stand.

However, conditions are never ideal and the road systems on most Federal forests fall far short of any such perfection. On vast areas of these lands the allowable cut, which is logically based on long-term considerations is legitimately figured on the entire area that will ultimately be roaded. However, the allowable cut of a given year can come only from lands served by the existing network. If the road system is short and being only slowly extended, it is inevitable that the managers will be forced toward taking the required allowable annual cut in the form of large clearcuttings close to the existing roads. Furthermore, opportunities to get this allowable annual cut from partial cuttings aimed at salvage or positive silvicultural improvement as well as immediate yield will be small.

It has long been obvious that the only way out of this trap was "advance roading," that is, a policy of extending roads as far as possible and leapfrogging past as many stands as possible to harvest timber from stands most in need of improvement cutting or replacement. It would be incorrect to imply that none of this has been done. However, appropriations for the purpose seem to have been controlled too closely by shortrun outlooks on timber revenues and not enough by long-term or intangible benefits.

Some of the road construction that has taken place appears to have involved higher design standards than are consistent with most crucial needs or the objective of minimizing the damage to soil and water associated with roads. In steep terrain every foot of road width directly or indirectly adds substantially to the one kind of environmental damage that undeniably results from logging. If this be the case, designers must look farther than such things as the increase in stumpage revenue that can result if log trucks can go faster and ought to take a less indulgent attitude about ultimate multipurpose use by the general public. A single-lane road with turnouts can sometimes fit all considerations better than a two-lane road suitable for 30-mile-per-hour travel.

As indicated in the section on "Logging," it is desirable to encourage the development and use of skidding equipment which can operate economically over the longest possible distances. Such action can materially reduce the proportion of area covered by logging roads.

A high proportion of the poor practices that lead to damage from roads are not the result of engineering design but of inadequate supervision of construction. There is a human tendency for operators of mechanical equipment to do things by ways that are easiest at the moment.

For example, the questionable practice of "side-casting" in road construction may be the result of debatable plan or the violation of plan. This is the practice of casting material off the edges of roads being cut into the sides of steep slopes. Such side-castings are a major source of erosion, especially if they are unplanned deposits left forming



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slopes steeper than the angle of repose of the materials involved. It is better practice to plan to "end-haul" the cut material and use it for designed fills elsewhere on the same road. This may or may not be more costly, depending on the circumstances, but the resulting erosion is less in either case. It is also necessary, however, to prevent the unplanned side-casting that results when a bulldozer operator cuts a road that is wider and probably more costly than was planned.

There are instances in which environmentally wise precautions actually decrease harvesting costs. This may be true where poor construction, maintenance, or use causes roads to be muddy. Mud slows all operations and wears out equipment rapidly. The same mud is also a symptom of soil damage and a source of downstream damage.

Forest managers should not be reluctant to close and put ditches across purely temporary logging roads as soon as their use ceases. On initial consideration it often seems a witless affront to hunters and other casual travelers to close what may seem a perfectly good road. However, at least one of the reasons becomes more apparent if the hunters also fish in waters downstream that may become silt laden. On the other hand, there are instances in which deliberate extension of use of such roads by hunters may reduce browsing pressure on the new stand. This illustrates that intelligent management of the forest ecosystem is not necessarily a straightforward proposition.

Forest road systems should be looked upon as a powerful tool of land management. While there should be more investment to extend the networks faster into areas that should be roaded, the systems themselves should be skillfully designed as means to ends and not as ends in themselves. On Federal lands, better results might sometimes be achieved if roadbuilding was more commonly done under separate contract by specialized firms rather than by timber buyers under sale contracts.

## Logging

Most of the problems, environmental and otherwise, of timber production forestry are directly or indirectly associated with logging. It is not just the means by which wood is harvested; it is also the primary silvicultural tool by which vacancies are created in the forest growing space to foster the growth of desirable residual vegetation or to make way for the establishment of new.

Logging is the most expensive and difficult operation that goes on in the forest. It went on long before there was any concern for environmental damage or for applying silviculture to make timber a renewable rather than a stock resource. Furthermore, it is generally conducted by timber buyers, independent contractors, or separate organizational divisions with little or no real incentive to be concerned about either the problems or rewards of the future. While forestry as a whole has a uniquely long scale of time, the efficiency of logging is conventionally judged on the basis of the year or even the week. Consequently it should not be astonishing that most of the analytical thought and technological developments in logging have been directed at getting the wood out as cheaply and expeditiously as possible.

This is not to imply that accommodation between the shortrun outlook of logging and the long-term viewpoint of the whole of forestry is impossible. Very substantial progress had been made even though much more is necessary and there probably can never be enough. However, it is crucial to recognize that the long-term benefits of improved logging practice go mainly to the ownership of the land and indirectly to society and not to the logger. Higher costs must be paid by land ownership in the form of lower stumpage prices and by consumers as increased prices for wood products. These are sound long-term investments in improved and sustained timber production and in the less tangible environmental benefits but they redound to the logger only to the extent that he too is a consuming member of society.

### Logging Equipment and Damage

One awkward manifestation of the dichotomy between logging and other concerns lies in the nature and development of logging machinery. An industry composed of many small units has great difficulty in marshaling the capital necessary to support progressive technological development. Most logging machinery has been designed almost exclusively to minimize logging costs and with distinctly less investment of engineering expertise than has gone into such machinery as that used in agriculture and construction. Attention to minimizing damage to the soil and residual trees has been scanty but not altogether lacking. As far as damage in the woods is concerned, foresters and loggers generally have to try to do the best they can with what is available.

The most crucial concerns have to do with the equipment used in skidding, the operation by which logs are moved from the stump to some central collection point.

The obvious damage caused by skidding within a forest stand is to the soil and any desirable residual trees. Many of the most efficient silvicultural procedures depend on the capacity to harvest some trees and leave others to grow. Where these are employed, excessive damage to the vegetation that should remain can be intolerable, hideously wasteful, and a source of increased accumulation of fuel for forest fires. However, the pattern of development of forest stands is such that the destruction of saplings in swaths up to 8 or 10 feet wide can be a blessing in disguise. The ideal spacing for trees in a sapling stand is seldom denser than 8 by 8 or 10 by 10 feet so loss of trees that contribute to greater stand density than that is at least partly beneficial. Small seedlings which might logically be left at closer spacing are often supple enough to escape silviculturally unacceptable damage unless some wholesale scraping action is involved.

At risk of overgeneralization, it can be stated that skidding seldom causes anywhere near as much direct damage to soil and water as appearances often suggest. In fact, very little of these kinds of damage would result if skidding machinery never gouged into the mineral soil, never moved the unincorporated organic matter more than a few feet sideways, and never caused major compaction of the mineral soil. Such damage can occur but it is ordinarily confined to loading zones and those skidtrails that are traversed repeatedly.

The erosive effects that damage soils and make streams turbid result when the soil porosity is so reduced that water runs over rather than sinks into the surface. The uppermost mineral soil beneath forests is typically so rich in organic matter incorporated into it by the feeding and plowing action of soil organisms that it remains highly porous unless heavily compacted. However, problems can arise if the superficial mineral soil that is rich in organic matter is gouged away and the thickness of the porous mantle thus decreased. Even if this does happen erosion can result only if the ground is sloping and the subsurface materials are nonporous. It would be ideal if the surface organic litter or unincorporated organic matter remained in place. Its horizontal displacement removes a major portion of the chemical nutrient capital and also the food on which the soil plowing organisms feed. In practice, horizontal displacement of this material by scraping action does not become serious unless the distances are greater than can be reached by the remarkably aggressive root extension of plants newly established or remaining after the disturbance.

The second but most important relationship between skidding equipment and damage to soil and water is the indirect and not immediately apparent relationship to roads. It has been demonstrated repeatedly that more than 95 percent of the erosion and stream damage associated with logging usually comes from truck roads and similar ways rather than from disturbance caused by skidding itself. The amount of soil and water damage, therefore, depends on the proportion of surface covered by roads and the care exercised in their construction and maintenance. Skidding equipment which can operate economically and effectively over long distances reduces this kind of damage simply by reducing the extent and density of the logging-road network.

It used to be easy to fall in love with horses and mules as the motive power for skidding when one looked only at the small amount of damage they caused to the soil and residual trees. However, they tired quickly enough that skidding distances were only several hundred feet so the network of haul roads was dense. Nowadays one can follow the path of a high-speed, articulated, rubber-tired skidder with considerable horror but these machines operate over distances of a quarter mile or more. The reduction in the mileage of truck roads is spectacular. It is because of this effect that much of the effort to reduce environmental damage from logging is aimed at developing equipment, including balloons and even helicopters, to increase skidding distances and reduce the extent of truck roads.

In considering the skidding of logs, it is useful to distinguish between two basically different methods which have developed mainly because of geographical contrasts in the steepness of terrain. In regions where the terrain is comparatively gentle, as in the East and South, developments have revolved around the self-propelled unit that drags logs over the ground; it started with oxen and has evolved to such devices as the rubber-tired skidder. In the steep, mountainous country typified by the Pacific Northwest an even more diversified variety of overhead skidding equipment has been developed. The initial purpose was to lift the ends of the logs far enough off the ground so that they would not catch on stumps as they were dragged along the steep terrain. This equipment has sometimes developed to the point where one takes advantage of the steep topography rather than fighting with it. The motive power is stationary and the basic idea is to hang and move the log tongs through the air.

Ground-skidding equipment, if operated with care, can often be used without intolerable damage to desirable residual trees and is, therefore, relatively compatible with various kinds of partial cutting. On the other hand it is more likely to cause direct damage to the soil than the cable systems. The greatest problems with ground skidders arise when the soil is wet and on steep slopes. If slopes become too steep, as in many parts of the West, it is unsafe to use tractors without practically making roads on which they can operate. It is for this reason that the Forest Service often bans their use in favor of cable systems on steep slopes.

Most of the cable or overhead skidding systems do less damage to the soil than self-propelled skidders. However, their use often involves enough sideways shifting of cables that they can be very damaging to any residual stand. Some kinds of this sort of equipment can, with suitably shaped and steep terrain, lift trees out of the stands with small damage to those which remain. Nevertheless with most such equipment the damage to residual trees is enough that cable skidding is far less compatible with partial cutting than ground skidding.

Where the terrain is gentle enough to use any kind of equipment and for trees of a given size, ground skidding is the cheapest. Conventional kinds of overhead skidding are more expensive; in general, the higher the lines are lifted the more expensive is this kind of skidding. Balloon skidding is even more costly and the costs of helicopter logging are, so far, so great that it can be used only on the most valuable trees.

While helicopter logging has some remarkably attractive features, there is risk that it may not be compatible with sustained yield timber production. The fact that helicopters leave no roads behind can become a curse as well as a blessing. If the portion of the high value of fine, old-growth timber that is now commonly used to buy road access is instead used to rent a helicopter, the economic opportunity to make the stand permanently accessible may be lost. Future technological developments might overcome this problem, but it is important to remember that the accumulated value of old-growth timber can support the development of permanent access where second-growth timber could not.

### Logging Costs and Partial Cutting

Logging costs have such an important effect on the choice of methods of cutting that it is necessary to consider how this effect operates under different circumstances. If these costs were the sole consideration, the objective would be to minimize the cost per unit of product harvested; this action would also maximize the stumpage value.

There are two basic categories of costs, fixed and variable. The fixed costs are mainly those associated with roads and with the moving and setting up of quasi-stationary equipment. These fixed costs are the same whether the volume of timber harvested from an area is large or small; they are logically regarded as charges per acre covered in a given operation.

The variable costs are mainly those of processing individual trees or parts thereof. They include such costs as those of felling, log making, skidding, and loading insofar as the handling of separate pieces is involved. These variable costs are basically costs per tree. When converted to costs per unit of product, for any given set of equipment, they are large for relatively small trees and small for large ones. These costs also vary according to the capacity of the equipment. Within limits, light equipment can be used to harvest small trees at acceptable costs per unit of product; heavier equipment can be used to harvest large trees at very low-unit costs but cannot handle small trees economically.

The fixed or per-acre costs are high and dominant in their effect in difficult terrain where roads are costly or where the timber is large enough to require ponderous equipment. Under such circumstances it is economically desirable to maximize the volume cut per acres; this reduces the cost per unit of product by maximizing the volume against which the fixed cost must be charged. This phenomenon works in favor of the use of clearcutting in stands of large trees in mountainous terrain. This is especially true of new roads which must be constructed to make the cutting areas accessible.

Partial cutting is economically more feasible with gentle terrain, small timber, cheap roads, and highly mobile equipment. Under these circumstances, the effect of variable or per-tree costs tends to outweigh that of the fixed, per-acre costs. If the burden of fixed costs is small, the owner or forest manager has more financial latitude for prescribing kinds of cutting in which some merchantable trees are left for additional growth or other purposes.

Nevertheless, if the logging costs of a single operation were the sole consideration, the objective would be to minimize both fixed and variable costs simultaneously under all circumstances. This would almost invariably be achieved by harvesting every tree that was just valuable enough to pay the cost of operation. The result would actually be true clearcutting only in the uncommon instances in which every tree in the stand was large enough and sufficiently sound to be worth harvesting. Single-minded concern for harvesting costs would normally produce high grading rather than true clearcutting.

There can be important financial benefits in reserving presently merchantable trees for future growth in partial cuttings. This kind of logging inevitably costs more, for a given operation, than cutting everything merchantable. Ownership must pay the increased cost either by paying the logger more per unit or by accepting a lower stumpage price. The question for the owner or forest manager is whether the future values to be gained from reserving merchantable trees exceed the immediate cost of doing so.

If the fixed costs are low enough and if the reserved trees are capable of increasing substantially in value, it becomes logical to reserve them in partial cutting. The practices of thinning in immature stands and shelterwood cutting in those approaching maturity typify programs in which the costs and benefits of partial cutting can be balanced to maximize the overall net return from a single timber rotation.

Logging costs can neither rule nor be ignored. So long as there is overmature timber to be harvested and difficult terrain requiring expensive roads, all these factors weigh heavily in favor of clearcutting. The problems of steep terrain will not go away, although the gradual establishment of permanent road networks will mitigate their financial effects. There will be an increase in the number of stands young and plastic enough for application of partial cutting. However, if partial cutting is to be feasible, there must be continuing development of suitable logging equipment.

#### Logging Research and Development

There is clearly a need for invention of logging systems that are more closely integrated with total programs of forest management than those now available. From the environmental standpoint, the most important requirement is for systems that will reduce soil and water damage. From the silvicultural standpoint, the need is for equipment that will make partial cutting more compatible with mechanization. Most recent developments have been with ponderous equipment designed mainly for clearcutting and economically more adapted to harvesting large- and medium-sized trees than small ones. It is also necessary that new equipment be of a nature consistent with safety and decent living standards for the loggers who operate it.

It will require money, talent, and imagination to meet such goals. While it is possible to conceive of substantial improvement through modification of existing machinery, effort should also be directed at creation of entirely new engineering concepts beyond the limited imagination displayed in this report.

### Pest Management and Damage Control in Forestry (by David M. Smith and Earl L. Stone)

Increase of net wood production comes not only from stimulating tree growth but also from reduction of losses. The damaging agencies are the physical or nonbiotic ones, notably fire and weather, and the biotic pests, such as insects and other animals, fungi, and forest weeds. Many types of biotic and nonbiotic agencies are useful or destructive depending on the goals and circumstances. For example, wildfire is a well-known source of harm but prescribed burning is a valuable tool for fuel reduction and preparation of sites for regeneration. Though some insects, mammals, and fungi harm trees, many are indispensable to the trees themselves or to other objectives of forest management. Some insects feed on harmful ones; others are essential to pollination of some shrub and tree species. Weeds are plants growing out of place in terms of human objectives, yet the tree which is a competitive weed in one place may be the most highly desired in another. Examples of this sort are infinite; the main point is that management based on sound ecological principles must balance harm and benefit.

It would be ruinously expensive to prevent all damage and all loss. Considerations of both economics and ecology militate against the creation of forest systems that are absolutely damage free or utterly simple in composition as far as the total population of living organisms is concerned.

These lines of reasoning underscore the long-standing principle that damaging agencies in the forest are controlled and losses reduced, rather than completely prevented. In recent years this approach has come to be looked upon as one of management of pests and damaging agencies (Beirne, 1967). The basic concepts of pest management have been recognized and used, under other terms such as "integrated control," for many decades. Their status has been comprehensively reviewed in a series of publications by the National Research Council (1968–70) which draw information from many sources. The various measures which may be included in the strategy of pest management include both direct and indirect control (Graham and Knight, 1965).

The strategy does and should consist of a multiplicity of tactics. Reliance on a single control measure is almost invariably less effective, more costly, and more questionable in ecological terms than some combination of partial measures. There must also be judgments about how many fires, deer, bark beetles, or gray birches can be tolerated or, for that matter, desired.

Since current concern is mainly about measures involved in managing biotic pests, the remainder of this particular report will be limited to this general problem.

Direct controls, aimed at the pest itself for its immediate suppression, can include mechanical, biotic, or chemical methods. Indirect controls are intended mainly to modify environmental factors in attempts to keep pests at tolerable levels on a long-term basis. Measures for indirect control include quarantines but consist mainly of manipulation of the physical and biotic characteristics of the living systems being protected. Biological control is one category of manipulation which has come to mean the use of organisms that attack the pests; its application may be for short-term direct control or long-term indirect control. The other manipulative tactics involve silvicultural techniques designed to create kinds of vegetation or microclimates unfavorable to serious pests. Selection of species and genetic improvement are ways of developing resistant vegetation. Finally, the role of such passive tactics as salvage or merely acceptance of losses must not be underemphasized.

The general strategy of pest management is the basic approach to problems with forest pests and has been since long before the term was coined. It is a fundamentally ecological concept that has been applied much more consistently in forestry than in modern agriculture. This results not so much from any superior wisdom among forestry interests as it does from inferior financing.

### Passive Tactics

Realistic pest management must include some deliberate acceptance of loss. Damaging agencies are constantly at work, so it is continually necessary to decide which are trivial and which are not. While such decisions are not necessarily easy, it must be recognized that cures may cause more harm than good or may cost more than the results are worth.

Salvage of losses involves action but is still an essentially passive approach to pest management. It is sometimes a powerfully effective means of reducing economic loss. Theoretically any ideal salvage program would anticipate rather than follow the damage; in any case, dead trees deteriorate so fast that useful salvage operations must be prompt. Opportunities for successful and continuing salvage programs heavily depend on keeping stands accessible with roads. This is another manifestation of the vital role which roads play in forest management in spite of the harm that they can inflict on soil and water if improperly managed.

### Indirect Control

#### *Silvicultural control*

Silvicultural control measures are aimed at creating or maintaining conditions of vegetation or physical environment that are unfavorable to serious pests. The most important set of silvicultural tactics are simply those of evasion or avoidance. Most potential difficulties with forest pests are avoided merely by refraining from creating kinds of stands that are unduly subject to damage. Trees live outdoors in all seasons for many decades in places where it is physically very difficult to protect them. Therefore, it is only prudent to grow kinds of forests that have demonstrated resistance in nature. This does not eliminate all problems because the pests are part of the same ecosystem and are also adapted to survive the circumstances. In fact, all trees ultimately succumb to some damaging agency and it is a prime objective of silviculture to harvest them before they become too vulnerable.

In a narrower sense, silvicultural control can also be aimed more specifically at reducing problems with certain pests in particular situations. For example, if oak seedlings are not wanted and are not present, the combination of heavy cutting and destruction of litter covering will discourage the germination of acorns, which must remain moist and covered to sprout. If a stem-deforming insect such as the tip-weevil of eastern white pines thrives only in the sunshine, the damage can be reduced by growing the young trees under a shelterwood cover until an acceptably long length of straight stem has been formed.

Cutting can be used to eliminate some pests by interruption of their life cycles. For example, the dwarf-mistletoe is a parasitic seed plant which causes debilitation and premature death of many conifers of the western interior. Mistletoe seeds can be likened to sticky spitballs capable of spreading little more than a 100 feet. If all susceptible host trees, large and small, are removed in a complete clearcutting, a new stand of trees free of mistletoe can be established promptly. However, the reservation of small, infected trees perpetuates not only the tree species but also the dwarf-mistletoe. Fortunately, the seeds of most of the tree species blow farther on the wind than those of the mistletoe can be propelled from the parent plants.

In similar manner, undesirable tree species can be eliminated by cuttings so that their progeny do not proliferate on regeneration areas. Such attack on the undesirable seed source may reduce need for subsequent herbicidal treatments.

Damage from some insect and fungus pests can be reduced by developing stands of mixed species or by restricting the size of stands of a single species and age. Such action dilutes the food supply of pests which are specialized to attack only a single tree species or age class thereof. The interspersal of trees of species or ages unusable by the pest with trees which are susceptible can present a physical barrier to its movement. It is because of such effects that mixtures of species or age classes within forest stands are often properly regarded as safer from pest damage than stands of uniform age or species.

On the other hand, the pests themselves can also be well adapted to survive in and feed on almost any kind of forest that ever existed. They have a way of making a mockery of nearly any sweeping generalization that might be made about their control. For example, the natural, mixed forest of spruce and balsam fir of the Northeast has been periodically decimated by massive outbreaks of a native defoliating insect not very appropriately called the spruce budworm. The outbreaks tend to start in forests where balsam fir has been allowed to get old enough to produce abundant male cone buds which are especially nutritious to the insects. It appears unlikely that this insect could become a serious pest in a pure spruce stand, although there is no certainty that another pest would not do so if given the apportunity. The spruce budworm can be kept in partial check in spruce-fir stands by systematically cutting the firs out before they get very old. There is additional incentive to do so because they also often become badly heart-rotted about the time they become highly susceptible to budworm attack.

Damage from some pests can also be reduced by such measures as thinning which enhance the vigor of the trees. However, this is true only of the pests adapted to feed on weakened trees. Just as man prefers to eat the fruits of vigorous plants it is not surprising that there are pests adapted to feed on the more vigorous trees. Browsing animals tend to do so. The aforementioned white pine tip-weevil does so as well and the control by shading works partly because it reduces the vigor of the host trees. Many of the important stem rusts of conifers appear to thrive on vigorous rather than weakened trees, although there are no known instances in which practical advantage can be taken of the phenomenon.

*Biological control*

A closely related form of environmental control is that which involves reliance on the biotic enemies of the target pests. The economically damaging pests which feed on trees are, in turn, food for other organisms. It has long been recognized that, without this form of natural biological control, any organism which feeds on the forest could cause infinitely more damage than it does. Since most well-adapted organisms do not destroy or seriously impair their food base, those which cause economically important damage to forests are actually a very small minority of those which feed on trees. Introduced pests are more likely to become serious than native ones because their natural biological controls may have not immigrated with them or because the native hosts lack resistance to them.

The operation of biological controls can be made more effective by actively fostering appropriate parasites and predators or simply by avoiding measures which discourage them. There is, for example, ample ground for skepticism about the use of broad-spectrum insecticides which are apt to kill not only the target insect but also its own insect enemies. The deliberate introduction and encouragement of the organisms which attack introduced pests is the most aggressive form of bioligical control. If done with appropriate caution, it represents an effective artificial way of redressing a balance irreversibly altered by the initial introduction of the target pest.

While biological control is ordinarily thought of most commonly in connection with insect pests, it is not limited to them. There are instances in which selective feeding by wild and domestic animals or even insect and disease attack has freed desirable trees from the competition of undesirable vegetation.

The possibilities of biological control are substantial though not limitless. Any organism which feeds on another is dependent upon it. If dependent organisms can feed only on one pest, they will not ordinarily start to reduce the pest population until it has become large. Omnivorous predators, for example, birds, mice, or insects that feed on many species of insects, are usually more quick to operate on and more effective in holding pest populations at low levels than those which feed only on a single species of pest.

The effectiveness of biological control is highly variable and almost inevitably incomplete. It is also rather slow to operate. Paradoxically it is remarkably efficient in keeping minor pests from inflicting economically important damage but least effective against pests, especially introduced ones, which develop large populations and cause serious damage. The fact that natural biological control keeps a myriad of potential economic pests at innocuous levels does not mean that it can be made into a universal panacea for all pests. It is best viewed as having a very important role as one of several used in adroit pest management.

*Role of indirect control*

Most forest pest control in managed forests is accomplished by maintaining environmental conditions that are at least quasi-natural and by refraining from the use of all but the most well-adapted exotic species. North America is so well-endowed with tree species that the use of introduced ones in American forestry is minimal. Difficulties have arisen in attempts to use trees species or strains outside their natural ranges or on sites to which they are not adapted. This source of damage is best eliminated by avoiding such unwise extensions of natural tree populations.

This situation is very much different from that of agriculture or even the landscaping of the suburban home. These kinds of plant culture rely heavily on introduced species and strains selected for characteristics other than pest resistance. They also involve maintenance of very artificial environmental conditions.

In forestry, chief reliance is placed on natural biological controls reinforced by the kinds of vegetational manipulations chosen for silvicultural purposes that include attempts to control pest damage. Even though silvicultural and biological control measures are heavily used, with and without conscious intent, in forestry, this is not to say that they should not be used even more than they are. The processes are exceedingly complicated. They cannot be used effectively until their nature is known. While they have been the subject of decades of research and development, this effort has probably only scratched the surface.

Among the virtues of biological and silvicultural control of pests is their ability to operate more or less automatically over long periods once set in motion. They are far less likely to depend on the prompt timing that is typically necessary in direct attack on the pests themselves. On the other hand, the indirect measures involved in biological and silvicultural control are typically slow and sluggish in operation. They may or may not be economically acceptable and practicable. In general, they play a very important but incomplete role in forest pest management. They leave a residue of problems to be attacked, on occasion, by direct control measures.

### Direct Control

Many thoughts about pest control are strongly influenced by matters of human psychology and culture. If a pest is causing damage, the first reaction is to attack it directly with such tangible weapons as chemicals. The management of forest pests has, in varying degrees, both resisted and been partly subverted by conventional attitudes favoring the direct chemical approach. It is important to note that there are many nonchemical direct-control measures. The process of release cutting is a common and traditional means of reducing the competition of forest weeds. It is also sometimes possible to lure insect populations to deadened "trap-trees" or logs and then kill the pests by burning or by drowning them in a log pond. Biological control can become a direct means of control if parasites or viruses of the pest organisms are actively or artificially grown and released.

Most of the public concern about environmental impacts of forest pest management has involved the residue of problems attacked by direct chemical control, that is, the use of pesticides. It is to this portion of forest pest management that the rest of this report is directed.

#### *Pesticides*

Concern about pesticides seems fated to be based on mixtures of solid fact, prudent doubts, and hysterical misapprehensions. Prudent doubt about their use is customarily introduced by efforts to leave large margins of safety in application. For example, the maximum safe dosage of a pesticide is commonly regarded as a hundredth of the greatest tested dosage which showed no harmful effect on desirable nontarget organisms. The leading hysterical misapprehension is one that ignores the most basic principle of toxicology, which is that no substance is absolutely safe or absolutely poisonous. Any substance taken in great enough amount by an appropriate route can produce harm or death. Conversely, no substance is harmful if administered in small enough amount. The popular demand for assurance that something is safe or poisonous simply cannot be met objectively in such absolute terms. Observations about the toxicity of pesticides to nontarget organisms in this report are based primarily on those gathered by Tucker and Crabtree (1970) and Heath et al. (1972).

So much attention has been focused on insecticides that it is necessary to point out that pesticide and insecticide are not synonymous. Fungicides, rodenticides, and the herbicides are pesticides as well. There are many different chemicals in each category and any generalizations about them should be approached with caution.

Much of the popular concern about forestry use of pesticides appears to stem from the misapprehension that they are applied as routinely, frequently, and heavily as they are in some of the more intensive kinds of agriculture and horticulture. In these other kinds of plant culture, attack by pests is often presumed to be inevitable and potentially damaging enough to warrant prophylactic chemical measures to prevent attack before it takes place. In forestry, prevention of attack is customarily sought by passive and indirect tactics; pesticides are used as weapons of last resort rather than as first line of defense. They are typically withheld until intolerable damage is already underway or clearly imminent. In fact, errors of timing of pesticide application in forestry are usually those of being too late rather than too early.

The chief exception involving heavy pesticide use in forestry is in the very limited areas used for tree nurseries or tree-seed orchards. Pesticides are routinely used as preventive measures here. The practice reflects the fact that crops of nursery-grown seedlings and tree seed are more valuable per acre than most intensively grown agricultural crops. For somewhat the same reason, a shade tree is much more likely to be sprayed with an insecticide than any tree growing in an intensively managed forest.

The vast majority of managed forest stands in this country have grown to their present condition without any pesticide applications. Under prevailing silvicultural practices, many will continue without such treatment. If stands are so treated, the applications typically range from 1 to 3 during a half century. An idea of the limited extent of pesticide usage in forestry may be obtained from a survey of industrial forest holdings in the South reported by Johnson (1972). The 27 million acres covered in his survey include the most intensively managed lands in the country; the techniques and silvicultural philosophy involved in growing the southern pines come closer to agriculture than those of most American silviculture. He found that, in 1969, insecticides had been applied to 0.009 percent of this acreage and herbicides, to 0.7 percent. Furthermore, he pointed out that "Where applied, agricultural usage averages 14 pounds per acre of pesticides" annually while forestry applications of insecticides seldom exceed 1 pound per acre and are not annual. He also reported that in 1968 only 0.8 percent of the industrial forest land in Washington, land which is also managed with unusual intensity, was treated with any kind of pesticide. It is reasonable to assert that foresters have worried more about pesticides and used less than any other group concerned with growing plants.

Fungicides are seldom used in forestry outside nurseries and intensively managed seed-production areas and in treatment of wood products. There have not been many experimental efforts to use fungicides in the forest and most such efforts have not been successful. This is possibly because the minute spores that spread fungus-caused diseases are so small, mobile, and abundant that it would take at least annual treatments to put artificial chemical barriers in their way. Most reduction of damage from fungus diseases in the forest is accomplished by such indirect measures as salvage, silvicultural control, or development of resistant genetic strains.

The pesticides most likely to be used in forests are insecticides and herbicides. Insecticides are used mainly against a limited number of those native or introduced defoliating insects that sporadically burst the bounds of indirect control and develop massive populations. The use is episodic rather than routine. Herbicides, on the other hand, come closer to routine use, especially in intensive silvicultural practice, and are likely to become increasingly important. The use of insecticides is fraught with greater peril than that of herbicides.

One fundamental reason for this difference is the mobility of target and nontarget organisms. Plants do not move but insects and other animals do. Modern organic pesticides are developed to the point where herbicides are, in general, toxic only to plants, usually just to green plants, and animal poisons, such as insecticides, only to animals. A nontarget animal can easily wander into exposure to an animal poison. A herbicide may conceivably drift out of the target area but susceptible nontarget plants cannot drift into it.

A purely psychological consideration is that man tends to set more store by some of his fellow animals than by plants. A high proportion of the concern about use of herbicides actually arises over the question of how much the resultant modification affects wildlife populations rather than over effects on the plants themselves.

*Insecticides.*—DDT and the other chlorinated hydrocarbon insecticides are no longer an issue as far as management of forest insects is concerned. Their use in American forests was greatly curtailed during the middle 1960's as soon as doubts about their suitability began to mount. State and Federal restrictions have now limited their use in forests to control of bark-beetles and other insects which can be combated by spraying parts of tree stems. Consideration of this category of compounds serves mainly to provide background for thought and future action.

The chief problem with DDT and the chlorinated hydrocarbons was their low solubility in water and high solubility in fats and oils. This meant that they tended to be sequestered in the fatty tissues of animals or other oily materials and thus to be withheld from the aqueous media in which various destructive organisms and chemical processes could break them down into innocuous substances. Their tendency to accumulate in fats also allowed them to be concentrated in ever-increasing amounts as the fats were passed from herbivore to carnivore to secondary carnivore. The most clearly demonstrable reason for greatly curtailing their general use has been their harmful effect on the reproduction of carnivorous birds such as eagles and pelicans. It took much investigation to uncover this obscure but important eventuality. It had been known from the beginning of use of DDT that it was a broad-spectrum poison with harmful effects on many coldblooded animals such as fish and beneficial nontarget insects. In fact, application of these materials in and adjacent to streams was consistently held to be poor practice and usually prohibited.

The more general and significant lesson learned from the DDT debacle is the undesirability of any toxic chemical, whether it be a pesticide or not, that tends to persist in the environment. It is not really a question of whether the chemical is known to be harmful to desirable organisms. It is not even a question of how much value society places on carnivorous wildlife. If persistent chemicals accumulate and concentrate in any organism, it must be assumed that there may ultimately be harmful effects whether they are ever detected or not.

One of the important effects which DDT had on forest pest control was that, from 1945 until the early 1960's, complacency about the possibility of using it tended to divert attention from development of other categories of insecticides and from indirect control measures.

The most generally serious problem with forest insects is the control of defoliators such as the spruce budworm of northern and western conifer forests and the introduced gypsy moth and native defoliators of hardwood forests.

To the extent that insecticides are used in the management of these pests, they are most effective if sprayed from the air. The very uniform coverage that can be achieved by aerial spraying from above the forest enables control to be achieved with quantities of chemical substantially smaller than would be necessary with application from the ground. Spraying from the ground typically gives erratic and uneven coverage of foliage and requires much more chemical to produce a given result. While intuition may suggest that spraying from the ground is environmentally safer, most of the facts favor aerial spraying when treatment of the foliage of tall forest is involved. The low cost of aerial spraying is an important consideration, but far from the only one. Either kind of application raises questions about the blanketing of substantial areas with potentially harmful chemicals.

The synthetic insecticides used for control of forest defoliators are now limited to a few characterized by low persistence and, in most instances, low toxicity to warmblooded animals. The one in most common use is carbaryl or sevin. Gardona and methoxychlor are in somewhat less common use but also meet the test of low persistence and low toxicity to nontarget organisms. Zectran is an insecticide developed by the U.S. Forest Service for the spruce budworm. While it has a rather high toxicity to warmblooded laboratory animals, this shortcoming is largely negated by its very rapid degradation (Tucker and Crabtree, 1966). It also appears to have the advantage of low toxicity to nontarget insects.

A wider diversity of suitable chemicals would be desirable. Active efforts are underway to find, evaluate, and develop more which meet the tests of rapid degradation and minimal effects on nontarget organisms.

Varying success in combatting defoliators has been achieved by spraying with BT, a material of natural origin not chemically foreign to natural systems. This substance is a mixture of the spores and toxins produced by a bacterium, *Bacillus thuringenis*, which attacks certain defoliating moths. The toxins sicken the target insects more often than they kill, but can reduce losses of foliage. While the effectiveness of the material is debatable, it is a step toward more sophisticated measures of direct control. The use of certain insect viruses is at least equally promising in specific cases.

One of the objectives of seeking more sophisticated controls of defoliators and other harmful insects is the development of measures that will affect only the target pest. One of the basic shortcomings of all insecticides in present or former use is their toxicity to a rather wide variety of organisms, including some which are beneficial. Among the promising developments, but not the only such, is the synthesis of insect sex attractants which are operative with single species and may be useful in deranging their reproductive behavior. The possibilities are great enough to justify a substantial research effort, particularly on the more troublesome species. Nevertheless there are practical limitations on how far efforts can proceed simply because so many different insect species might be involved. Each important pest might well require a large, separate research program.

*Herbicides.*—The herbicides that are now used in silvicultural operations appear to be toxic primarily to green plants. Their toxicity to members of the animal kingdom is low or very low and they do not greatly affect the microscopic nongreen plants of the soil. They are readily biodegradable in the soil and seldom escape from it. Their effect on the soil and stream runoff is, on balance, less harmful than the techniques of plowing and surface scraping that might otherwise be used for controlling some forest weeds.

Most silvicultural use of herbicides takes the form of either foliage spraying or injection into the stems of individual trees. Sometimes they are also applied to cut stumps or on the stems of trees or brush clumps. Their use in forests is supplemental to that of mechanical treatments, prescribed burning, or regeneration cutting practices designed to create environments favorable to establishment of desirable species or restrictive of the undesirable.

The herbicides in most common silvicultural use are the chlorophenoxy acids, notably 2,4,5-T, and

2,4-D. These are especially useful for selective foliage sprays mainly because of their highly variable ability to enter and move within different species of plants. For example, they can be used to kill broadleaved trees to favor conifers mainly because spray droplets fall off the narrow leaves of the conifers. Earlier difficulties with the tendency for vapors of these particular herbicides to drift to nontarget plants have been overcome by using formulations that have high molecular weight and low volatility. The compounds are produced in many forms with differing physiochemical properties so that they can be used for a variety of different purposes.

Picloram is a herbicide that is very poisonous to green plants but apparently very low in toxicity to other forms of life. Because of its high plant toxicity it can be used effectively in very small amounts but is too toxic for selective foliage spraying. It is somewhat more persistent than other modern herbicides but apparently not dangerously so.

Use is also made of cacodylic acid and several other organic arsenicals mainly for stem injection. The forms of organic arsenic compounds used appear to be adequately safe if normal precautions are observed (Tarrant and Allard, 1972). An older inorganic arsenical, sodium arsenite, is so toxic and dangerous to handle that it fell into disuse before its general prohibition.

Several other herbicides, such as simazine, fenuron, and ammonium sulfamate, are also used for special silvicultural purposes and appear to involve no serious hazards.

Most of the doubts that have recently arisen about herbicides are consequences of their military use for defoliation in Vietnamese forests (Tschirley, 1969; Westing, 1971). Regardless of how badly this use may be found to have affected the vegetation and environment, it has little relevance to silvicultural practice. The rates of application were commonly six times those ordinarily used in forestry and the treatments were often repeated. There are always grounds for doubt about pesticides but guilt by association with chemical warfare should not be one of them.

As far as silvicultural use of 2,4,5-T is concerned, however, one consequence of military use has raised unresolved doubts. The heavy military demand for the compound appears to have induced episodes of dangerous shortcuts in its manufacture. If one step in the manufacture of 2,4,5–T (but not 2,4-D) is conducted at excessively high temperature and pressure, traces of one of the chemical ingredients form a highly toxic byproduct called dioxin. The Commission on Pesticides (1969) reported that laboratory animals with samples of commercial 2,4,5-T, later shown to be contaminated with this byproduct (Williams, 1972), were found to cause birth defects. It now seems established that the dioxin rather than the 2,4,5-T caused these alarming symptoms. It is understood that the Environmental Protection Agency is now attempting to resolve the question of whether 2,4,5-T can be produced without unacceptable dioxin contamination. In the meantime it has prohibited use of 2,4,5-T on food plants and close to concentrations of people but not its use in ordinary forests.

*Rodenticides and other mammalian poisons.*—Although wild mammals are a chronic source of damage to timber production, especially in young or regenerating stands, chemical controls have seldom been employed against them. Most such effort has been restricted to the control of rodents feeding on seeds and young trees. The limited amount of such activity has been still further curtailed by the direct and indirect consequences of a recent Executive order prohibiting Federal participation in any sort of widespread use of mammalian poisons. The programs that were the target of this order were mainly those designed to protect range forage resources and to control carnivorous predators.

Efforts to develop chemicals that repel rather than kill mammalian pests of timber crops are largely in the experimental stage. The most important chemical used as a mammal repellant in forestry, endrin, has been severely restricted as a side effect of the limitations imposed on chlorinated hydrocarbon insecticides. This compound is effective in small quantities as a rodent repellant when applied to seeds sown directly in the forest. No satisfactory substitute has yet been developed.

*Need for Pesticide Development*

Pesticides are used to such a limited extent in forestry that there has been very little ordinary commercial incentive to develop many that are designed for use against forest pests. Virtually all of those now in use have been borrowed from agriculture, although some have been slightly modified to fit forestry purposes. It is significant that

Zectran was developed by the U.S. Forest Service rather than by private industry. As far as herbicides for control of woody plants are concerned, the treatment of rights-of-way for roads and utility lines is a more attractive market than use in timber production.

This situation is not conducive to the development of forest pesticides that would be more target-specific and less threatening environmentally than those now in use. It is even possible that the recent wave of restrictions on pesticides has reduced the repertory of those used in forestry more than those of the major users. The use of pesticides in forestry is small and would remain small even if quadrupled. This limited use is nevertheless an indispensible supplement to the increases in intensive silviculture advocated elsewhere in these reports. Under the circumstances it appears logical that more of the essential research and development be assumed by public agencies. Such efforts should be coupled with increased investigation of indirect, nonchemical means of pest management.

## SILVICULTURAL ACTION TO INCREASE NATIONAL TIMBER SUPPLIES

The charge to the Panel is clearly that of proposing ways not only of improving the forest environment but also of increasing timber supplies. Since it takes trees decades to grow, all improvements in production require long periods of lead-time. For example, the present timber supply would be much poorer than it is but for developments, planned and fortuitous, that took place decades ago.

Forest fire control, which was most rapidly accelerated in the 1930's, rescued a major portion of the timber now being harvested and has literally turned long-term forest management from a dream to a reality. The agricultural revolution has allowed vast areas in the eastern half of the country to revert back to forest from agricultural use. Most of the possible benefit from these two sources has been realized and further improvements must be sought in other ways.

Evidence presented elsewhere in this report indicates that the most crucial problem is in maintaining supplies of timber from softwood trees large enough to convert into lumber and plywood. The problem is best viewed in the short, middle, and long ranges of time. The middle range is here interpreted as extending to the period 1980–99 when forecasted shortages are the most serious.

### Efficient Utilization of Wood Resources

There is little that can be done silviculturally in the short range, except to the extent that dependable increases in future production enable accelerated harvests of the existing inventory under sustained yield. Improvements in efficiency of utilization are most promising in the short run. Closer utilization in the woods does have a number of indirect silvicultural benefits. An outstanding example is the increased use, for both pulp and particleboard, of materials that would otherwise be left in the woods as logging residues contributing to problems of slash disposal, reforestation, fire hazard, stream damage, and esthetics. Advantage can be gained from this whether the material is used to reduce the burden on the domestic wood supply or is shipped abroad to redress balance of payments. On the national forests, the question of whether timber buyers pay for it or are paid to put it to use is really a minor financial consideration.

There is chronic concern over the diversion of sawtimber-sized material to pulpwood. This is not exclusively a short range problem but actually has more alarming implications for sawtimber supply from private lands in the middle and long dimensions of time. In private enterprise the investment of money over time is so costly that the growing of trees for sawtimber on rotations of 40–100 years is even less attractive than growing smaller trees for pulpwood on those of 20–50 years. The higher prices paid for sawtimber trees and their products can partly offset the effect of the cost of the longer term investment. Any direct or indirect public incentives that would encourage the growing of sawtimber more than that of pulpwood would enhance sawtimber supplies.

### Softwood Conversion in the East

If an increase in the national supply of softwood is desired in the middle and long range of time, the greatest, but not the most easily attainable, opportunities lie in small, private ownerships in the eastern half of the country. This category of ownership includes tens of millions of acres now fully or partly covered with hardwoods but on soils that are really too dry or otherwise too poor for the hardwoods to grow well. The growth of softwoods is far less sensitive to unfavorable conditions than that of hardwoods, except when the trees are young.

As a consequence there are vast areas in the East where the hardwoods grow well enough in youth to keep the softwoods either in check or excluded, but in the longer run not well enough to be very productive of timber. If the production of a whole timber rotation is considered, almost all softwoods will produce more wood than their hardwood associates and will do so on any site. In terms of board feet of sawtimber, the production of softwood is commonly twice that of hardwood and, in general, the poorer the soil the greater is the difference.

The advantages of favoring softwood over hardwoods in timber production in the East are great enough that most industrial forest owners seem to be doing at least as much stand conversion as can be justified economically and ecologically. In the West, climatic factors almost exclude the hardwoods so that opportunities to increase production by such conversions are few. This is why the greatest potentialities for increase in softwood production lie on small ownerships in the East.

Considerations of biology, economics, and multiple use combine to indicate that most of any such conversion from hardwoods to softwoods probably should be on the mediocre sites. Conversion on the poorest sites would be the least rewarding in both money and timber supply. It would also often involve rocky ridgetops and similar sites which have greater potentialities for other uses. Furthermore, some of the poor sites are biologically restrictive enough that they are often stocked with softwoods already. At the other extreme are those soils which are biologically most productive, such as the southern bottom lands, the deep soils of the Midwest, and the ravines of more rugged terrain. Here fine hardwoods, which are also in short supply, grow well and offer powerful resistance to displacement. While softwoods also grow better here than anywhere else, the silvicultural operations necessary to maintain them would not only be the most costly but the most questionable ecologically.
conversion of hardwoods to softwoods would be the most favorable. Moreover, it is also on these sites that there is likely to be ecological precedent for the alternatives of having stands of either hardwood or softwood, or both in mixture. It was on such soils, as well as the poor ones, that natural fires led to the development of virtually all of such virgin stands of pure pine as once existed in places in nearly all parts of the East. The quasi-natural pure stands of pine, spruce, and other softwoods that colonized vast areas of abandoned agricultural land were mainly on such sites. These stands, which can be so magnificent at advanced age, that they are sometimes mistaken for samples of the virgin forest, have already provided evidence of the major advantages and minor shortcomings of the kind of conversion to softwoods that is envisioned.

The greatest opportunities for increase in production from stand conversion are in the South because the area of suitable sites is very large and the southern pines mostly grow rapidly as soon as they are established. While the conversion of hardwoods stands back to pines by planting has taken place on hundreds of thousands of acres in the South since about 1950, there are still millions of acres where it might logically be done.

In the Lake States, the major possibilities still lie in reestablishing softwoods, notably by planting red and jack pine, on millions of acres where the once-famous pineries were destroyed by wholesale clearcutting and uncontrolled forest fires around the latter part of the 19th century. In the Northeast and the Appalachians, the most logical opportunities lie not so much in planting as in releasing white pine, spruce, and hemlock where they exist in mixture with hardwoods; these species grow slowly when young but their average production over rather long rotations can be great. The possibilities for increased production are more numerous and varied than the foregoing account implies, but it covers the most important potentialities for major increases in softwood timber supply that exist in the entire country.

Advocacy of conversion of hardwood stands to softwoods, especially to pure stands of softwoods, suggests questions about possible problems with monocultures and departures from natural stand composition. It is noteworthy that in many instances the conversion would represent reestablishment of kinds of stands that had existed in the same places as a result of natural fires before high-grading for softwoods. In many other instances, the consequences of the conversion may be learned from the widespread phenomenon of the "old field" softwood stand on abandoned farmland. It should not be presumed that any creation of nature does not allow site and soil to degrade. However, as the report of another Panel consultant, Earl Stone, indicates, the matter has been investigated frequently and nearly all of the evidence against forest monocultures involves special cases or observations of dubious scientific validity.

Probably the best argument that can be raised against softwood monocultures has to do with their interaction with animal populations. Simple composition of vegetation leads to simple populations of dependent animals. As is indicated in the report of another consultant, William Webb, softwood forests provide more cover than food for eastern game animals. The best management tool for handling this problem lies in fitting the composition of stands to the intricate pattern of soil variation that inevitably exists even in what seems to be the most uniform, level terrain. Proper silvicultural attention to this sort of variation would probably leave strips and islands of hardwoods within any 100-acre square that might be found.

There is, in addition, the risk that the simplified population of organisms in a pure stand may include an overabundance of pests damaging to the stand itself. There is certainly evidence that this can happen. However, it is not a general case and there are even some important pests that can exist only in mixed forests. The best safeguard against this source of harm lies in the fact that if the damage proves bad enough, the intelligent forester does not or should not long persist in creating such vulnerable stands. The timber crop is simply not valuable enough to bear the cost of such measures as repeated pesticide applications to defend highly vulnerable stands.

### Alleviation of Middle Range Shortages, 1980–99

It is now too late to start new trees to remedy projected shortages of softwood sawtimber in the last two decades of this century. The new, uniformly stocked stands that are being created now and should be continuously established in the future will ease the situation in the 21st century but not earlier. Their anticipated production can allow some increase in the rate of harvesting of existing, old-growth reserves but there are prudent limits to this kind of optimistic action.

The only silvicultural actions that can increase the physical supply of softwood sawtimber that can be cut in 1980–99 must take place in existing immature stands. Furthermore, they can only be in the form of partial cuttings or other measures designed to accelerate the growth of softwoods already beyond sapling size. The most promising operations are various kinds of release cutting, fertilization, thinning, and those forms of shelterwood and selection cutting that stretch the productive lives of some trees in existing stands.

The rationale of these recommendations may be exemplified by the fact that a pine tree that is 18 inches in diameter at breast height typically has 10 percent more board-foot volume than a 17-inch tree and 25 percent more than a 16-inch tree. The smaller the diameter of the sawtimber tree the greater is the proportionate gain in board-foot volume from relatively small increases in diameter. A 14-inch tree may have 15 percent more than a 13-inch tree and 35 percent more than a 12-inch tree. This means that whatever is done during the next few years to make trees now roughly 8 to 18 inches in diameter slightly larger than they would otherwise be in 1980–99 will contribute to alleviating the projected shortage.

Furthermore, if the stimulating action takes the form of thinnings that capture trees that would otherwise be lost to the inexorable natural thinning process the greater will be the total realized yield and the less the amount that need come now from true regeneration cuttings. The gain from thinning comes partly from making the residual trees in a stand grow faster and partly from capturing useful material that would otherwise be lost during the tremendous diminution of numbers of trees that takes place as stands become older.

The same general effect can be produced by release cuttings in mixture of hardwood and softwood if hardwoods are reduced to favor softwoods which commonly grow slowly or even die if not freed of the competition. While fertilization of forests is scarcely out of the experimental stage, it is clear that its chief economic benefits happen to lie in stands approaching maturity, which are the very sort where growth stimulation is now most vital.

Another way of describing the present dilemma is to state that the country is approaching the last two decades of the present century with a deficiency of good, vigorous trees in the part of middle-sized trees in its national sawtimber growing stock. The more that can be done, by manipulation of existing stands, to carry trees of this sort to time of harvest during the critical period, the less serious will any shortage be. In addition to the measures just discussed, shelterwood and selection cutting represent classic ways of dealing with such imbalances in the distribution of growing stock. These cutting methods can be employed to retain the more productive trees of a stand for additional growth and harvest in the middle term even while the less promising elements are replaced with trees to harvest in the long term. Measures of this sort are commonly desirable for management of growing stock even where the establishment of an entirely new stand would clearly give better production if only the long term were considered.

It would, in other words, be fallacious to devote single-minded attention to the creation of new stands in management of Federal forests or in providing incentives to private owners. Fully as much emphasis must be placed on the wise manipulation of immature stands. Just as the needs of posterity must be balanced with those of the present, so must those of the middle term be integrated with those of the long term.

### Timber Supply in the 21st Century

The long-range outlook is, in a sense, easier to cope with than that of the middle range but it too will require a massive effort. At some time during the next century the reserves of old-growth in the West will either be replaced with new stands or set aside permanently in wilderness and natural areas. The opportunity to use them to compensate for past inattention to timber supplies will be gone. The Federal lands, under an appropriately balanced program of multiple use including intensive timber management on some land and extensive management on some other, will continue to play a dependable role. It is very possible that timber production can actually be increased on both Federal and industrial lands but the commercial forest area in these categories has not been enough to maintain the supply in the past and will not be in the future.

It is clear from evidence presented elsewhere in this Panel's reports that ways must be found to maintain or increase the major contribution that has consistently come from small, private ownerships, especially in the eastern half of the country. Because of American land policies of the 18th and 19th centuries, most of the best and most accessible timber-growing sites in the country have come to be in this kind of ownership. The nature of most of the ownerships is such that the application of silvicultural measures for timber production must depend on a new combination of financial incentives and stable land-use policies.

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BY EARL STONE

# The Impact of Timber Harvest On Soils and Water

This paper considers how cutting and removal of wood products affect the stability of forest land, its capacity for sustained productivity, and the characteristics of its streams. It considers only lands that are intended to remain as productive forests, excluding clearings for other purposes—agriculture, powerlines, recreational developments, housing—and their consequences.

## GENERAL

In North America, forests cover an enormous range of topographic and soil conditions—from steeplands to level, with different geological makeups and soil characteristics. These occur under a wide variety of climates, from semiarid woodlands to temperate rain forests. For such reasons it is impossible to generalize from results or observations at only a few locations, or to make narrowly specific rules for on-the-ground action except within relatively small units where physical environment and vegetation do not vary greatly.

Broad understanding requires viewing both forests and the soils that support them as inseparable components of the landscape, shaped by present day processes and those of the remote past. The products of this landscape and at the same time the agents of its formation are the streams. They carry dissolved substances, including plant nutrients, that leach in some quantity from all soils; they transport solid materials from finest clays to boulders; they cut into their beds and banks or deposit terraces, fans, and deltas. Transport of solids takes place mostly during periods of high water and especially during great floods. Floods and other large events such as landslides, slumps, and headwaters cutting leave their marks upon the landscape. If understood, these evidences tell much about the frequency of such events and the vulnerability of the landscape to man's impact.

## HOW ARE IMPACTS MEASURED?

The inferred history of stream development together with records of flow rates, water composition, and debris loads indicate how natural downwearing of the landscape occurs, and the changes arising from man's activities. For this reason, hydrologists, foresters, and soil scientists have invested much effort in stream gaging stations and surveys, in both natural and experimentally modified watersheds. Much of the evidence mentioned in this report is the product of these studies.

Other measures of harvesting impacts are subsequent growth and vigor of the forest, and any significant changes in soil properties. Unfortunately, precise growth records for periods longer than century or more are nearly nonexistent even in the earliest managed European forests. Measuring rules, management methods, and even the species and products favored have changed over time. Nevertheless it is clear that productivity of managed forests has remained high over three to five centuries of continuous use (*38*, *90*). More specific information is available for periods of a century or so. The forest of Couvet, Switzerland, for example, has been inventoried at 5-year intervals since about 1870, with points for exact measurement marked on each tree.

Exact records of forest productivity in North America seldom extend for more than a few decades. Much can be learned, however, from the large areas of even-aged forests that arose after windthrow, fire, or cultivation half a century or a century ago. Their productivity can be measured with fair accuracy, and conditions at their origin can be compared with those that follow harvesting or forest management practices of the present day. Such comparisons may contain much more information than yet evaluated but have long provided a historical perspective and rationale for forest management methods. The extent of this perspective is often unrecognized outside the forestry profession.

Other measures of harvesting impacts are the responses of fish and animal populations, or measurements of environmental features thought to be significant for them. But summing the impacts is no simple matter, for the alterations in food and habitat that favor one organism may be intolerable to another. Moreover, the initial impact of harvesting or other treatment is followed by several years of progressive changes in vegetation, and accordingly in the animals most favored.

## WATER FLOW AND FLOOD PROTECTION

Water and watershed protection are the indispensible products of many forest lands despite the greater attention often given to timber, wildlife, and recreation. Fortunately, regulated wood production and most recreation use—even ski developments on steep slopes—usually can be reconciled with water yield, water quality, and watershed stability. In fact, forest cutting is the only precise and feasible means of regulating canopy density and thus reducing water use, or altering snowpack accumulation. But optimizing the sum of these several uses without risking irreparable damage to any calls for understanding and skill.

Though each watershed is unique, the basic principles of how watersheds respond to forest cutting are now well established. These findings do not always accord with earlier beliefs.

The capacity of undisturbed forested soils to accept rainfall (infiltration capacity) is very high—normally greater than the rate of delivery in maximum intensity storms. Ordinarily, in temperate climates it remains high even for some years following heavy cutting if the surface is not otherwise disturbed. Surface runoff, so important in agriculture and grazing land, scarcely occurs except in three situations: (*a*) Exposed rocky surfaces, (*b*) near streams, swamp margins, and drainage ways when the soil is fully saturated by water moving from higher ground within the soil pore system, (*c*) disturbed or compacted surfaces where the normal porosity has been disrupted. The effects of disturbance are discussed later.

Water entering the soil is subject to either permanent retention or short-term delay, although both are commonly termed "storage." The first (retention storage) is the source of water transpired by most forest canopies during the rainless periods. Its minimum or dry limit is set by the capacity of roots to extract water (wilting point), whereas the upper or moist limit is established by natural gravitational drainage. The actual volume of plant-available water stored in a soil depends on these two limits and also on the depth exploited by roots. Both limits are inherent soil properties not easily changed by surface treatment.

After the capacity for retention storage is satisfied, additional water entering the soil is only temporarily delayed (detention storage). But this delay extends for periods from several minutes to a few or several days. The rate of delivery to stream channels thus lags far behind rainfall intensity, and peak discharges are reduced by spreading over longer times. This behavior contrasts with the rapid movement of surface runoff. Temporary storage depends strongly on the volume of large pores in the upper soil layers, and can be decreased by compaction or loss of soil organic matter.

Temporary storage capacity is most useful when the soil readily accepts high rates of rainfall or snowmelt. Reduction of either infiltration or this detention storage is important when it leads to surface runoff over large or critical portions of a watershed. On gaged watersheds the effects of forest treatments can be evaluated because surface runoff produces a characteristic rapid rise in the outflow record.

The water transpired by most forest areas is taken largely from retention storage and the slow deep seepage associated with it. The actual withdrawals from storage depend on the climatic factors but cannot exceed the amounts available within rooting depth. Expressed in the units of rainfall required to replace them, withdrawals range from only a few inches (acre-inches) on shallow soils to 15 inches of water or more for deeply rooted vegetation in summer-dry climates. Permanent ground water tables are normally available only to vegetation near the borders of swamps, lakes, or water courses.

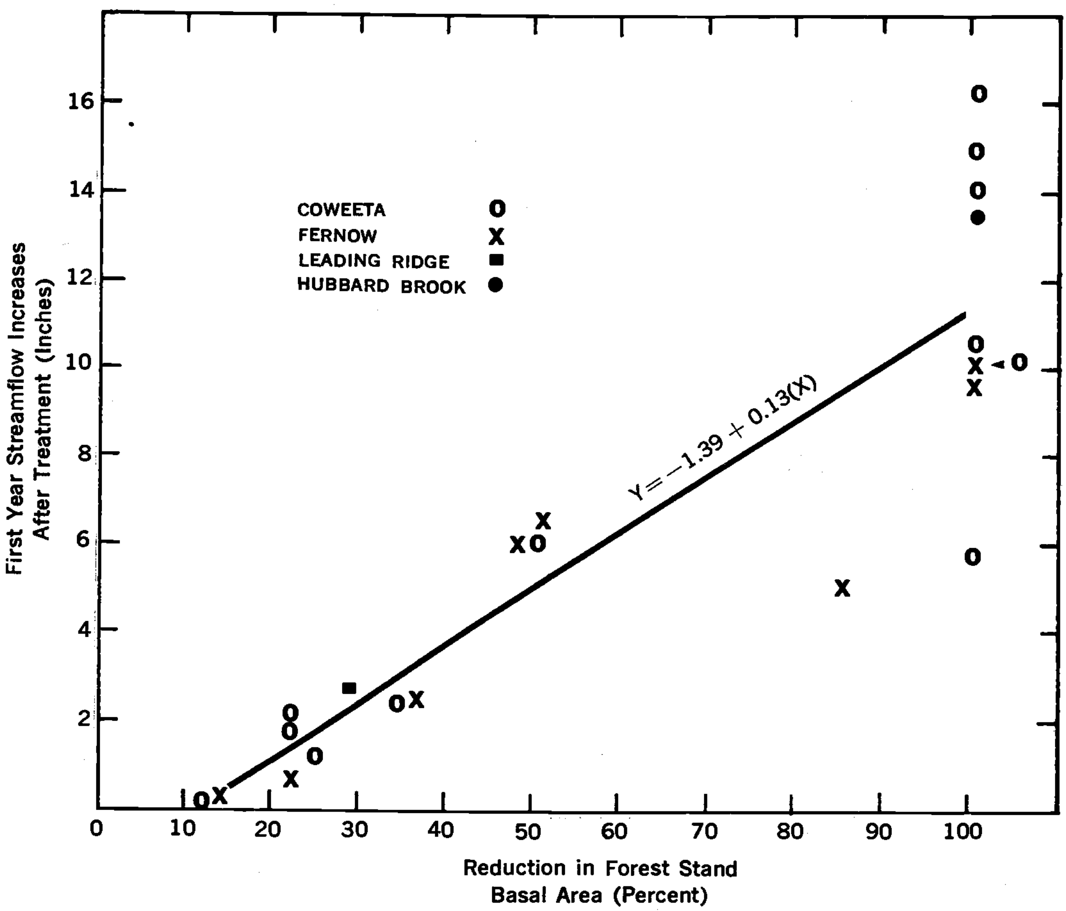
### Water Yield

Cutting of trees, then, or any other destruction of leaf surface (as by insect killing or defoliation), reduces the draft on stored and slowly seeping water, and so usually increases amounts moving into streamflow or ground water. This fact has been repeatedly demonstrated by controlled watershed studies, which in North America began with the classic Wagon Wheel Gap experiment before 1920 and have continued to the present (for example *21, 39, 40, 43, 70, 75, 76*). Such experimental observations are increasingly explained and amplified by a new understanding of soil moisture and energy budgets of vegetated land.

Important questions now are the actual amount and timing of any increased flow following forest cutting, and any adverse consequences on quality. The answers are of particular interest because of the possibilities of increasing water supplies to downstream users dependent on limited areas of forest watershed, or of raising the summer minimum flows of small streams (*56*). W. E. Sopper (*88*) has recently reviewed the extensive evidence bearing on these possibilities, as well as estimates of the potential increases in yield achievable by vegetation management in various regions. Accordingly only a few illustrations of forest cutting effects are mentioned below.

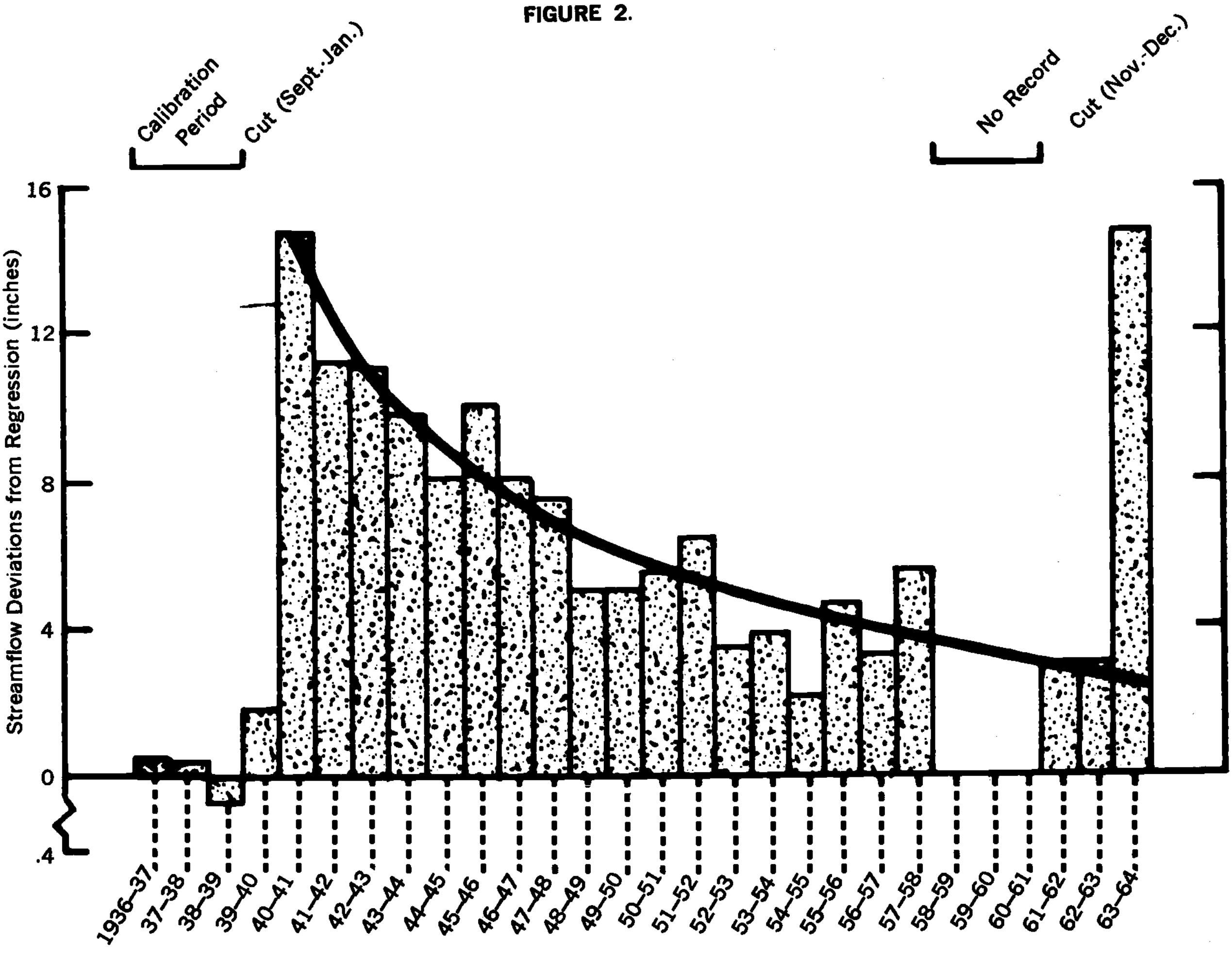
Within a given climatic region, increased water yield is somewhat proportional to the reduction in forest canopy (fig. 1), and so to the intensity of partial cutting or percentage of clearcut area. A very light selection cutting has a negligible effect. Duration of the yield increase depends on how rapidly the canopy of foliage is reestablished, and also upon full reoccupancy of soil by roots. Though experimental data are limited, the additional yields from heavily cut areas appear to fall off systematically and rapidly as regrowth occurs. Some investigators consider that small effects may persist for several years. In one long-term experiment (fig. 2), recutting the new forest after 23 years growth restored the initial increase in water yield.

**FIGURE 1.**




Increased streamflow in the first year after cutting is more or less proportional to the percentage of cutting (expressed by basal area). Removing less than 15% has no detectable effect.—Combined results from 4 experimental areas in the eastern U.S. (Douglass and Swank, 21).

FIGURE 2.




A 27-year experiment shows how water yields following clear-cutting increased above predicted yield-if-uncut, then died away as the forest regrew, and increased again after a second clearcutting.—Coweeta Forest, N.C. (40).

In regions with summer rainfall, much of the increased yield after cutting appears as greater streamflow during the fall and midsummer low periods (*70*, *82*). In the dry-summer, wet-winter climate of the Oregon Cascades, however, 80 percent of the additional flow took place during the wet October–March season (*83*). Nevertheless, the effect of clearcutting more than doubled low flow rates during a dry September.

In many parts of the Sierras and Rocky Mountains, soil moisture and streamflow depend strongly on winter snowpacks. Within the forest zone harvest cutting is the only feasible means of manipulating snow accumulation and melt rate. Efforts to improve yield and timing of water for downstream users has encouraged research in snowpack management. Results to date indicate that pattern and size of individual canopy openings are the important factors; neither light selection cuts nor large clearcuts are effective. Snow blown from the surrounding conifer canopy is trapped in small clearcut or very heavily thinned blocks and narrow strips. Melt rate is delayed and evaporation reduced, both by the ponding of cold air in properly designed openings and by shade of the bordering stand. Presence of a residual stand, methods of slash disposal, and windthrow hazards are considerations in some locations (*80*).

Yield increases persist for several years after cutting, well after establishment of the new stand. Inasmuch as water is a major economic limitation in these regions, it appears that amount and pattern of harvest cutting will be strongly shaped by their capacity to influence water yield. Recent research in simulating effects of cutting systems has produced results that agree reasonably well with experiment, and this approach may provide useful guides to application (*48*).

## Maximum Flow

The prospect of greater flood peaks after timber harvest, especially after clearcutting, has provoked concern and sometimes hot debate. Since harvest of trees generally entails road construction, skidding, and other soil disturbance, the collective effects of these are often lumped together with the consequences of tree cutting itself. It is useful to separate the two in order to consider the possibilities of control. Much the same is true of soil erosion effects, as discussed later.

During the dormant season, after rains have filled the soil storage capacity, streamflow from the uncut forest differs very little from that of partially cut or clearcut areas. Exceptions may occur if roads and skid trails have markedly reduced water intake, or if snowmelt is involved. Depending on particular combinations of snowpack, melt rate and coincidence with rainfall, peakflows from cleared areas may be either larger or smaller than from uncut forests. Watershed analysts usually conclude that a mixture of open and dense canopy "desynchronizes" melt rate and so reduces likelihood of a major peakflow at this time.

During the growing season, however, transpiration during rainless periods removes water from storage, as described earlier, creating a moisture deficit that is also a storage opportunity. Complete canopies create more storage opportunity than heavily cut or clearcut areas can in the period before full revegetation. When this deficit is large, replenishing it withholds a substantial fraction of any rainfall from streamflow. Once the deficit is fully satisfied, however, there can be no large differences between uncut and clearcut lands since their further storage possibilities are now equal. Thus, small watershed studies show widely variable effects of cutting on peakflows during the growing season (*39*, *70*, *71*), depending on soil moisture content at the beginning of a storm.

The most careful analysis of how cutting affects stormflow was given by Hewlett and Helvey (*39*). After calibration for 18 years, one of two 100+ acre watersheds in the southern Appalachians was completely cleared, leaving the wood in place to avoid any possibility of soil disturbance. Land slopes were exceedingly steep, averaging 70 percent, and annual rainfall in this area is 90 inches. A computer program allowed analysis of numerous stormflow records before and after cutting. In this study only stormflow was examined, not total water yield. The increase of peakflow rates from the clearcut areas was relatively minor, averaging about 7 percent, and the time to peaking was not affected.

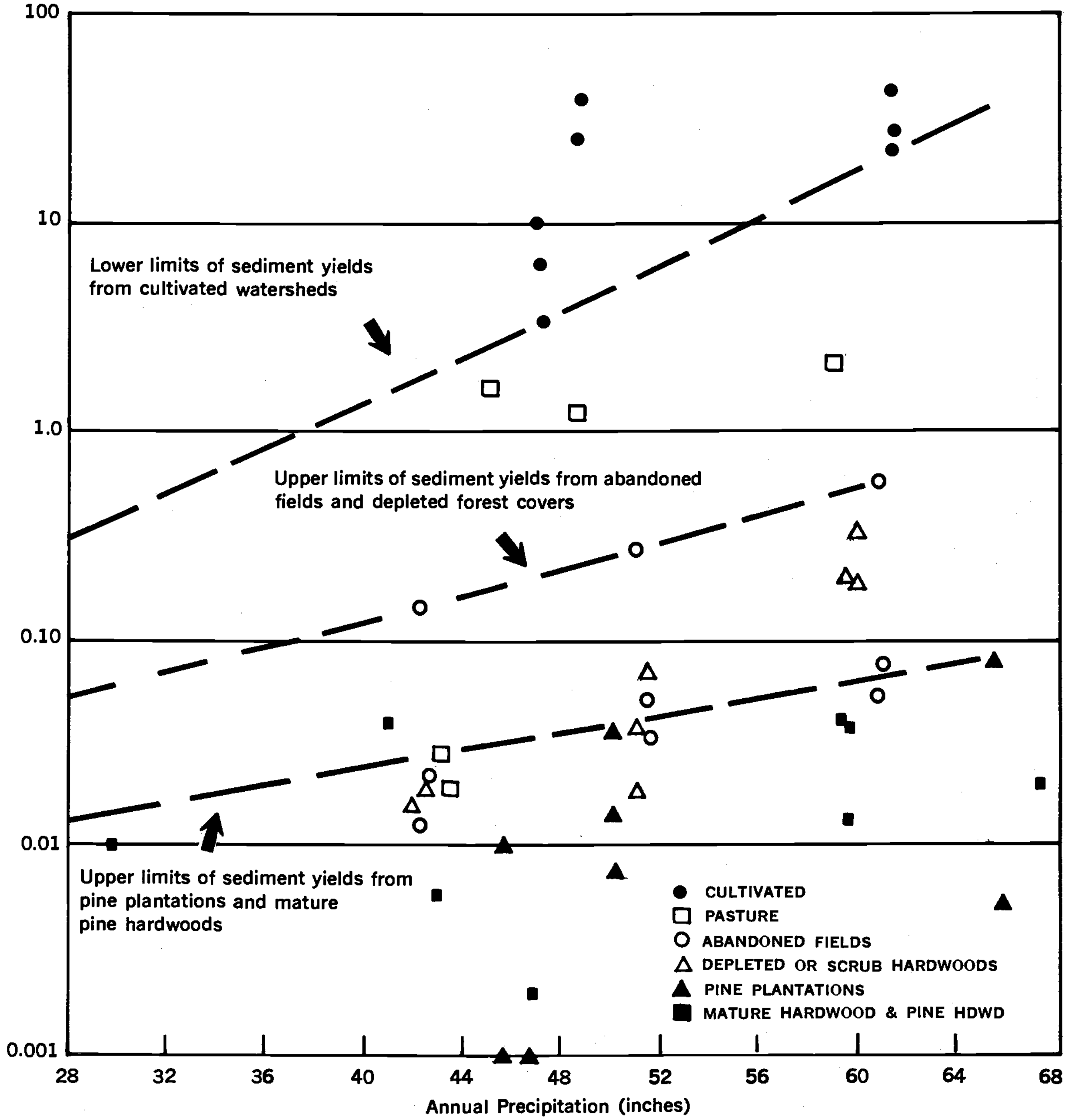
The experimenters then considered total volume of stormflow, that is, "quick flow" during and soon after periods of heavy precipitation. It is total volume from many such small watersheds that influences flood levels downstream. An extreme test occurred in the second year after clearcutting. After a long dry period, two major storms 5 days apart produced the largest regional flood on record. The clearcut watershed produced 1.9 inches more quickflow than the 8.7 inches expected had it remained uncut. No overland flow was observed on either the control or clearcut watershed. This study demonstrates a real but relatively small effect of heavy forest cutting. It also illustrates the limitations of forest cover in reducing peakflows during extreme flood periods in this region.

Applying such fiindings to real life harvest operations involves the additional effects of logging disturbance on soil, and consideration of how much of the watershed area is affected. Only a small percentage of a large watershed would be harvested in a single year by any cutting method. Lull and Reinhart (*56*) summarizing the evidence for eastern United States, emphasize that even the most drastic harvesting likely with careful management would have slight effects on peakflows from watersheds of any substantial area. Thus, choice of harvest methods in the managed forest, whether selection, group selection, or various clearcutting patterns, will, of itself, have little influence on the flood hazard along large streams. Care in application is more important than method. Nevertheless various findings suggest that it would be a wise precaution to avoid clearcutting the entire area of an intermediate-size watershed within a brief time period—say, 5 to 10 years—if high peakflows are both probable and consequential to downstream values. Rothacher's comments (*84*) seem to sustain this view.

## SOIL LOSS AND EROSION

Long concern with soil losses from agricultural lands has generated much information about rates of normal and accelerated erosion on gentle and moderate slopes (*86*). Though differences in rainfall, slope, and inherent soil properties are highly influential, loss rates closely reflect land-use treatment. Prolonged lack of soil cover or reduced porosity from any cause leads to increased runoff and surface erosion. Figure 3, chiefly representing

**FIGURE 3.**




Annual soil loss rates from these individual small watersheds (mostly in northern Mississippi) depend on type of vegetation or treatment, and secondarily on amount of precipitation. Note that loss rates are on a logarithmic scale. The pine plantations were established on abandoned fields and pastures, and so demonstrate the possibility of rapid rehabilitation (From Ursic and Dendy (107) added to by Ralston and Hatchell (74).

highly erosive soils in northern Mississippi, illustrates the enormous differences due to vegetation and treatment. Soil loss under native forest and pine plantations averaged less than 0.1 ton per acre per year—a reduction in land surface level of only about three-fifths of an inch in 1,000 years. Losses from scrub or depleted forest cover and abandoned fields were 8 to 10 times greater, although still moderate in absolute amounts. Soil losses from comparable cultivated plots were far greater—100 to 1,000 times more than from good forest cover. However, better soil management practices could hold losses from cultivated lands much below these high levels.

Soil Conservation Service planning standards for agricultural lands place the upper and lower annual loss limits at 6.0 and 0.5 tons per acre per year. Great areas of long-cultivated farmlands have loss rates well above the half ton lower limit and yet remain productive. These limits should be borne in mind when appraising the short-period loss rates resulting from harvesting activities on forest land.

Nevertheless conspicuous increases in soil movement and stream turbidity sometimes accompany harvest operations. Studies in forest regions demonstrate that these increases are due chiefly to road construction and other activities that expose soil or concentrate water. The exceptions are localized although they can be severe in effect, as indicated later. It is certain also that in most landscapes such accelerated erosion can be reduced, and its effects on stream quality largely eliminated, by applying knowledge already at hand or forthcoming from research.

Misunderstandings of erosion processes and the action of forest cover on soil stability are common, even among those deeply concerned with environmental protection and forest use. The basis for this misunderstanding is due less to ignorance of geomorphology and soil science than to public attitudes created during the long uphill struggle to insure forest protection.

The Mediterranean area and Asia have a history of deforestation measured in millennia, and the steeplands of Europe one of several centuries. There, as in the shorter history of the United States, grazing or agricultural use often followed forest cutting, and all of these were carried on with little regard for longrun productivity of soils or stability of landscapes. The sad consequences are well known; many are still to be dealt with. Beginning early in the last century and continuing until today, however, almost all modern nations have had to make strenuous efforts to increase dwindling wood supplies, arrest erosion, and mitigate the disastrous effects of steepland torrents, slides, and avalanches. In humid regions the principal public emphasis was focused on planting trees on long-abused lands, and protecting the remaining forests against grazing, agriculture, fire, and excessive cutting.

The great progress achieved has been possible only through public education and sympathy, as well as long sustained governmental expenditures. In the process of developing this sympathy and support, however, many simple slogans and generalizations were entrenched in the public consciousness and have been kept alive by repetition. Among these notions, none dies harder than the belief that cutting forests, especially heavy cutting, necessarily lays bare the soil and causes erosion. With but few exceptions, the facts are otherwise wherever the forest is allowed to regrow immediately or is replanted. The rightful enemy is not forest cutting but permanent deforestation, or treatments that lead to progressive erosion.

Four kinds of erosional processes are involved in the downwearing of all land: Stream cutting, sheet and gully erosion, and mass movement. The last includes abrupt or violent events such as landslides, slumps, flows, and debris avalanches, as well as continuous, almost imperceptible creep phenomena. Mass movement is the normal mode of downwearing in most steep landscapes.

Even in the absence of geological or climatic changes, all four kinds of erosion are subject to enormous increases in intensity, occasionally or at long intervals. Often these increases are triggered by great storms, droughts, earthquakes or destruction of vegetation by forest fires or other means. Long periods of stream cutting or channel filling, and rock weathering or slow loading of slopes "precondition" portions of the landscape, rendering them vulnerable to either natural triggering or unwitting disturbance by man. Thus, especially in steeplands, some natural events are wholly beyond man's influence; others are highly sensitive to triggering actions by man but may be avoidable; and still other potential events are largely within man's capacity to cause or prevent. Distinguishing these events and the situation where each may occur is difficult but essential to devising appropriate land management.

## Mass Movement

Evidences of past landslides, slips and flows, channel scouring, and similar violent mass movements are commonplace in steep landscapes undisturbed by man. So also are indications of cutting and transport by major floods. In any one locality, however, such events are infrequent on the human time scale, and their newness is often soon concealed by new growth of vegetation (*5*, *94*). All too commonly, laymen regard the few events that come to notice as unfortunate natural accidents rather than normal processes in the downwearing of steep landscapes. Fortunately, violent mass movements in forested areas have been increasingly studied during the past few years, creating a base from which to evaluate the impact of cutting, logging activities, and road construction.

For example, C. T. Dyrness (*23*) examined the mass-movement events that occurred following some 13 inches of rain in 3 days plus snowmelt in the Andrews Experimental Forest of western Oregon. Of the 47 events studied, only five occurred in undisturbed areas (table 1). Four of these were very large, however, and accounted for 40 percent of the total soil volume displaced. Sixty-four percent of all events occurred on one rock class, greenish tuffs and breccias, which made up only 8 percent of the area. This indicates the overwhelming influence of geology as well as the prospects for classifying such hazards in advance. Again, the frequency of slides in undisturbed forests on the excessively steep slopes of coastal Alaska has been studied in some detail (*5*, *94*, *95*). Failures are common as slopes approach a critical angle of about 75 percent (37°).

**TABLE 1.—Frequency and Associations of Violent Mass Movement Events on Steep Slopes Resulting From a 13-inch Rainfall in the Winter of 1964–65. U.S. Forest Service, H. J. Andrews, Experimental Forest, Western Cascades, Oreg. (from Dyrness, (23))**

| Type of disturbance | Events (number) | Material moved | |
|---|---|---|---|
| | | Cubic yards | Percent of total |
| Roadfill failure | 12 | 40, 900 | 52 |
| Road backslope failure | 5 | 14, 400 | |
| Road backslope and fill failure | 6 | 38, 325 | |
| Events caused by road drainage water | 8 | 86, 450 | |
| Road removed by stream | 3 | 4, 350 | 1. 3 |
| Events in logged areas | 8 | 22, 150 | 6 |
| Events in undisturbed areas | 5 | 141, 200 | 41 |
| Total | 47 | 347, 775 | |

## Tree Cutting

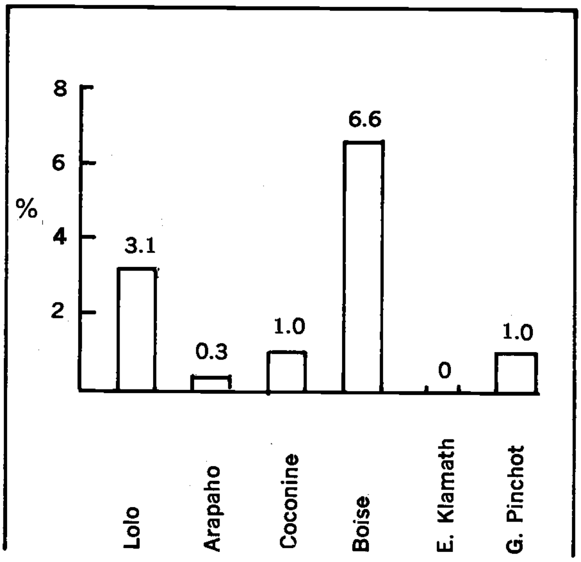
Cutting of trees, even clearcutting, does not immediately change the water-handling capacity of a forest soil. Unless otherwise disturbed, the forest floor is still physically intact during the first few years; water entry rates remain very high; and no overland flow occurs. Any increase in stream turbidity is minimal. Even on heavily cut areas, regrowth of trees or other vegetation normally occupies the soil long before the stabilizing influences of the former forest have disappeared. Many observations and several studies on experimental watersheds demonstrate that sheet and gully erosion simply do not occur as a result of tree cutting alone (*55*, *56*, *75*) even on slopes as steep as 70 percent (*39*). These forms of erosion are products of mechanical disturbance or fire.

But in certain types of slide-prone slopes, usually very steep, tree cutting alone may increase likelihood of mass movement. Tree roots have an important function in reinforcing the soil mass on slopes near or above the angle of release, and some instances anchoring it by penetrating into bedrock fissures. The effect is to suppress the beginnings of slips and flows at critical points. Destruction of trees, whether by cutting, fire, or insects, is followed by decay of the old root systems. Decay is gradual but more rapid than redevelopment of root systems by the new vegetation. As a result, the frequency or severity of landslips may gradually increase, beginning some 4 to 5 or more years after the death of old stand. Slopes of this kind appear to be most common in northwestern United States and coastal Alaska and are only occasionally of concern in commercial forest lands elsewhere. Some ski runs cleared in noncommercial forest lands are also vulnerable to such slippage. In the Andrews study (table 1), 8 of the 47 mass-movement events occurred in logged areas remote from roads; these were small and accounted for only 6½ percent of the total soil volume moved. On a cutover area of coastal Alaska, the frequency of slides increased greatly about 5 years after clearcut logging of very steep slopes (*5*). Most of these slides moved over a base of smooth bedrock or compacted till, on slopes greater than 67 percent, indicating a highly unstable mantle susceptible to sliding even in the absence of disturbance. Three recent summaries (*33*, *81*, *96*) describe the conditions and processes involved.

Although landslides are conspicuous and dramatic, and may have disastrous effects on stream values, only a small total area of designated commercial timberland is vulnerable as a result of cutting alone. Much vulnerable land is distributed as small fractions of very steep or undercut slopes in generally steep landscapes. This distribution makes it easy to underrate hazard before slides occur, if accurate soil inventories are not available, and to overestimate significance afterwards. It is essential to recognize that such areas exist, and that potential problems there cannot be avoided merely by use of ingenious "off-the-ground" logging systems employing balloons or helicopters. Little is known about the feasibility of partial cutting on such areas although long-term experience in the European Alps may provide useful guides.

Actually, a large fraction of the high-hazard area is readily identifiable in preharvest surveys or inventories, through slope, rock type, or geomorphic clues. Such areas can be delineated, and harvesting either avoided or modified (fig. 4).

**FIGURE 4.**




Identification of excessively unstable soils reduced land area previously designated as suitable for timber management by 0–6.6% on 6 western national forest management units. (Amounts shown for the Lolo include other soil factors also). The reductions are based on a detailed re-inventory.

(Modified from Wikstrom and Hutchinson, 113).

The damage from slides and other abrupt mass-movement events depends, first of all, on whether they occur in or reach to stream channels. Otherwise the physical damage is chiefly reduced productivity on the actual area of the slide, a very small part of the total landscape. It is absurd to equate the gross volume of such a slide with erosion of an equal volume of fertile surface soil when considering effect on productivity of the whole area. Moreover, some kinds of slides revegetate readily and eventually produce commercial timber so that the long-term loss on the slide area is probably less than commonly imagined.

## Logging Operations

In sawtimber stands felled stems or logs are moved to loading points near roads by cable or tractor. In some cable systems part or all of the log is held off the ground during transport whereas in others the soil surface is furrowed into tracks converging on the winch points. The length of haul roads is determined by the "reach" of the skidding system. Among standard methods haul roads are least for skyline systems and greatest for jammer (table 2). Balloon and helicopter systems are still highly experimental but promise less disturbance if proven feasible. The cable systems of western United States were developed for clear-cutting of large timber, but some systems are also adaptable to partial harvests on suitable terrain.

Tractor logging in its various modifications is adaptable to either light or heavy harvests but obviously is more limited by slope than cable systems. Much of the travel takes place over a converging net of skid trails. On steep slopes these must be cut into the soil and become in fact narrow unsurfaced roads.

A variety of specialized equipment is now being used in harvesting pulpwood-size trees on favorable terrain. The accompanying problems of erosion are generally slight and not detailed here.

Physical damage or increased hazard of surface erosion from yarding and skidding comes about in three ways: Exposure of the soil surface, deep disturbance of soil, and compaction. The proportionate areas affected by different logging methods in the same terrain are illustrated by tables 3 and 4. Exposure of the mineral soil surface, and minor mixing of litter and soil by logs and equipment moving over dry ground are common to all kinds and intensities of logging. Such disturbance is sometimes taken as an index of erosion hazard. This degree of disturbance is usually of little consequence, however, except on highly erosive soils,

**TABLE 2.—Soil Exposure During Timber Harvest Depends on Cutting Method and Logging System (after Rice et al. (81))**

| Logging System | Percent bare soil | Location |
|---|---|---|
| Tractor, clearcut | 29.4 | East Washington. |
| Do | 26.1 | West Washington. |
| Cable, selection | 20.9 | East Washington and Oregon. |
| Tractor, selection | 15.5 | Do. |
| High lead, clearcut | 18.8 | West Oregon. |
| Do | 15.8 | Do. |
| Skyline, clearcut | 12.1 | Do. |
| Do | 11.1 | East Washington. |
| Do | 6.4 | West Oregon. |
| Balloon, clearcut | 6.0 | Do. |

or adjacent to flow channels or where water concentrates. Either surface disturbance by logging or later scarification may in fact be necessary preparation for abundant gerimnation and establishment of a new crop unless broadcast burning is planned.

In contrast, disturbance that disrupts or penetrates below the highly permeable soil surface may have more serious effects. This type of disturbance results from dozer cutting of skidroads and landings, by logs plowing deep into the soil, and by heavy equipment, especially during wet weather. These disturbances sometimes occur as continuous streaks downslope, creating opportunities for interception and flow of water. Whether or not surface erosion actually follows depends greatly on soil properties, rainfall intensities, and any followup treatment. If erosion does not occur, healing of such scars usually is rapid.

As would be expected, the area physically compacted is greatest with tractor logging and least with off-the-ground methods (table 4 A and B). The damage caused by compaction varies enormously according to kind of soil, its moisture content and the frequency of traffic or packing impacts. Soil compaction data are not easy to interpret, however. In table 4B the area classified as compacted still averaged 63 percent pore space—which is greater than found in many undisturbed forset soils of other regions. This again emphasizes the importance of local conditions in determining what levels of disturbance are tolerable.

As with many gross area statistics, averages are less important than the fraction of extreme events and occurrences on sensitive areas. The worst effects of compaction are in skid trails and other

**TABLE 3.—Choice of Logging System Influences Area Disturbed by Roads, Skidroads, and Landings (after Rice et al. (81))**

| Logging system | Percent of logged area bared | | | Location |
|---|---|---|---|---|
| | Roads | Skidroads and landings | Total | |
| Jammer (group selection) | 25–30.0 | ----- | 25–30.0 | Idaho. |
| High lead (clearcut) | 6.2 | 3.6 | 9.8 | Oregon. |
| Tractor (selection) | 2.7 | 5.7 | 8.4 | California. |
| Do | 2.2 | 6.8 | 9.0 | Idaho. |
| Tractor group (selection) | 1.0 | 6.7 | 7.7 | Do. |
| Skyline (clearcut) | 2.0 | ----- | 2.0 | Oregon. |
| Helicopter (clearcut) | 1.2 | ----- | 1.2 | |

**TABLE 4.—Logging Systems and Local Variation Affect Amount of Soil Surface Disturbance Within the Same Area—Andrews Forest, Western Cascades, Oreg. (22, 24)**

[Values rounded; sum does not equal 100 percent because of rocks, stream bottoms, etc.]

A. Percentage of area in 4 disturbance classes after clearcutting 4 cutting units (numbered) with high lead or tractor skidding.

| | Skidding method | | | |
|---|---|---|---|---|
| | High lead | | | |
| | No. L222 | No. L141 | No. L221 | Tractor L522 |
| Undisturbed | 58 | 51 | 63 | 36 |
| Slightly disturbed | 21 | 24 | 19 | 26 |
| Deeply disturbed | 10 | 14 | 6 | 9 |
| Compacted | 10 | 7 | 11 | 27 |

B. Percentage of area in disturbance classes after clearcutting with high lead or Wyssen skyline

| | Skidding method | |
|---|---|---|
| | High lead | Skyline |
| Undisturbed | 57 | 64 |
| Slightly disturbed | 21 | 24 |
| Deeply disturbed | 10 | 5 |
| Compacted | 9 | 3 |
| Bare mineral soil exposed (included in above) | 15 | 12 |

deeply disturbed areas (*91*). Here they add to the likelihood of runoff and erosion unless subsequent treatments are applied to stabilize the surface and deflect drainage concentrations. The desirability of such treatments has been emphasized repeatedly (*46*, *47*, *63*, *100*, *106*).

Severe compaction may retard subsequent growth of trees on the affected portion (*70*). Natural recovery of porosity may require a decade or two or even more (*71*). Such effects are easily visible in new stands, and so prudent land managers are now impelled to minimize damage outside the major skidroads. Compaction and deep disturbance are also highly undesirable in partially cut stands because of damage to residual trees even though watershed values are unaffected (*64*).

Procedures for minimizing compaction and related damage vary with soil. They include avoidance of wet weather logging, shift of activity to nonsusceptible areas when susceptible soils are moist, concentration of main haul traffic on a few major trails, choice of logging methods or use of low bearing-pressure equipment. Loosening, revegetating, or mulching the disturbed area may hasten recovery.

As Rice and his coworkers point out (*81*), researchers concerned with logging damage or watershed impairment are problem oriented. They chiefly investigate specific locations where disturbance and damage appear. For this reason, compilation of their research reports by no means describes average conditions prevailing over large areas. A truer perspective is given by their overall summaries or state-of-art accounts. These repeatedly emphasize that surface disturbance caused by felling, hauling, or skidding, apart from skidroads and road construction, generally does not lead to appreciable soil erosion or impaired stream quality (e.g., *19*, *47*, *63*, *69*, *81*, *88*). Soil detached at points of disturbance is usually trapped by organic debris or vegetation within a very short distance. Exceptions are common, however, because erosion hazards vary greatly with location, even within small areas (*62*). Unfortunately some of these exceptions have the capacity to damage streams or create conspicuous scars. But these are largely preventable, although sometimes at the price of increased operating costs or timber values foregone.

These findings point to the following guidelines to prevent or minimize damage:

1. Classify soil or landscape attributes, and plan harvesting layout and operations accordingly. The locations of haul roads, primary skidroads, and decks or landings are important not only for their own effects but because they dictate the patterns of all other operations.

2. Select logging methods, equipment, and operational patterns to reduce serious disturbance to soils and watercourses. Cable systems have replaced tractors on some steep slopes and improved cable systems sometimes offer further gains.

3. Avoid, treat gently or go around sensitive areas, leaving buffer zones where appropriate. Yarding or skidding through or near stream channels should be prohibited or controlled. Undisturbed buffer or filter strips may be a necessary measure or precaution—but whether they should be entirely uncut or not may hinge on factors such as windthrow hazard.

4. Require care and flexibility in actual operations; for example, discontinuing skidding on easily compacted soils during wet periods.

5. Minimize deep disturbance and situations that favor drainage concentrations during operation. Require any needed surface protection, followup treatments or revegetation to be done as soon as feasible—not after major damage has occurred.

Within each of these categories are many specific decisions or techniques appropriate to terrain, forest type, and management of nontimber values. New demands and standards will call for new research and technical innovation. But one cannot resist the conviction that methods now at hand would result in many fewer instances of soil and watershed damage if applied with greater forethought and concern. The capacity to allow or to minimize damage is variously in the hands of administrators, forest officers, or technicians, logging superintendents and machine operators. Increasing knowledgeability and sensitivity about resource values at all points along this chain is perhaps the most difficult, but certainly the most important single step to be taken.

### Roads and Skidroads

Though most forest roads are built to harvest the current stand of timber—and are paid for by its proceeds—their existence then provides access for all other purposes, including recreation, fire protection, and management of the new forest for any of its uses.

Megahan's statement, "Roads create a disproportionate share of the problem, probably greater than 90 percent in most instances" (*62*), is also the conclusion of most investigators concerned with reconciling efficient timber harvest with unimpaired soil and watershed values. But forest roads are in no way unique. Construction of public or private roads of any dimension presents similar difficulties and potentials for stream damage that are too often ignored.

Roads on gentle to moderate slopes in stable topography pose few problems except perhaps through careless movement of soil during construction. Great areas of forest land are served by such roads which draw little attention or criticism.

But both difficulties and hazards mount when roads are pushed onto steep terrain, cut into erosive soils or unstable slopes, or encroach on stream channels. Criteria for location, design, and construction which are satisfactory on even moderate slopes may fail to cope with steepland conditions, or lead to intolerable levels of disturbance. The following paragraphs highlight road erosion problems on moderately to steeply sloping lands and so apply to only a part of the forest area.

Roads inevitably disturb soil. Much of the disturbance is only localized in consequence though it may be objectionable visually until revegetation occurs. It is the movement of soil and debris offsite that threatens watershed values, and measures of this threat are changes in turbidity, bedload, sediment deposits, or spawning success of fish populations. Numerous studies of such effects have been made (table 5) although more are needed. In many, the specific causes of damage have been discovered and methods of prevention proposed or put into effect (*30*, *37*, *46*, *55*, *62*, *63*, *75*, *81*, *100*).

Hazards to watershed values through surface erosion of forest roads and skid trails were recognized early. They have commanded attention of investigators ever since World War II. For most of this time, however, research findings and development of protective measures consistently outran acceptance and general application. Part of the delay in acceptance reflected lack of understanding; part because rapid changes in woods labor and equipment made some proposed techniques infeasible; and part simply through lack of economic or other motivation. It is only fair to note, however, that acceptance was rapid on many public and industrial holdings as soon as the significance of stream values was appreciated.

The sources of increased sediment entering stream courses are three: Direct movement of soil during construction and maintenance, surface erosion, and mass movement or mass erosion. The length of time over which these act generally increases in the same order, except for maintenance. Narrow unsurfaced skidroads or temporary haul roads chiefly contribute to surface erosion.

Soil removed by cutting into side slopes commonly is used as fill or "side cast" over the edge. Too often, on slopes already near the angle of repose, the added soil slides or soon washes into stream channels. The amount entering streams, or placed to enter, during the construction period may exceed all subsequent erosion. "End hauling" of excess soil to safe dumping areas is now advocated to avoid such damage but it is often costly and sometimes unfeasible. Other major remedies are locating roads further from streams, providing

**TABLE 5.—Summary of Studies of the Effect of Logging on Erosion and Sedimentation in the United States (After Megahan, (63))**

| Study location | Accelerated sediment production | | Location and type accelerated erosion | | | | Comments |
|---|---|---|---|---|---|---|---|
| | | | Cut + skid | | Roads | | |
| | Yes | No | Surface erosion | Mass erosion | Surface erosion | Mass erosion | |
| North Carolina | | × | | | | | Cutting only; no roads, no skidding. |
| Michigan | | × | | | | | |
| Colorado | | × | | | × | | Slight road erosion, no sediment to streams. |
| Washington | | × | | | | | Sediment not discernible. |
| Oregon | | × | | | | | Do. |
| Alaska | | × | | × | × | | No significant sediment increase. |
| Oregon | × | | | | | | Regional, statistical studies; sediment source not defined. |
| California | × | | | | | | |
| Colorado | × | | | | | | |
| California | × | | | | | | Mostly from channel encroachment. |
| Idaho | × | | × | | × | | Accelerated sediment in some drainages, none in others. |
| North Carolina | × | | | | × | | |
| West Virginia | × | | × | | × | | Varied with care in logging. |
| Oregon | × | | × | | × | × | Cut and skid erosion due to slash burning. |
| Do | × | | × | | × | × | |
| Idaho | × | | × | | × | × | |

barriers to soil wash, and giving greater attention to containment or stabilization of fill at critical points. If initial location and construction cause movement directly into stream channels, then maintenance operations likely will continue the process.

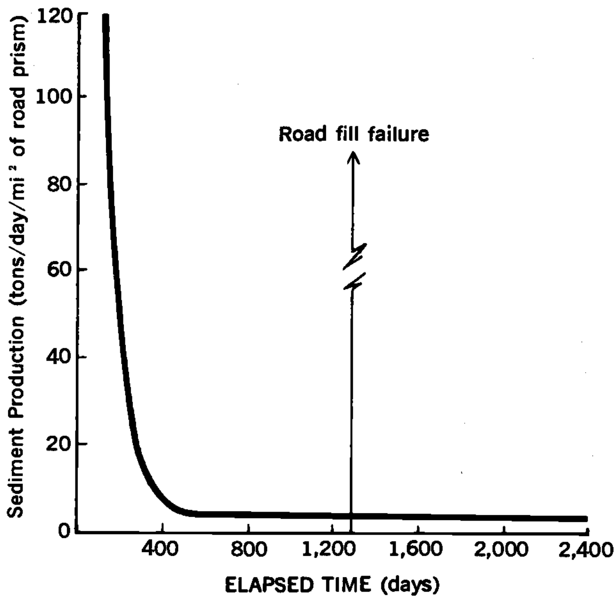
Washing of exposed cut and fill slopes, road surfaces and ditches is the most widespread cause of stream turbidity and occurs even on gentle slopes. Susceptibility to surface erosion varies enormously with rainfall intensity and soil type, as all investigators emphasize. Incohesive sandy soils may almost melt away when exposed to heavy rain, and are often too infertile or droughty for rapid development of stabilizing vegetation. Special treatments such as surface mulching may be required. Soils of this kind, derived from weathered granites of the Idaho batholith, account for the well-known erosion problems on the Bitterroot and Payette National Forests, and on many private holdings as well (*46, 63, 73, 106*). But still other soils have a resistant structure, or revegetate rapidly, or contain too much stone for deep erosion. The significance of such specific factors for forest road design and stabilization is now fairly well known (*30, 37, 55, 62, 100, 186*).

Typically, surface erosion of smaller roads is at maximum during construction and initial use, and declines rapidly with time (fig. 5). It may continue, however, if drainage concentration is allowed to occur, as on incised skidroads. And large cuts and fill surfaces in steep slopes sometimes yield sediment for many years if left to natural stabilization.

Unlike surface erosion, mass erosion associated with roads is limited to very steep or otherwise unstable slopes, and its likelihood does not immediately diminish with time. As indicated earlier, mass movement is an inherent risk in many mountainous landscapes but only very recently have many wide, low-gradient, heavy-duty roads been pushed into steeplands for timber harvest. Some of the engineering hazards were unrecognized or unknown. Moreover, the delay in landscape response did not immediately penalize over-optimism of inexperience. As a result the frequency of mass erosion problems seems to have accelerated greatly. In fact they are substantially unknown in large parts of the United States and even in much of the regions where they do occur.

Deep cuts in steep side slopes obviously remove support from the soil mass above. Occasionally,

**FIGURE 5.**




**Sediment production by surface erosion from logging roads decreases rapidly with time after construction. Mass erosion, however, occurs as a sporadic event, usually when the soil is saturated. Central Idaho (Megahan, 62).**

these cuts intercept large volumes of subsurface stormflow which ditches and culverts must then handle. Side cast spoils and fills place additional loads on slopes that may already be critically steep. Design and siting of drainage structures may prove inadequate to cope with unknown peakflow rates or the problems of fills across sloping drainageways. Such features set the stage for failures or triggered mass movement. But many potential slumps, slides, or washouts do not occur until the soil is nearly saturated, as during major storms, and when any weakness in support or drainage structures leads to massive cutting and collapse. It has been Forest Service investigators, especially, who have studied the circumstances of mass erosion associated with roads (*23, 80, 84, 96*), although other observations and criticisms have not been lacking.

Although concentrated regionally, such events are spectacular and sometimes highly damaging to stream values. Like the related slides in cutover areas, they are easily regarded as the ultimate in visual insult or man's capacity for unwitting destruction. But in another sense they are convincing evidence of need for better terrain appraisal, road location, and construction methods.

The approaches necessary to reduce or avoid damage from future roads are now abundantly clear in principle: Much greater attention to soil and geological characteristics in planning; avoidance of high hazard areas; improved engineering surveys, road design, and construction methods. Specific practices and standards to minimize road-related erosion are spelled out in several regional guides and manuals (for example *47*, *62*, *106*). These are widely applicable, though in some steeplands the engineering difficulties and added costs may be formidable. Not all steep landscapes offer simple choices between stable and unstable routes. Further, both the amount of soil moved and the impact of roads in steep country increase disproportionately as design standards for width, grade, curve radius, etc. are raised. The needs are new and some required geomorphic and geotechnic skills are not widely available even in otherwise well-trained engineers.

But no matter how adequate technical knowledge and capabilities may be, actual performance on the ground is determined by organizational and administrative arrangements. Other PAPTE background papers (especially apps. F, G, and L) discuss possible changes in national forest policies affecting management procedures, timber sale contracts and availability of sufficient skilled supervision. Structural changes in these may be essential to achieve the technically feasible performance standards indicated above. But, additionally, the goals to which these standards apply may call for review. On national forests many roads constructed for timber removal are built to standards much higher than required for this purpose. These roads are properly seen as components of a permanent access system for management of all resources and for public use. Similarly, main haul roads on many industrial forest holdings have been designed to high standards of durability not only for low cost transport of heavy loads but as part of the infrastructure required for intensive management. The commitment to high design standards may be unarguable wherever slope stability and environmental values are small. But increasing appreciation of the full environmental costs of some roads, and the high capital investments required to minimize physical damage in steeplands, are now forcing reassessment.

Table 6, by R. B. Gardner, illustrates the economic components that have influenced previous goals for the kinds of forest roads useful to general vehicular traffic. This analysis gives no attention to the comparative environmental impacts, although single-lane roads obviously require far less soil movement on sloping land. Nor does it take into account the special problems of very steep or fragile landscapes. But Gardner argues for a wider consideration:

> Today, widespread concern for the environment necessitates reorientation of the economic analyses and methods that are being used to determine forest road standards. Most of the design standards and techniques for forest road location were borrowed from methods that evolved from values associated with major freeways and highways. This former approach emphasized the cost to the user assessed over a predetermined economic life of the structure * * *
>
> The thought of building a forest road and assuming a relatively long life of 50 to 100 years would probably be considered unrealistic by many engineers and economists; however, this may be more realistic than using a short period 15 to 20 years if we decide that protection of the environment should be given major consideration. This approach will force us to sacrifice some economic values, mostly short-term ones. Such sacrifices are always necessary when environmental protection decisions take priority over purely economic ones. Economic values related to speed of travel and vehicle maintenance are examples of values that many users would consider giving up in favor of environmental protection. (*31*)

Somewhat similarly, industry purchasers of national forest timber have advocated a "Minimum Land Impact Road System" for national forests (*25*). The intent is to reduce construction difficulties and prospective environmental hazards or insults, as well as to lower the high capital outlays by purchasers required to build access roads to sale areas.

Plainly, combination of low or modest design standards (for width, grade, alinement) in steeplands with the construction safeguards against erosion mentioned above would greatly reduce environmental consequences of the projected large increases in mileage of forest roads.

## Slash Disposal and Post-Harvest Burning

In the managed forest harvest is prelude to regeneration. Intermediate, and closely allied with both activities, is slash disposal or its modern successor, residue management. Harvest in an intensively managed forest leaves chiefly small residues. Previously untended stands, however, usually contain many dead or grossly defective stems that remain after harvest of any kind. These together with stemwood unused for other reasons and tops make up the residues seen after logging. The total in heavily cut areas may amount to some tens of



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**TABLE 6.—Illustrative Construction and Total Economic Costs for Different Types of Forest Roads, Assuming Traffic of 10,000 Vehicles per Year. Vehicle use Costs Include Maintenance, Operation, Depreciation, Costs of Time of Driver and Passengers (from Gardner (*31*))**

| Cost distribution | Road standard | | | | | |
|---|---|---|---|---|---|---|
| | 2-lane paved | 2-lane chip-seal | 2-lane gravel | 1-lane gravel | 1-lane spot stabilization | 1-lane primitive |
| Dollars per mile: | | | | | | |
| Initial construction | 50, 000 | 40, 000 | 30, 000 | 20, 000 | 15, 000 | 10, 000 |
| Annual dollars per mile (20-year period): | | | | | | |
| Depreciation [1] | 4, 360 | 3, 490 | 2, 610 | 1, 740 | 1, 310 | 870 |
| Maintenance | 200 | 400 | 600 | 800 | 1, 100 | 500 |
| Vehicle use | 2, 200 | 2, 300 | 2, 700 | 3, 000 | 4, 400 | 8, 500 |
| Total annual | 6, 760 | 6, 190 | 5, 910 | [2] 5, 540 | 6, 810 | 9, 870 |

[1] 20 years at 6 percent using capital recovery.
[2] Lowest annual cost.

tons per acre though only a portion is waste by current economic standards.

In time, of course, all these materials decay although the rates vary enormously with climate. In the summer-dry, winter-cold climate of northern California, for example, some 30 to 40 percent of the volume of piled conifer slash was still present after 30 years. While these residues remain conspicuous they present an unesthetic, even distressing appearance to many viewers; they handicap access, and thus any seedbed preparation or planting operations. And the fine materials, especially, often constitute highly hazardous fuels in which wildfires rapidly become uncontrollable. (As early as 1909, a New York State law required lopping tops of conifers to a 3-inch diameter.)

Any or all of these considerations—cosmetic, seedbed, or protective—commonly outweigh the positive values that slash and residues have as shelter for soil, seedlings, or wildlife, and call for slash disposal. The broader concept of residue management emphasizes that coarse or dense slash is sometimes essential to successful regeneration of certain species in open areas, despite the short-term conflicts with visual quality or maximum hazard reduction. In other places, also, desirable advanced reproduction reduces choice of slash reduction methods. But elsewhere in clearcut blocks or strips, slash disposal may be combined with seedbed preparation for natural regeneration, sowing, or planting.

The need for fuel reduction is greatest after heavy cutting or clearcutting of untended conifer forests, especially in summer-dry climates. Hardwood slash presents a much lower volume of fine fuel and usually decays more rapidly. Partial cutting methods obviously generate less slash, although localized concentrations are sometimes high. Fewer disposal methods are feasible in partially cut stands but the need for reduction is often less acute, except as required by law or for esthetic reasons.

Any treatment that reduces shading of the soil surface increases soil warming and organic matter decomposition. These in turn increase the immediate availability of some nutrients. Sometimes high surface temperatures are lethal to newly germinated seedlings. Or, again, cooling of the exposed soil increases the hazard of unseasonable frost. On the other hand, disruption of the loose litter cover or exposure of mineral soil may be essential to satisfactory natural restocking. Litter layers often dry too rapidly for germinating seedlings to survive. Or, as is now known for redwood and Engelmann's spruce, fungi in the litter may completely destroy the seedfall (*16*). Experience with such events strongly influences silviculture practices, as indicated in appendix L. The discussion that follows, however, is concerned only with less transient impacts upon productive capacity and stream values.

Greater removal of stemwood, chipping, lopping, drum chopping, or crushing normally have relatively little long-term effect upon the soil if regeneration follows promptly. The sheer massiveness of large crushing machines normally keeps them off of moist soils, and compaction is seldom a consequential problem with tractor crushing. Similarly, piling or short distance windrowing of slash, with or without subsequent burning, is unlikely to be adverse unless highly erosive soils are exposed or significant quantities of nutrients concentrated.

Two other disposal methods, broadcast or area burning, and tractor raking over long distances, have much greater potential for damage on sloping lands. Whether or not these methods are appropriate to use depends first of all on local soil and climatic conditions and, almost equally, on the control in application.

Broadcast burning causes remarkable little damage to many soils of the Pacific coast region in spite of the steep slopes. This is due in large part to high soil porosity and aggregation, as well as to the predominance of low-intensity rainfalls, and the relatively large percentage of surface cover left when a light fire burns over moist soil (*98*, *99*). Then, heating of the soil is slight except in localized spots; reduction in total nitrogen is small; and the ash elements are retained.

But burning conditions are neither fixed nor wholly predictable. When excessively hot burns occur, a large percentage of the soil cover is consumed. Without cover, localized particle detachment and surface runoff may occur, and barriers to movement of loose or eroded materials are fewer. Thus, individual studies of slash burning indicate a moderately wide range in soil movement and, especially, in the consequences for stream turbidity. Most commonly the effects are minor.

On the other hand, after a very hot slash burn on a 175-acre watershed in coast range of Oregon, sediment yield increased fivefold, to about 0.9 ton per acre per year, with a maximum sediment concentration of 7,600 ppm (*8*). Even larger losses of soil occurred after burning a very steep (average slope 63 percent) clearcut in the Cascades, which left 53 percent of the mineral surface exposed (*28*). In both instances soil loss diminished rapidly as revegetation occurred. In both, also, the total losses were too small for detectable effect on terrestrial productivity (see also fig. 3) and damage must be judged in terms of impaired stream values. Fixing standards for such judgment is by no means simple, however, for as Brown and Krygier (*8*) indicate, an uncut control watershed may by chance yield more sediment in flood periods than adjacent areas clearcut and slash burned.

A small plot study of sixty-five 10- to 58-acre units in the northern Rocky Mountains revealed somewhat similar response (*18*). Losses of dissolved nutrients in surface runoff after clearcutting and slash burning were minor, although larger than from unlogged controls. In one of the two localities, soil losses were less than 0.1 ton per acre per year in the first 2 years and diminished rapidly as revegetation took place. In the other locality a single high intensity rain during the first summer after burning raised soil loss to three-fourths ton per acre. It is likely, however, that some of the eroded soil was trapped before reaching streams.

These few examples bear out the general observation that prescribed slash burning has only minor consequences for productivity but on some occasions is sufficient to degrade water quality and fish habitat (*6*). Improvements in predicting burning conditions may reduce the frequency of very hot burns—which are undesirable on other counts also—but prediction is by no means an exact science. Leaving undisturbed filter strips along stream channels, as discussed later in connection with water quality would avoid most instances of impaired stream values after slash burning. Protecting such strips will often complicate the burning operation, however, and the two may sometimes prove irreconcilable.

The foregoing comments about light slash burns do not apply without qualification to other types of prescribed burning or wildlife. In certain circumstances, fire may render soil layers beneath the surface nonwettable and so impair rainfall absorption (*17*).

A further aspect of area burning deserves brief mention: Fire in nature has a dual role, destroyer but also shaper of vegetation. Long before the coming of European man, frequent, even annual, burning by aboriginal man determined the character of the southern pine forests. Today, prescribed fire is a widely useful land management tool in that region. Effects of Indian burning at short intervals are recognized also in California and parts of the Northeast. Through great parts of the Pacific coastal region, the Rockies and intermountain areas and the Lake States, fire was likewise widespread, though commonly less frequent, more erratic in occurrence, and often drastic in effect. Foresters have long recognized large areas of forests in these regions as fire types, that is, composed of species that regenerate freely after fire, and either even-aged or with distinct age groups marking recurrent fires.

In fact, fire often was a dominant ecological force, and suppression by present-day protection activities is generating a series of profound changes in the character of forests *(111)*. These often entail increases in fire-sensitive or shade-enduring species, at the expense of those better adapted to fire or to regeneration on open, burned surfaces. Canopy or understory densities increase; glades and openings close in; and light-requiring herbs and shrubs diminish. Reduction in browse or forage decreases the carrying capacity for deer and elk. At the same time, widespread fuel accumulation commonly increases hazard and the difficulty of wildfire suppression.

Protection against wildlife remains essential but there is now substantial interest in the purposeful use of fire to influence plant succession over large areas, maintain wildlife habitat and scenic values, and modify fuel accumulations so as to reduce probability of major wildfires. The impact of fire is never wholly uniform, however, and even the best informed decisions to prescribe fire, or allow natural fires to burn (as in the Kings Canyon and Sequoia National Parks), involves balancing known benefits against some risks and probable damages.

This recognition of the natural role of fire, and of the trade-offs inherent in its use bears also on its application to slash disposal. Rather than being a reluctantly allowed precaution against wildfire, in many situations area burning will prove to be a method of choice for ecological reasons, favoring perpetuation of desirable species and plant communities that are discriminated against in the absence of fire.

The requirement for favorable combinations of fuel moisture and weather greatly restricts the time available for safe application of area burning. Where terrain permits, tractor raking and piling of slash, often with subsequent burning, can be carried on over much longer periods. Such treatments may also facilitate use of planting machines.

With adequate control over equipment movement, stream values and water quality are usually unimpaired by tractor raking. But adverse effects on productivity may follow when such methods are applied carelessly to highly erodible or infertile soils. Movement of equipment and their loads of residues bares and harrows the soil. This sets the stage for soil detachment and washing if high-intensity rains occur before revegetation. Steep slopes disturbed by downhill piling are particularly vulnerable. On such soils localized erosion is sometimes severe and the sediment may or may not be effectively trapped before reaching water courses.

Again, removal of surface organic matter along with slash concentrates soil fertility at the deposit sites while depleting broad zones between. The effect on low-fertility soils may be irregular establishment and lower total growth for the area as a whole, even though no erosion occurs.

Two recent Forest Service reviews (*103*, *105*) stress the consequences of insufficient care or control in residue treatment and the need for adequate appraisal and supervision. Viewed broadly, however, residue management systems are evolving rapidly in response to new and sometimes conflicting pressures. Failures as well as successes must be expected when new procedures are tested in practice. The need is for continuous followup and analysis to insure that the basic objectives of prompt regeneration and watershed protection over broad areas are not compromised by the new demands and technologies.

## Summary

It would be difficult to provide a more thorough-going summary than the conclusions reached by Rice, Rothacher, and Megahan, in their appraisal of the "Erosional Consequences of Timber Harvesting":

> Erosion in an undisturbed forest represents a minimum for the site, and most of man's activities will increase the erosion rate to some extent. The environmental objective of a timber harvest, therefore, is to minimize the erosional "costs" and to balance them, together with other resource "costs", against the wood products benefits received from the harvest.
>
> Erosion rarely occurs uniformly in a forested watershed. Even in a logged area, most of the soil surface is undisturbed. Because erosion tends to be localized, it is often deep and includes a large proportion of subsoil and weathered parent material. The volumes of sediment lost from the site, consequently, probably represent much less actual degradation of site quality than would be the case if erosion were taking place more or less uniformly over the whole surface.
>
> Because of the diversity of species within a natural forest ecosystem, bared areas are quickly invaded by pioneer species, and initially high rates of sediment production decline rapidly. Erosional recovery does not require the return to predisturbance conditions but rather to the cessation of accelerated erosion, which occurs much sooner.

Landslides and creep are the principal forms of natural erosion in mountainous regions under a wide variety of climates and site conditions.

The cutting of trees, by itself, does not significantly increase erosion, but clearcutting on steep unstable slopes may lead to increased mass erosion. Therefore, on steep slopes, slope stability requirements as well as silvical considerations should weigh heavily in the selection of silvicultural systems.

Accelerated erosion is a possible undesirable side effect of use of fire following a timber harvest. The effects of fire are most harmful on steep slopes, where it induces dry ravelling, and on coarse-textured soils, where it can—by the creation of a water repellant layer—increase overland flow and retard the regrowth of the forest.

The road system installed to facilitate timber harvest far overshadows logging or fire as a cause of accelerated erosion. Roads increase surface erosion by baring soil and concentrating runoff. And they trigger landslides more frequently than any other disturbance by man.

Most erosion tends to occur in localized unstable areas. Consequently, it is possible, particularly with respect to landslides, to identify potentially hazardous areas in advance of the timber harvest. Erosion associated with timber harvest can be substantially reduced by either avoiding these areas or by minimizing the effects of disturbance. (*81*).

## WATER QUALITY

Streams issuing from little disturbed forests, even those on steep, thin or erosive soils, are ordinarily of high quality—low in dissolved or suspended matter except in flood periods, high in oxygen content and relatively low in temperature. The exceptions are few, usually where streams are cutting rapidly into soft sediments.

Unlike water yield, water quality is a relative term, defined only by arbitrary standards. Yet the features determining quality have an evident importance for man's use and enjoyment, and for the natural populations of streams and lakes. Moreover, reductions in quality usually indicate some degree of man-caused or natural disruption on the watershed. For these reasons features of water quality and the impact of timber harvesting upon them are being studied with increasing intensity.

Numerous investigations and especially recent evaluations (*6*, *19*, *69*, *73*, *81*) leave no doubt that harvest and harvest-related operations have the potential to degrade water quality and have done so on many occasions in the past. Yet they also emphasize that the adverse effects can be greatly reduced or entirely avoided by skilled planning and sufficient care.

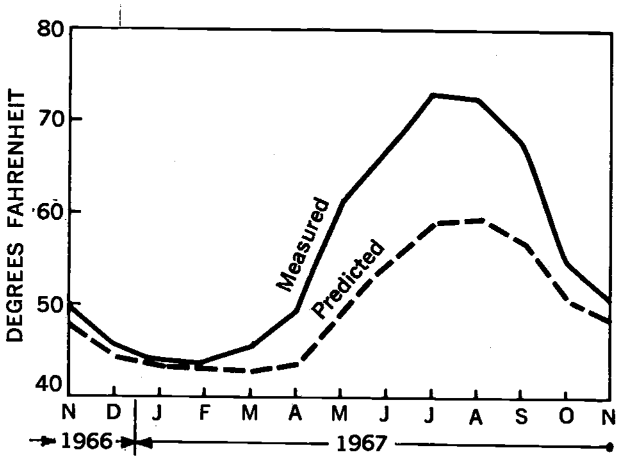
The major cause of impaired water quality associated with logging is soil washed or otherwise moved from disturbed surfaces, especially from roads and skidtrails. On occasion, other sources contribute—landslips, soil exposed by slash disposal treatments, and bank cutting in debris-choked or altered stream channels.

The response of a stream is sometimes complex but the likelihood of damage depends chiefly on four features: (1) Removal of shade above the stream, with consequent increases in summer water temperatures; (2) disturbance of stream channels and their immediate vicinities; (3) amount and character of soil materials reaching the streams as a result of logging and roadbuilding activities on the remainder of the area; (4) changes in amount of organic matter and dissolved nutrients reaching the stream.

(1) Regardless of any other disturbance, removal of overhead or streamside shade increases maximum water temperatures. Evidence from several regions makes this point quite clear, although the amount of increase is not fully predictable (*7*, *9*, *49*, *61*, *97*). Complete exposure of small streams to direct sunlight by clearcutting can bring increases ranging from a few degrees to as much as 15° F. (fig. 6), and in one instance 28° F. Response of individual streams varies according to the amount of overhead canopy removed, to length of full exposure, to stream width, and to volume and initial temperature. Temperatures increased in openings are often lowered again downstream by the inflow of cool ground water or tributaries. Warming is small or negligible in cloudy weather. Moreover, low shade from dense shrubs is fully as effective as equal shading by high trees.

The significance of small temperature increases in very cold mountain or Alaskan streams is not well understood. It seems likely that warming may enhance their productivity, as Meehan (*60*, *61*) has suggested for southeast Alaska. Several studies at lower elevation in both Eastern and Western States, however, have shown that maximum temperatures following full exposure of small streams may approach or exceed the limits tolerable to trout and salmon. Sustained high temperatures below the lethal points of various species may be decidedly unfavorable also, affecting feeding behavior, disease incidence, and the oxygen content of water. These effects are particularly serious in many Pacific drainages where small headwater

FIGURE 6.




All shade was removed by clearcutting and slash-burning on this 237-acre watershed in the western Cascades. *Measured* average maximum stream temperatures then rose markedly above the values *predicted* for the watershed in the uncut condition. This rise could have been avoided by leaving a buffer strip along the stream (Levno and Rothacher, 49).

streams serve as nurseries for anadromous fishes (*6*).

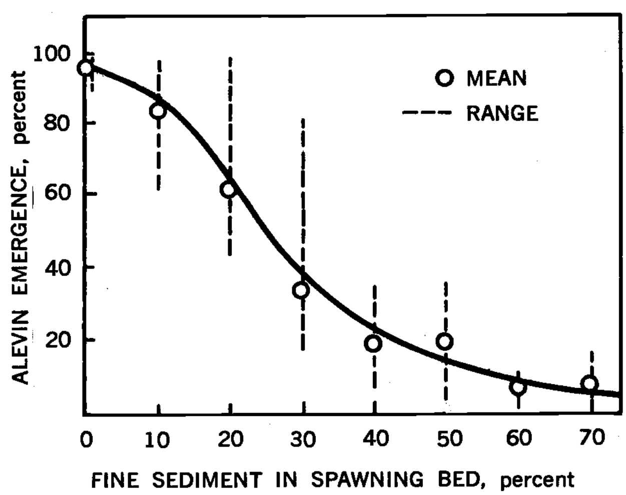
Timber harvest methods are important, then, simply to the degree that they reduce high and low cover along the channels, or contribute to widening of streams in open areas by debris dams. Fortunately, temperature increases can be almost wholly avoided by leaving a narrow strip of shade along all live streams in clearcut areas. Such strips are by no means inexpensive. Even apart from the timber values foregone their presence and protection increases costs of logging and subsequent residue disposal or regeneration treatments. Leave strips have other important benefits for water quality, however, as indicated below; and so are now being widely advocated or required (*4*, *6*, *106*).

(2) In the recent past, operations associated with logging frequently caused direct disturbance of stream channels. In some landscapes stream terraces or even the channels of small or intermittent streams provided graded avenues for roads or skidtrails. Bridge construction, stream deflection at crossings, and even gravel removal stirred bottom deposits or increased bank cutting. Cross-stream skidding or yarding were common. Other effects included channel deflection when tops or cull logs fell into streams, or worse yet, channel scouring when such debris temporarily dammed flood waters. The consequences of such treatments varied widely with locality, from negligible to severe. Though records of increased stream turbidity caused by logging operations often did not distinguish sources, turbidity in rainless periods was often traceable to streamside skidding or road construction. Mixing organic debris into coarse gravel bottoms or clogging them with finer particles may drastically lower the spawning success of salmon in headwater streams (fig. 7).

Almost all of the damage indicated above is fully avoidable. And in fact, the operations causing it are rapidly being prohibited or limited by the provisions of timber sale contracts on public lands, logging prescriptions on industry timberlands, and, in some States, by forest practice laws. Further progress is needed, however, with particular attention to the education of equipment operators and lower echelon supervisors—who in the end determine the care given to any operation.

The practice of leaving narrow buffer strips of vegetation along stream channels not only maintains water temperature but serves also to prevent many kinds of streambed or streamside disturbances. In addition such bands often act as filter strips trapping any sediment washed from above. Though a widely useful precaution, buffer strips are in no sense panaceas, nor substitutes for careful planning and treatment on the remainder of the watershed. Windfall is a common hazard to

FIGURE 7.




The proportion of salmon alevins that develop and emerge from gravel spawning beds decreases as the relative amount of fine sediment in the gravel beds increases (U.S. Dep. Agr., Forest Service, 102).

tall trees exposed by cutting of their surroundings, and windthrown tops and logs in streams are no more desirable than logging debris. Hence careful thinning or removal of overstory trees from buffer strips will frequently be preferable to complete nondisturbance.

(3) As already discussed (p. 438), roads and skidtrails are the major causes of increased turbidity and bedload associated with timber harvest activities. Though small increases in turbidity sometimes will be inevitable during construction and initial use of roads, almost all major or continuing damage is fully avoidable—though often not without increased costs for planning and construction.

Continuing research in engineering and in logging methods is essential to further technological improvements and cost control. There is also need for better understanding of unstable slopes. Though these may compose only a fraction of an entire watershed (fig. 4), they sometimes control access or contribute inordinately to stream damage when unwisely disturbed. But it must be emphasized that we already have the knowledge and technology to avoid most impairments of water quality on most forest land.

The Federal Water Pollution Control Administration recently published a compilation (*106*) of the numerous specific practices already in use in the Pacific Northwest, explaining their needs and urging their consistent application throughout the region. The rationale of the preface deserves repetition here:

> How the logging is done has immediate and long-term impacts on water quality. Well planned and properly executed logging operations will keep water quality degradation to the minimum. But such careful logging operations may add significantly to the cost of cutting and removing logs from the forests. It is a cost which the forest land owners and the logging industry must recognize as a necessary cost to protect the quality of the waters originating on and flowing through the forests of the Pacific Northwest. It is a cost which is paid in the end by the consumers who purchase the many useful products manufactured from wood (*106*).

(4) Until recent years the overriding importance of turbidity and bedload left little room for concern with other aspects of water quality. The chief exception concerned washing into small streams of ash left by severe wildfire. Numerous such observations have been reported but without chemical details. In one carefully studied instance, ash did not affect stream chemistry, apparently because the soluble components leached into the porous soil and were retained (*44*). Similarly, surface runoff following broadcast burning of slash in the northern Rockies transported only minor amounts of ash elements (*18*).

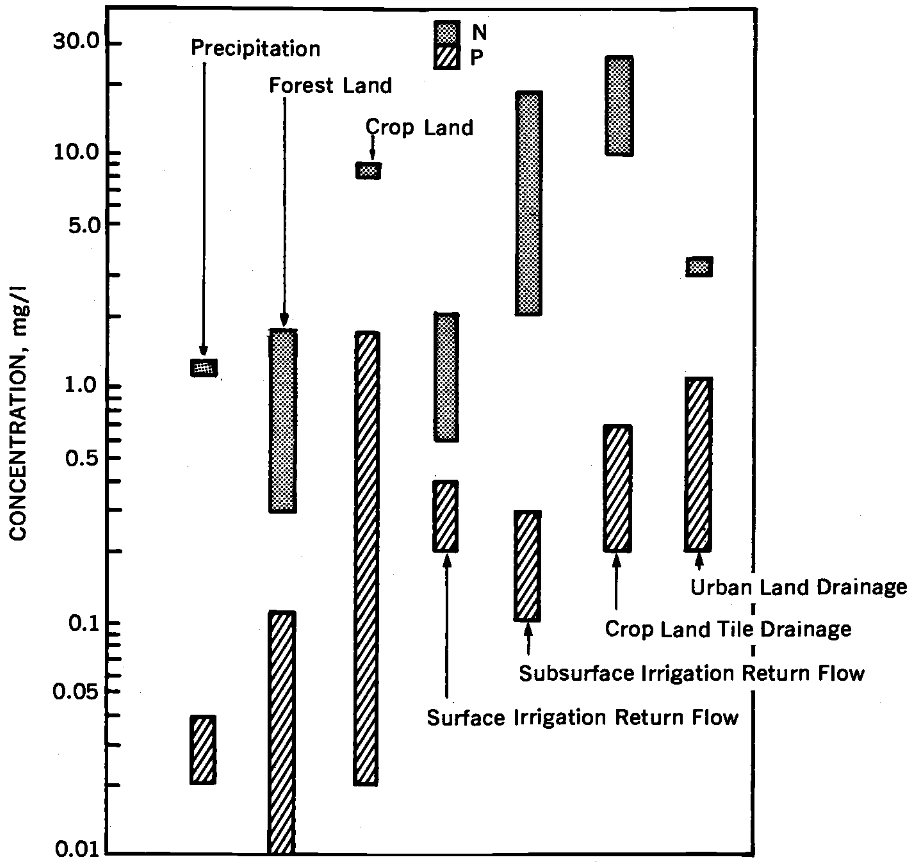
The chemical composition of streams from undisturbed forests varies because of differences in geology and weathering rate. On the Walker Branch (Tennessee) watershed, for example, where the bedrock is limestone and dolomite, stream water concentrations of calcium and magnesium were about 25 times higher than from forested watersheds on noncalcareous bedrock at Coweeta (*93*).

Atmospheric contributions may strongly influence outflow waters. For example, estimated sodium losses from three old-growth Douglas-fir watersheds near the Oregon coast averaged 75 to 100 pounds per acre per year, reflecting oceanic input (table 13). At Walker Branch, which is in the vicinity of coal burning power stations, dry fall—which is mainly fly ash—amounted to 220 pounds per acre per year, and calcium, magnesium, and potassium concentrations in precipitation averaged 2½ to 10 times greater than at Coweeta (*93*). Also, it is well recognized that sulfur and other elements from fossil fuels are now being added in appreciable quantities to many forests remote from industrial sites.

Nevertheless streams from forest areas are characteristically low in nitrogen and phosphorus in comparison with those affected by other kinds of land use, as illustrated by fig. 8.

The influence of forest cutting on stream water chemistry has received much attention as a result of studies at the Hubbard Brook Experiment Forest. These are discussed in detail later (pp. 453 et seq.). In brief, experimental clearcutting of a small watershed followed by herbicide applications to prevent regrowth greatly increased concentrations of most elements in the outflow stream. Accelerated decomposition of the fully exposed forest floor released nitrogen which was converted to soluble nitrate. The nitrate together with accompanying basic elements then leached through the soil (*51*). As a result, stream water concentrations of nitrate greatly exceeded recommended standards for drinking water (fig. 9). Whether in response to nutrient increases, light, temperature, or their combination, an alga population developed in the waters from the denuded watershed but was absent from the uncut control stream (*52*).

**FIGURE 8.**




COMPARISON OF CONTAMINANT SOURCES—TOTAL NITROGEN AND TOTAL PHOSPHORUS, mg/l

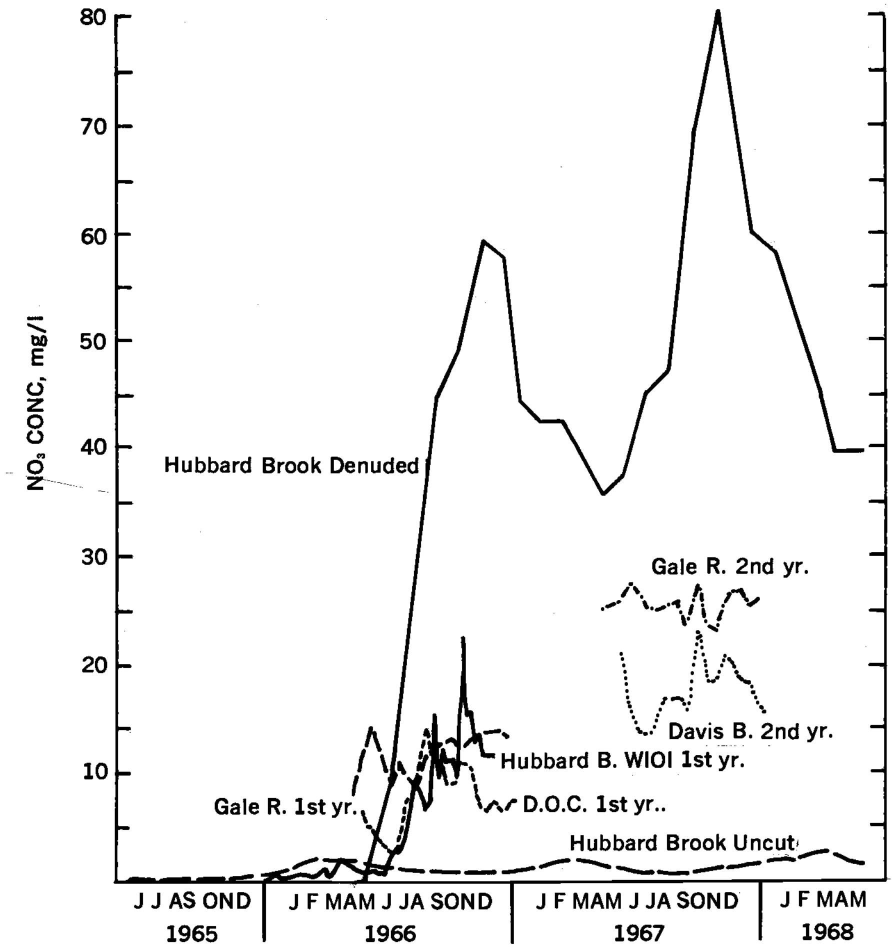
Nitrogen and phosphorus concentrations in outflowing water are affected by land use. The range of concentrations in forest land streams is normally somewhat more or less than in precipitation. Note that scale is logarithmic.—Values from U.S. literature (After Loehr, 54).

The same investigative team subsequently studied stream water concentrations following harvest clearcuts—where denudation was not complete and natural regrowth was allowed—in the vicinity of Hubbard Brook (*72*). Nitrate concentrations averaged much lower than in the experimentally denuded watershed—at maximum, one-third (fig. 9). Even so, the nutrient increases were certainly large enough to have affected stream biology. Little is known of their actual influence or fate, however, and as demonstrated by the investigators, the concentrations are diluted downstream by tributary waters. Thus the maximum change in stream water chemistry at any point is limited by the proportion of recently cut land upstream. This may be high in very small watersheds but obviously can make up only a small percentage of any large area under sustained yield management.

The Hubbard Brook studies clearly demonstrate the value of monitoring stream water chemistry as a sensitive indicator of unseen or unsuspected changes resulting from use or manipulation of forest lands—cutting, burning, powerline clearance, species change or recreational developments (*53*).

It must be emphasized, however, that the results obtained in the Hubbard Brook area appear to be unique to the region. Thus far, no such large increases in stream water concentrations, or conductivity after clearcutting have been detected in any other region, as fig. 10 and table 7 suggest. Indeed, the changes reported are remarkably small, and trivial in their influence on water quality. The probable reasons for these differences, as well as the area to which the Hubbard Brook findings

FIGURE 9.




Nitrate concentrations in stream water increased rapidly and remained high after total denudation of forested watershed at Hubbard Brook (Upper curve vs lowest). Concentrations monitored after harvest clearcutting of small watersheds in the vicinity (five intermediate curves) show similar response but at much lower levels. Intermediate curves represent 1971 data superimposed on Hubbard Brook time scale axis,but variation in cutting periods makes matches only approximate. (Re-drawn from Pierce et al., 71, 72).

probably do apply, are discussed later (pp. 453 et seq.).

## NUTRIENT LOSSES AND RECOVERY

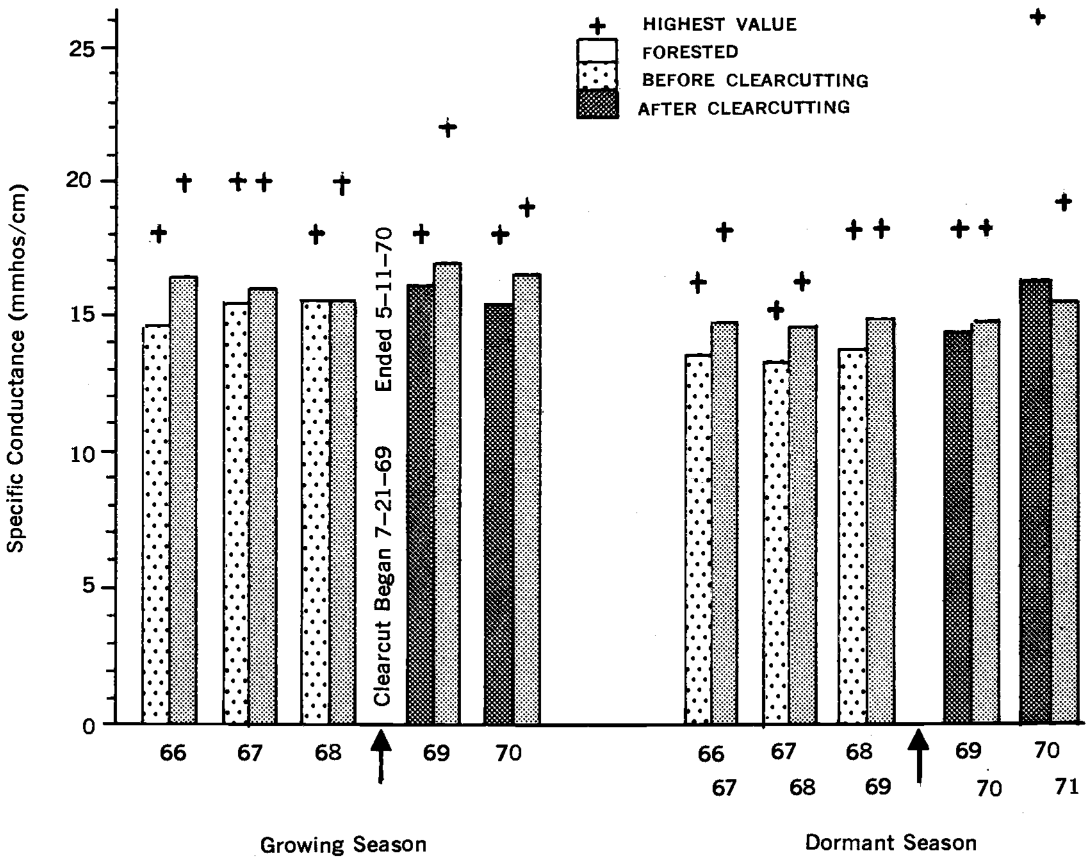
The present-day concern with nutrient cycling and losses in forests is far from new. Historically it grew out of the European agricultural practice of gathering leaf litter from forests to use as cattle bedding. When the Bavarian forestry experiment station was established a century ago, one of its first tasks was scientific examination of the nutrient losses caused by decades and centuries of such removal, and their effect on tree growth (*2*). The reality of these losses and their adverse effects was clearly established, and litter gathering was eventually ended by prohibition and by purchase of vested peasant rights.

Interest in nutrient budgets and cycles then extended to the losses incurred by removal of wood from intensively harvested forests. Rather good estimates for the major elements were made in Germany and France before 1900 (*57*), and their implications were well known to early American foresters. In general, these results have been borne out by numerous modern studies, and estimates of minor element losses have been added to them.

### Removal of Wood

Forest stands absorb appreciable amounts of all essential elements each year, the quantities be-

FIGURE 10.




Average conductance values of streams from paired control ("forested") and clearcut watershed were little affected by clearcutting. Conductance is a measure of total ion content. Mixed hardwood forest, Fernow Experimental Forest, West Va. (Aubertin and Patric, 4). See also Table 10.

**TABLE 7.—Mean Annual Concentration of Chemicals Dissolved in Streamflow of Paired Clearcut and Control Watersheds. The Clearcut Watershed Was Broadcast Burned for Fuel Reduction Early in 1967. Old-Growth Doulgas-fir Forest, Andrews Experimental Forest, Oreg. (from Fredriksen (29) see also table 14)**

| | Milligrams per liter | | | |
|---|---|---|---|---|
| | Nitrate-N | | Ortho phosphate-P | |
| Year | Clearcut | Control | Clearcut | Control |
| 1966 | 0.020 | 0.010 | 0.024 | 0.026 |
| 1967 [1] | [2] .05 | .003 | .039 | .016 |
| 1968 | .200 | .001 | ----- | ----- |
| 1971 | .046 | .003 | .036 | .032 |

[1] Following slash burning.
[2] Ammonia nitrogen concentration was 0.11 mg/l.

ing very roughly comparable to uptake by agricultural crops. Only a fraction is deposited in the stem and larger branch wood, the portions that may be eventually harvested. The remainder, in foliage, twigs, roots, and fruits, returns to the soil. Harvest of wood, then, removes an accumulation of nutrients that has been gradually withdrawn from the soil over the life of the tree. The totals removed vary considerably with species and harvested volume (table 8). When divided by age of the stand, however, the annual removal is exceedingly modest, ranging from less than 1 to perhaps 3 pounds per acre per year for elements such as phosphorus, up to as much as 10 pounds per acre per year for nitrogen and potassium, or even more for calcium in some hardwoods. So far as the bases, calcium, magnesium, and potassium, are concerned, these small removals fall within the same ranges as the solution losses in streamflow, excluding streams from limestone bedrocks (compare table 8 with tables 10, 11, 13, 14). In most soils, then, natural weathering of soil minerals together with low levels of nitrogen fixation and atmospheric contributions seem ample to replace removals in wood (*15*, *57*, *114*). This conclusion is reinforced by the sustained productivity of many European forests that have been continuously harvested for as much as five centuries (*38*, *90*). To be sure, in occasional circumstances trees may be planted in soils that do not contain enough of a critical element within the rooting zone for even a single crop of trees, as has happened in western Australia. But in general, it seems unlikely that soils of the commercial forest areas of North America will be seriously depleted by normal levels of timber harvest, possibly excepting some infertile soils of the southeastern coastal plains, where phosphate fertilizer is already being routinely applied in order to obtain satisfactory growth.

Two recent developments have prompted renewed interest in nutrient removal. Full tree logging practiced in some pulpwood stands removes the unlimbed stem with much of the adhering crown to a central loading point where the remaining branches are cut off. Thus the quantity of nutrients removed from the stand is substantially increased. Recent estimates in black spruce and spruce-fir forests in Canada indicate that the exceedingly small losses associated with normal shortwood harvesting methods—less than 2 pounds per acre per year for any element—might be increased up to 3½ to 4½ times if the entire crown were removed with the stem (*110*). In this instance, the proportional increase from full tree logging is much greater than in other estimates, possibly because of the very low amounts in stemwood and bark alone.

**TABLE 8.—Estimated Quantities of Mineral Nutrients Removed in all Stemwood and Bark by Intensive Thinning Plus Clearcutting the Main Crop at 100 Years (from Rennie's compilation of European data (77))**

[Pounds per acre]

| | Total removal from site after 100 years | | |
|---|---|---|---|
| | Ca | K | P |
| Pines | 249 | 93 | 18 |
| Other conifers | 505 | 247 | 35 |
| Hardwoods | 1, 278 | 291 | 57 |

Another example for which data are available concerns a fast-growing 26-year-old pine plantation in New Zealand. Removal of the complete crown with the stem would increase annual loss rates of various elements as shown below (*115*):

| | Pounds per acre per year | | | |
|---|---|---|---|---|
| | Nitrogen | Phosphorus | Potassium | Calcium |
| Stemwood and bark only | 4. 4 | 0. 6 | 5. 4 | 3. 6 |
| Full tree above ground (100 tons/acre) | 7. 7 | 1. 0 | 7. 7 | 4. 4 |

Data from other sources similarly suggest that increased nutrient removal is likely to be a minor problem from full tree logging, although increased soil disturbance might prove consequential.

A greater concern is increased nutrient losses through shorter rotations, lower mortality, faster growing varieties or genotypes, and closer use. Certainly, nutrient removal will increase in approximate proportion to the harvested volume and so is calculable. Even the most optimistic predictions, however, rarely foresee more than a twofold increase in yield above that from currently well-managed lands. And physical and economic considerations will limit intensive treatments to only a small fraction of the managed forest area, principally to highly accessible lands with favorable climates and soils that are either inherently fertile or responsive. It seems likely that nutrient additions through fertilization or nitrogen-fixing plants will be made to establish high productivity rates in some of these modified ecosystems, as in agriculture (*34*). At present, however, the reason for fertilizer application is not restoration of nutrients removed but either (*a*) acceleration of already favorable growth rates on productive sites, or (*b*) allowing reasonably normal growth on soils either naturally deficient or depleted by an earlier cycle of exploitive agriculture. In the latter instances, single applications of deficient elements such as phosphorus or potassium have increased growth for periods lasting to as much as 15 years.

## Development of New Forests

Soil scientists, foresters, and ecologists have had a long-standing interest in the plant nutrient transformations that occur when a forest is destroyed and allowed to regrow again. American settlers in forest regions, like the agricultural Indians who preceded them, were well aware that fertility accumulated under forests could be released by cutting or killing the trees, and burning or tilling the soil. Crop yields in the first year or two on land so prepared were far higher than could be obtained by sustained cropping of the same land without legumes or other fertility additions. Primarily for this reason, systems involving progressive forest clearing and cultivation for only a few years were widespread wherever primitive agricultural populations were sparse, land abundant, and soils inherently low or moderate in fertility. Such systems were by no means confined to the tropics: At an earlier date they were common also in remoter areas of Sweden, Finland, and northern Russia, as well as among the agricultural Indians of the Americas. Excellent forests now exist on former Indian corn fields in eastern North America and on lands cleared at long intervals, but probably repeatedly, in northern Europe. The same has been true in the past for many tropical forest areas, although shifting agriculture soon becomes intolerably destructive when increased populations cultivate land too frequently or too long by primitive methods, or when repeated burning favors grassland over forest.

Many other commonplace observations demonstrate the capability of most temperate forest soils to recover from drastic disturbance. In Western Europe some large fraction of nonmountainous forest land was once used for agriculture, sometimes repeatedly so. The heathlands of northern Germany, for example, were converted from forests to heather by Bronze Age man and were reforested only in the last century. In eastern North America, large acreages once pastured or cultivated with little or no fertility addition have recently returned to forest through planting or natural seeding. In southern New England, whole towns that were once 80 percent cleared land are now more than 80 percent forested. Again, great areas of even-age forests growing on old burns in many parts of North America demonstrate the capacity of soils to supply nutrients for new forests after complete destruction of old.

There are indeed instances of known or suspected nutrient deficiencies within these vast areas of secondary forests, and there are exceedingly poor forests on eroded, abused, or inherently infertile lands.

A new forest developing on open land makes relatively heavy demands especially when the tree crowns are expanding. Elements critically low before clearing are likely to be more so afterwards, except as agricultural use may have brought additions. The species that succeed and their growth rates often reflect nutrient deficiency or abundance. But deficiency or abundance is the sum of the remaining stores of plant-available nutrients plus the cumulative rates of replenishment—by release from soil minerals and residual organic matter, nitrogen fixation, and additions from the atmosphere. A measure of this sum is the accumulation of nutrients in new stands.

Table 9, representing 28 combinations of species and locations, demonstrates the capacity of new forest systems to obtain relatively large quantities of essential elements within a very few decades.

These numerous observations lend no support to assertions that forest soils may be irreparably depleted by clearcut harvests at long intervals. Rather, they emphasize the accumulative and essentially conservative actions of forest systems, an outcome of their large biomass and developing soil organic matter, their intensive and often deep root systems, and their effective retention and cycling of absorbed nutrients (*15*).

**TABLE 9.—Range of Nutrient Accumulation by Planted Forest Ecosystems of Several Individual Conifers and Hardwoods, at 3 Locations in England. For all Elements but Nitrogen, Values Are Total Contents in Standing Trees, Thinnings, Ground Vegetation and Surface Litter, Exclusive of Roots. Nitrogen Values Exclusive of Ground Vegetation Also. Range From Highest to Lowest Reflects Species and Age Effects (from Ovington, (*65, 66*); Ovington and Madgewick (*67*))**

[Pounds per acre]

| | Location and age | | | | | |
|---|---|---|---|---|---|---|
| | West Tofts 22 years | | Bedgebury 21–22 years | | Abbotswold 24–48 years | |
| | Minimum | Maximum | Minimum | Maximum | Minimum | Maximum |
| Nitrogen | 210 | 749 | 156 | 1,420 | 219 | 745 |
| Potassium | 75 | 281 | 83 | 616 | 93 | 414 |
| Phosphorus | 35 | 119 | 16 | 107 | 21 | 111 |
| Calcium | 264 | 823 | 137 | 572 | 218 | 730 |
| Magnesium | 27 | 54 | 22 | 107 | 40 | 123 |

## Accelerated Nutrient Release After Cutting

Heavy thinnings or partial harvests stimulate the growth of remaining trees through greater abundance of light or water, and also through reduced competition for nutrients and actual increases in their availability. The increases come about both through release from decaying residues of cut trees, and by accelerated decomposition of the soil organic matter. Greater radiation reaching the forest floor warms it above its former temperature regime and increases microbial activity. The effects seem most pronounced in northern climates, where thick humus layers accumulate on the soil surface and temperatures of shaded soils remain low much of the year. But eventually expanding crowns and roots of the residual trees reoccupy the growing space liberated by thinning and the soil is again shaded.

Several research workers have considered the possibility of increased leaching losses after partial or clearcutting, and especially on coarse-textured soils. Only a few direct measurements have been made but these show very slight effects at most.

Probably the best known recent study concerns a 31-year-old, 60-foot-high Douglas-fir stand, originally planted on a very gravelly (50 to 60 percent) soil after logging and repeated burning. Tension lysimeter plates were placed at depths of 1 and 36 inches to sample leachates from the soil volume above. Two treatments applied were heavy nitrogen fertilization with urea, and clearcutting. Total elements in the leachate over the first 10 months after treatment follow (*13*) (Rounded values):

[Pounds per acre]

| | Nitrogen (inchs) | | Phosphorus (inchs) | | Potassium (inchs) | | Calcium (inchs) | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 36 | 1 | 36 | 1 | 36 | 1 | 36 |
| Control | 3.5 | 0.5 | 0.75 | 0.03 | 6.6 | 0.8 | 10.4 | 3.6 |
| Fertilized urea | 155.0 | .6 | 4.95 | .07 | 11.9 | .8 | 8.1 | 5.1 |
| Clearcut | 9.6 | .9 | 2.06 | .10 | 14.4 | .9 | 18.6 | 7.8 |

The most striking feature is the very large reduction in concentrations from the surface to 36 inches. Unlike the Hubbard Brook study discussed later, nitrate formation in this soil is inconsequential, and downward moving elements are absorbed by the soil or root system. Only very small amounts of nutrients added or mobilized by the treatments were lost beyond rooting depth in this period.

Increased nutrient availability in the upper soil is often evident from the leaf color and growth rate of the new vegetation that springs up on cutover areas. In cool climates, such as the middle latitudes of Scandinavia and Finland, an accelerated release of nitrogen in cutover areas seems essential to full and rapid regeneration. Studies of nitrogen release more the 50 years ago led foresters there to employ clearcutting and partial burning of the surface to increase soil warming and nutrient release.

Somewhat parallel findings emerge from a study of second growth forests in southeastern Alaska (*92*). All stands were on a widespread group of very similar soil types, and all had heavy surface organic layers. But growth rates of stands arising after logging or wildfire were much superior to those after natural blowdowns (average site index 152 versus 126). Leaf analysis indicated lower levels of nitrogen available to trees in the uncut blowdown areas. In blowdowns the ground remained shaded by a deep mass of stems and branches, reducing warming, accelerated decomposition, and release of nutrients to the new crop.

Interest in accelerated nutrient release has been stimulated by an exceedingly well-conducted experiment at the Hubard Brook Experimental Forest. The initial results became available just at the time that public criticism of clearcutting as a harvest method was mounting rapidly, and were seized upon as evidence. Hence it seems worth detailing the experiment and the environmental conditions which influenced its outcome.

### Hubbard Brook and Other Watershed Studies

The Hubbard Brook Experimental Forest of the U.S. Forest Service contains six small forested watersheds at elevations of about 1,500 to 2,700 feet in the White Mountains of New Hampshire. The forest is long undisturbed hardwood—sugar maple, beech, and yellow birch. Bedrock prevents deep seepage so that excess rainfall moving through the soil eventually appears as streamflow. Through an initial calibration the stream behavior of any one watershed can be predicted quite accurately from the records for another. Following calibration, one 39-acre watershed was treated by cutting all vegetation to the ground in November and December, and leaving it without any removal. Thus the soil cover remained undisturbed by harvesting operations. For purposes of this experiment herbicide sprays were applied in such a way during the next three summers as to kill all sprouts and perennial ground cover.

The initial intent had been determination of water use by forest vegetation in this climate, and of forest influences on stream behavior. However, a fortunate collaboration was established between Forest Service investigators and two Dartmouth University scientists, F. H. Bormann and G. E. Likens. With National Science Foundation support, these two undertook analysis of elements brought into the watershed by precipitation or lost in outflowing stream waters. Forest Service investigators measured both total rainfall over the watersheds and streamflow. The combined data allowed relatively precise calculations of water and nutrient budgets for both treated and uncut control watersheds (*51–53*, *71*).

In the first year after treatment, streamflow from the denuded watershed increased by 13.6 inches, about 40 percent greater than expected from the uncut condition. Over 90 percent of this increase occurred during the 4-month growing season. These findings were in general agreement with results from similar studies elsewhere in humid regions (figs. 1 and 2).

Surprisingly, however, in the light of previous knowledge, concentrations of several dissolved nutrients increased greatly in streamflow from the denuded watershed. In the first year after denudation, the excess loss of nitrogen amounted to about 90 pounds per acre as compared with the control; losses of the accompanying basic elements, calcium, magnesium, and potassium, rose accordingly. Total excess losses over the 3-year period of complete barrenness were as follows:[1]

| | *Pounds per acre* |
|---|---|
| Nitrate-nitrogen | 312 |
| Calcium | 184 |
| Magnesium | 41 |
| Potassium | 77 |

Losses of sodium and aluminum also increased, whereas sulfate losses were somewhat lower.

In consequence of these large losses, nitrate concentrations in the stream water increased above the U.S. Public Health Service recommendations of 44 mg/l (10 mg/l $NO_3-N$) for drinking water during much of the 3-year period, rising at one point to 82 mg/l. Inasmuch as these findings have some times been cited as evidence of serious pollution resulting from forest cutting, it is perhaps worth noting that the outflow from this 39-acre watershed was diluted by stream flow averaging no more than 2 mg/l from some 7,000 acres before leaving the experimental forest.

No previous studies of forest cutting had even suggested losses so large as these. Fortunately, the data obtained are complete enough for an overall grasp of the mechanisms involved, even though some details are still unresolved.

In this region undisturbed forest soils have a thick surface organic layer or forest floor. At Hubbard Brook this ranged from 2 to 6 inches thick and contained about 1,000 pounds of organic nitrogen per acre (*20*). Even in summer, surface soil temperatures beneath the uncut forest are low, averaging 48° F over the 2- to 6-inch depth in one season (June–September) of measurement (*42*).

Complete cutting followed by herbicide treatment destroyed all live shade, allowing full radiation to reach the forest floor of the denuded area. As a result, comparable surface soil temperatures rose to 62° F, an increase of 14° F or somewhat less where shaded by slash (*42*, *71*). Additionally, the soil would have remained moist beneath the extreme surface because transpiring vegetation was lacking. This temperature increase suggests a doubling of decomposition rate in the surface of the denuded area, and the actual increase may have been greater.

The effect of microbial decomposition is to liberate some of the organically bound nitrogen as ammonia, which in turn is absorbed by living plant roots, reused by microbial activity, or held in exchangeable form by the soil. One of the unexpected features, however, was rapid conversion of ammoniacal nitrogen to the nitrate form. Nitrifying organisms are usually scarce or inactive in such strongly acid soils (pH 4) but in this instance they were present and their numbers increased many fold (*87*). Unlike ammonia nitrogen, nitrate is not retained by soil. Since transpiration and an adsorbing root system alike were lacking, the nitrate generated was continuously leached through the soil mantle into the stream by successive rains. Anions such as nitrate do not move alone, however, and thus basic ions, principally calcium but potassium, magnesium, and sodium and aluminum as well, were also leached, with the total approaching the stoichiometric requirement.

Herbicide applications were discontinued after the third year and nitrogen losses from the denuded watershed are now decreasing as vegetation redevelops (*104*).

As the investigators have emphasized, the experimental treatment was intentionally extreme, and its effects were intensified by repeated use of herbicide sprays to prevent regrowth. The com-

[1] Data from the Hubbard Brooks experiment have been cited in several ways. These values are the differences in net loss or gain between the denuded and control watersheds, as given by Pierce et al. (*71*). Thus, the effect of additions from the atmosphere or mineral weathering is largely canceled. The values are sums of the 3 water years, from June 1, 1966, to May 31, 1969, and so extended for 3½ calendar years after the cutting of the treated watershed.

bination was in no way a forest management treatment. In fact, the merit of this study from a scientific point of view lies both in the thoroughgoing analytical procedures and in the extreme nature of the treatment, which yielded results unaffected by the normal regrowth of vegetation. These results have demonstrated greater transformations in acid soil organic matter, and far greater nitrifying activity than any soil scientist would have predicted, as well as much other information about nutrient balance in this ecosystem. It is unfortunate that gross misapplication of the results, by nonbiologists, to the controversy over clearcutting has occasionally obscured the real scientific values of this study.

The same authors have now monitored streamflow concentrations in nearby areas following commercial timber harvest by clearcut methods (*72*). In these, residual shrubs and saplings were not destroyed nor were herbicides applied to prevent sprouting and seedling growth. Once again, prompt increases in nitrate-nitrogen and basic elements occurred, demonstrating the same seasonal pattern as in the Hubbard Brook experiment but at much lower levels (fig. 9). Over the eight clearcut watersheds studied, maximum nitrate concentration in streamflow was 28 mg/l, versus 82 from the experimentally denuded watershed (i.e., 6.3 versus 18.5 mg/l of nitrogen). The estimated maximum loss of nitrate-nitrogen for the first 2-year period was less than 90 pounds per acre, as compared with about 218 for the denuded watershed. The data are still too scanty to establish average total losses for the entire period between cutting and revegetation to apply to commercially clearcut areas in this region. It is quite clear that they will be substantial though far less than from the area kept denuded.

The Hubbard Brook ecosystem study is unparalleled among ecological studies thus far for its systematic examination of a single ecosystem. No other investigation of nutrient leaching after forest cutting is as thoroughgoing and long continued. Nevertheless, results from other regions afford reasonably accurate estimates of nutrient losses after clearcutting or other drastic changes. None of these reveal the large increases observed at Hubbard Brook and its surroundings.

Table 10 demonstrates the small loss rates from a pair of control and clearcut watersheds on the Fernow Experimental Forest, W. Va. The forest is mixed hardwood, at elevations similar to Hubbard Brook. An 86-acre watershed was cut clean between July and the following May except for a narrow buffer strip protecting the stream. Concentrations of most elements increased slightly after clearcutting and the greater volume of streamflow (fig. 1) further increased total removals. A significant feature is the complete absence of the nitrate pulse observed at Hubbard Brook (fig. 9).

Gross and net losses from manipulated forest watersheds are compared with those from mature hardwoods in table 11. Though cutting of the manipulated watersheds was long enough ago so that any nitrate pulse would have disappeared, the different kinds of vegetation show only small differences in cation output. The differences that do appear chiefly reflect lower water yield—hence less loss—from the pine vegetation, and slight leakage of earlier lime and fertilizer applications on watershed No. 6. No effects of depletion by previous clearcutting are visible.

Table 12, expressed only in terms of concentration, indicates exceedingly small gross losses from a pair of aspen-covered watersheds, and only trivial differences associated with cutting. Each of the pair contains an area of peat, however, which presumably would damp out any small effect of cutting on outflow concentrations.

Similarly, tables 13 and 14 examine element loss under old growth conifers in the coast range and Western Cascades of Oregon. They show only minor losses of nitrogen. The marked increases in calcium and magnesium output shown in table 14 are due in part to higher concentrations of these elements but also to 18 inches more streamflow in each of the 2 years following clearcutting.

Additionally, both the results tabulated on page 453 and Weetman's observations in 65-year-old black spruce (*109*) agree in showing essentially no nitrate loss after clearcutting, though neither study is definitive. Why then the large effect at Hubbard Brook? And why also are losses from the experimentally denuded watershed so much greater than those from commercial clearcuts nearby? Some parts of the answers are apparent; others, still uncertain or complicated despite the large research effort given to the Hubbard Brook study.

The first consideration is simply availability of organic nitrogen for rapid release and conversion to nitrate. Organic matter with its constituent nitrogen occurs in two major forms in forests—

**TABLE 10.—Estimated Gross Loss of Dissolved Elements in Streamflow [1] From Paired Uncut and Clearcut Hardwood Forest Watersheds; First Year Results. U.S. Forest Service Fernow Experimental Forest, W. Va. (from Aubertin, (*3*) [2]**

[Pounds per acre]

| Watershed treatment and number | Nitrogen | | | TKN [3] | Phosphorus $PO_4$-P | Calcium | Megnesium | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|---|
| | $NH_4$-N | $NO_3$-N | Organic N | | | | | | |
| Control, No. 4 | 0.8 | 0.5 | 3.4 | 4.5 | 0.1 | 3.9 | 2.2 | 2.8 | 2.6 |
| Clearcut, No. 3 | 1.4 | 2.7 | 4.7 | 8.6 | .3 | 5.5 | 3.0 | 4.4 | 4.1 |

[1] Sum of mean concentrations times outflow in dormant and growing seasons.
[2] An earlier compilation (*104*) from the same basic data is unfortunately erroneous.
[3] Total Kjeldahl nitrogen.

**TABLE 11.—Gross Loss of Dissolved Elements in Streamflow (Output) From 1 Undisturbed and 3 Manipulated Watersheds. Net Loss or Gain to the System is Based on Atmospheric Input (in Precipitation and Dryfall) Minus Output in Streamflow. U.S. Forest Service, Coweeta Hydrological Laboratory, North Carolina (Swank and Elwood, (*93*))**

[Pounds per acre]

| Vegetation and watershed number | Calcium | | Magnesium | | Potassium | | Sodium | |
|---|---|---|---|---|---|---|---|---|
| | Output | Net loss or gain | Output | Net loss or gain | Output | Net loss or gain | Output | Net loss or gain |
| Mature hardwood, No. 18 [1] | 6.2 | −0.7 | 2.8 | −1.6 | 4.6 | −1.8 | 8.7 | −3.9 |
| Coppice, No. 13 [2] | 4.5 | +.7 | 2.4 | −1.2 | 4.1 | −1.2 | 6.1 | −1.3 |
| White pine, No. 17 [3] | 3.7 | +2.2 | 1.5 | −.3 | 3.2 | −.2 | 5.4 | −.3 |
| Grass-to-forest succession, No. 6 [4] | 9.3 | −4.2 | 5.6 | −4.5 | 5.3 | −2.6 | 9.7 | −5.1 |

[1] Oak-hickory-red maple, undisturbed since 1924 or before.
[2] Clearcut twice, 7 and 30 years previously.
[3] 13-year-old plantation, on watershed denuded 14 years previously.
[4] Weeds and shrubs in watershed previously limed and fertilized.

**TABLE 12.—Mean Concentrations in Outflow From Partially Clearcut and Control Aspen Watersheds, Minnesota (Verry (*108*))**

| | Milligrams per liter | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nitrogen | | | | TKN [1] | Total Phosphorus | Calcium | Magnesium | Potassium | Sodium |
| | $NH_4$-N | $NO_3$-N | $NO_2$-N | Organic N | | | | | | |
| Cut [2] | 0.55 | 0.16 | 0.003 | 0.80 | 1.50 | 0.17 | 2.7 | 1.0 | 1.5 | 0.7 |
| Uncut | .41 | .12 | .003 | .85 | 1.39 | .12 | 3.0 | 1.3 | 1.5 | .8 |

[1] Equals total Kjeldahl nitrogen.
[2] Half of aspen area cut before, and an additional amount during 1971 growing season. Differences in element mean values similar to variation during preharvest calibration.

intermixed with the mineral soil, and as a surface humus layer or forest floor on the mineral surface but sharply separated from it. Over much of the United States the forest floor is low in weight in spite of its appearance of thickness, and contains only a fraction of the total nitrogen in the entire soil profile.

In cool humid regions, however, surface organic layers tend to accumulate to much greater depths. Such layers often contain 1,000 to 2,000 pounds of nitrogen per acre, from less than 1 to perhaps 2 percent of the total weight of the layer. Such thick layers develop slowly and their position makes them highly vulnerable to disturbance—cultivation, grazing, fire, or clearing. Only intense fires consume all of such thick layers but fires at intervals reduce accumulation. Typically, these layers shrink in thickness after heavy cutting, though actual weight losses are unknown. And clearcutting, fire, or grazing sometimes lead to greater incorporation of the surface organic matter into the mineral soil.

A full account of soils on the Hubbard Brook watersheds apparently has not been published but they are moderately strong podzols (haplorthods) belonging to the Hermon series. The surface or-

**TABLE 13.—Exploratory Calculations of Chemical Constituents Lost in Water Years "Before" Roadbuilding and Harvesting (October 1964–September 1965), and "After" (October 1965–September 1966). Alsea River Watershed, Oreg. (Marston, from (*104*))**

[Pounds per acre]

| | $NO_3$-N [1] | Total phosphate | Ortho phosphate | Potassium | Sodium [2] |
|---|---|---|---|---|---|
| Flynn Creek: | | | | | |
| Before roadbuilding and logging | 5.4 | 1.19 | 0.41 | 17.5 | 100 |
| Control, uncut | 4.1 | 1.22 | .47 | 13.8 | 75 |
| Deer Creek: | | | | | |
| Before roadbuilding and logging | 5.2 | 1.94 | .97 | 20.0 | 110 |
| After roadbuilding and patch-cut | 3.7 | 5.95 | .75 | 12.2 | 81 |
| Needle Branch: | | | | | |
| Before roadbuilding and logging | .52 | .91 | .53 | 13.1 | 91 |
| After 100 percent clearcut | .61 | 2.60 | .63 | 15.3 | 78 |

[1] Nitrate content of Flynn and Deer Creek attributed to streambank alders.
[2] Proximity to the Pacific accounts for high sodium values.

ganic layer varies between 2 to 6 inches in depth and is strongly acid (pH 4). The nitrogen content, 1,020 pounds of nitrogen per acre, is somewhat more than a fourth of the total in uppermost 18 inches of soil. Dominski's study (*20*) indicates that in the uncut forest about 5 percent of the nitrogen in the surface layer is turned over each year—that is, released by decomposition and reabsorbed—with very little apparent loss. About 20 percent of this turnover appears as nitrate, suggesting a much higher level of nitrification than known for any similar layers under coniferous forest.

As already noted, the denudation treatment eliminated plant uptake of nitrogen, and warming of the soil surface greatly increased decomposition rate above that in the uncut forest. Most of the released nitrogen was converted to nitrate, thus leading to leaching of some 300 pounds nitrogen per acre over the 3-year period of denudation (p. 454). Dominski suggests that at least three-fourths of this came from decomposition of the forest floor, which thus lost 22 percent of its total nitrogen content.

Only a very small percentage of the hardwood forest in the United States contains such a large quantity of nitrogen in the forest floor where it is so easily influenced by accelerated decomposition (fig. 11).

Thick forest floors are more common under northern and western conifers in cool climates. Yet as already indicated, only minor losses of nitrate have followed clearcutting of conifer forests (tables 13, 14, and p. 453). Nitrification rates under conifers are low, in the few examinations made (*10, 11, 109*), in agreement with older Scandinavian investigations. If the implied differences in nitrification rates of hardwood and coniferous organic matter are indeed real, they will be exceedingly significant in understanding nutrient cycles and the potential for loss. Two factors that may bear on such differences are: (*a*) Higher base content of forest floors beneath northern hardwoods, such as those at Hubbard Brook, despite the strong acidity (*12, 57*); (*b*) possible occurrence of nitrification inhibitors such as tannins, as proposed by Rice (*79, 80*), beneath some conifers.

It must be admitted, however, that relatively little is known about nitrification or the fate of nitrates below the surface soil layers. Pennsylvania State University investigators found, as expected, that sewage effluent was stripped of phosphorus and ammonia-nitrogen as it filtered through forest soils. Nitrate-nitrogen concentrations actually increased, from 5.6 mg/l to as much as 11.7, in percolating to the 2-foot depth because of nitrification. But concentrations then dimin-

**TABLE 14.—Gross Loss of Dissolved Elements in Streamflow From Paired Control and Clearcut Old-Growth Douglas-Fir Forests, in the 3 Years After Cutting. Cutover Area Also Slashburned Between 1966 and 1967. U.S. Forest Service, H. J. Andrews Experimental Forest, Oreg. (Fredriksen, (*28*))**

[Pounds per acre]

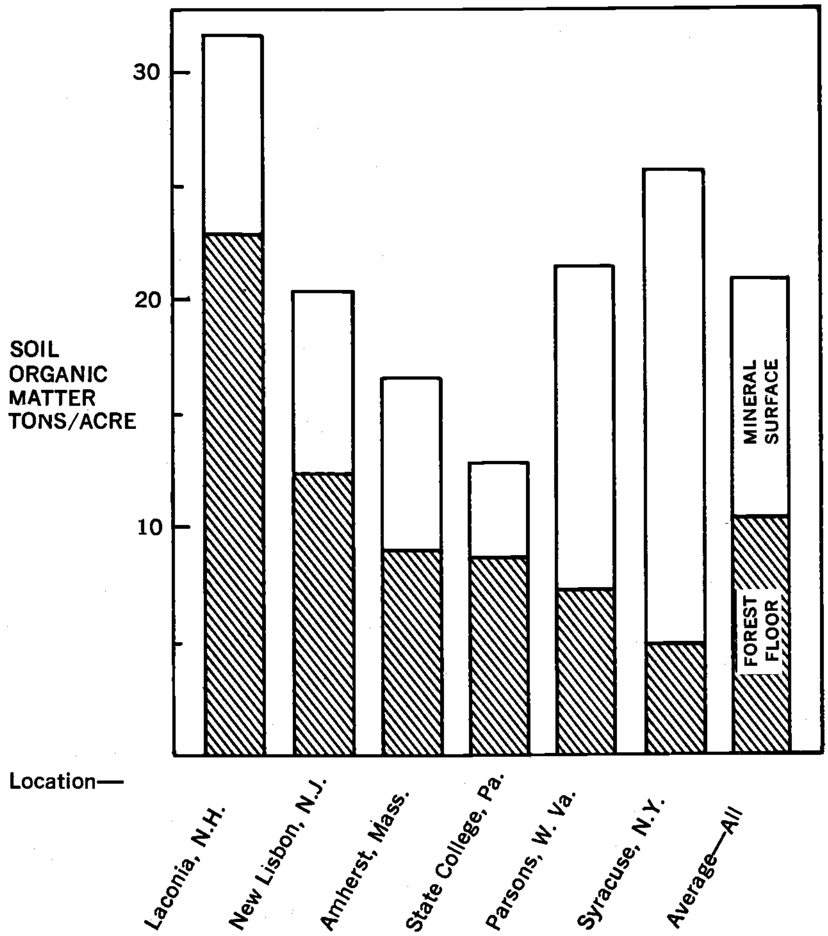
| | Nitrogen | | | Phosphorus | Calcium | Magnesium | Potassium | Sodium |
|---|---|---|---|---|---|---|---|---|
| | $NH_4$-N | $NO_3$-N | Organic N [1] | $PO_4$-P | | | | |
| 1966 Control | ---- | 0.07 | ---- | 0.19 | 24 | 5.0 | 3.0 | 17 |
| Clearcut | ---- | .23 | ---- | .27 | 54 | 14.0 | 4.8 | 31 |
| 1967 Control | 0.02 | .02 | 0.14 | .13 | 23 | 6.7 | 2.8 | 17 |
| Clearcut and slashburned | 1.34 | .62 | 3.4 | .49 | 73 | 23.4 | 5.4 | 32 |
| 1968 Control | .0 | .01 | .14 | ---- | 21 | 4.3 | 1.6 | ---- |
| Clearcut and slashburned | .01 | 2.15 | 1.7 | ---- | 55 | 14.3 | 3.1 | ---- |

[1] Organic nitrogen values are from suspended organic sediment. This sediment also contained small amounts of Ca, Mg, and K additional to those shown.



505-287 O - 73 - 30

FIGURE 11.




The amount of organic matter in the forest floor (black bars) beneath hardwoods varies according to climate, soil and past treatment. Open bars show amounts in only the uppermost mineral soil ($A_1$), not total in mineral profile. Each bar represents an average from 36 stands (12 each of 3 age classes) within a 50-mile radius of the location stand. "Laconia" includes the Hubbard Brook area.

ished downward, ranging from 1.0 to 5.3 mg/l at the 4-foot depth. The reduction did not appear due to anaerobic conditions. In control areas, not irrigated with effluent, nitrate-nitrogen concentrations also diminished with depth (*89*). Thus, it seems possible that nitrate production in the upper soil layers may be countered by other processes at depth, even in apparently well-aerated soils, reducing nitrate concentrations in the outflow.

There remains the question of why losses of nitrate and associated bases from the denuded watershed at Hubbard Brook were so much higher than from commercial clearcuts in the same forest type nearby (fig. 9). Herbicides were not used in the commercial clearcuts, and almost certainly an appreciable number of small trees, shrubs, and ground vegetation remained to provide an incomplete green shade that was gradually thickened by sprouts and new seedlings. Doubtless, this cover developed rapidly and absorbed some of the liberated nutrients. It is unlikely, however, that this small mass of vegetation could have absorbed more than a small fraction of the nitrogen liberated if release had proceeded at the same rate as in the denuded watershed. More probably, shading of the surface by residual and newly developed vegetation reduced average soil temperatures and thus lowered rates of nitrate production. On the other hand, any superficial mixing of surface organic matter along skidtrails with mineral soil would have accelerated decomposition in proportion to the area affected.

What may be concluded from these two studies at Hubbard Brook?

(1) Stream behavior patterns following denudation agree generally with results from similar studies elsewhere, and so extend conclusions already drawn to the New England environment.

(2) Careful chemical analyses of precipitation inputs and stream outflow demonstrate the relatively modest role of atmospheric contributions to the nutrient budget, other than for the elements sulfur and nitrogen. They also focus attention on the solution rates of soil and rock.

(3) Nitrification is a much more vigorous and important process in soils of this region than previously believed. Over a 3-year period it led to loss of some 20 percent of the total nitrogen in a fully exposed forest floor and significant losses of calcium, potassium, and magnesium.

(4) Losses of nitrogen and the other nutrients from harvest clearcuts in the region are much lower than from the experimentally denuded watershed, probably no more than one-third at maximum. The reduction is due to some uptake by the residual vegetation and regrowth, but probably much more to lower decomposition rates in the partially shaded soil.

(5) Nitrate concentrations in the outflow stream from the denuded watershed exceeded the recommended level for potable water by the Public Health Service for most of the 3-year denudation period, and at times were double this level. On the other hand, maximum measured concentrations in stream waters from the commercial clearcuts never exceeded the Public Health Service recommendations. In any case, these concentrations are in small headwater streams which are diluted downstream in proportion to the volume of entering water from other drainages.

(6) The similarity in nitrate leaching patterns from both the harvest clearcuts and the experimentally denuded area demonstrate that the same biological processes are involved, though operating at different intensities. Any management practices that reduce vigor of the residual vegetation or delay regrowth and regeneration—such as scarification, excessive herbicide application, or maintenance of excessive deer herds—could increase loss rates above those observed on the harvest clearcuts. On the other hand, greater surface soil shading, as by partial cutting methods, narrow stripcuts, increased cover density on clearcuts, or any means of hastening regrowth, would reduce losses even more. Fast growing pioneer species, such as pin cherry, can accumulate as much as 125 pounds of nitrogen per acre in the stand biomass within a 4-year period, as well as establishing a dense canopy (*59*). However, nothing is known about the soil temperatures most favorable to root growth and the trade-offs between root growth rate and nitrogen conservation that may be involved.

(7) The effect of nutrient losses on future productivity is wholly a matter of conjecture at present. There are no hard data indicating that stands following clearcutting are any less productive in a biological sense than those developed in partially cut or uncut forests. Pierce et al. (*71*, *72*) argue that losses after clearcutting come from the most available fractions in soil and, therefore, are more significant than quantity alone would imply. Although plausible, at least in the short term, this argument ignores renewal mechanisms other than the small contributions in rainfall. Its validity for these stands is simply unknown. Productivity measurements in second growth stands on clearcut areas could easily test this argument.

(8) The results from both denudation and harvest clearcut treatments are probably directly applicable to other dominantly hardwood old growth forest with similar accumulations of organic nitrogen in the forest floor. Such forests occur elsewhere in northern New England, New York, and adjacent Canada, and in the northern Lake States, but the total area is limited.

It is not yet clear whether the thick organic layers found under many northern and western conifier forests may generate nitrate at a much slower rate after exposure than does the hardwood humus at Hubbard Brook. In view of the usefulness of clearcutting in some conifier stands, this question calls for research.

## OTHER SUPPOSED IMPACTS

### Water Table Rise

Forest canopies transpire water throughout their season of leaf whenever the roots are in contact with moist soil and leaf temperatures favorable to loss. Evergreens use substantial amounts in early spring, before deciduous trees extend their leaves. Tree crowns also intercept a fraction, commonly a tenth or more, of incoming rain or snow, which evaporates without ever reaching the ground. The total yearly evapotranspiration loss from forest cover is generally greater than from other kinds of vegetation in the same climate on similar, nonirrigated soils. Thus, cutting the forest reduces water use and so increases the amount available to the remaining vegetation or moving to streamflow, as shown in figures 1 and 2.

In most landscapes this surplus water is not perceived except through records of soil moisture and streamflow. Our common experience rarely suggests that open fields, pastures, or heavily cut forests are notably wetter than uncut forests nearby. Yet, in certain well-defined conditions of terrain and soil the water unused by forests after heavy cutting accumulates to form ground water tables near the soil surface (*57, 114*). This can take place only in moist climates, on level or gently sloping land where lateral drainage is restricted, and over dense subsoils or already high water tables that prevent downward drainage. In such situations the soils are already ill drained, with seasonal water tables, and the effect of the surplus is simply to increase the degree and duration of surface wetness.

The best known instances are in the cool high latitudes of Scandanavia, Finland, and northern Russia where transpiration is low. Here the increase in surface wetness after clearcutting large areas is aggravated by accelerated growth of sphagnum mosses which inhibit seedling establishment and growth. This complex of conditions has no parallel in the United States except perhaps in some level portions of the northern Lake States. Similar increases in ground water levels are known in eastern Canada, especially in low areas already receiving surplus water from adjacent uplands.

Documented accounts of higher ground water levels after forest cutting are uncommon in the United States, except through attempts to increase water yields by clearing phreatophyte vegetation along stream courses. However, on impervious Bladen soils of the South Carolina coastal plain, Trousdell and Hoover (*101*) found that seasonal perched water tables remained much higher in 200-foot-wide clearcut strips than in the bordering uncut stands of second growth loblolly pine. Similar increases must have occurred at the time of previous cutting but obviously did not prevent regrowth. In Wisconsin, Wilde (*114*) noted a temporary rise in level of a perched ground water table after clearcutting aspen as well as small differences in depth to permanent ground water beneath grass and adjacent forest.

In humid climates, soil patterns on level or gently sloping terrain form mosaics of better and poorer internal drainages. These patterns are apparent on standard soil survey maps, which nevertheless cannot show all intricacies. The wetter portions are marked by either temporary or permanent ground water tables that fluctuate according to season, with sequences of wet or dry years, and with any marked change in vegetative cover. Thus it is certain that forest cutting, except in the smallest degree, will have a greater or lesser influence on water table levels.

But it is equally certain that the sites that will be affected are predictable, and the magnitude of change will be within the limits reached through climatic fluctuations and natural disruptions of the forest in the past. Such soils restrict over-the-ground trafficability. They may well call for different silvicultural treatment than better drained sites to maximize their potential for timber production, recreational value and wildlife habitat. But the likelihood of permanent soil change as a result of cutting alone is very remote. Concern over this possibility might better be directed to the large and permanent increases in ground water levels sometimes caused by large dams and by major highway fills across swamps and drainageways.

### Soil Physical Deterioration

In its formative period American forest management drew heavily upon European views and experiences. Subsequently, on both continents, many of these views have been modified or made obsolete by the rapid pace of scientific and economic change. Some remain as basic truths. Still others persist despite the lack of supporting evidence, or even in the face of much contrary evidence. Among the latter is the notion that certain species of trees lead to speedy and adverse soil changes.

Certain it is that tree species differ greatly among themselves in such properties as canopy density, chemical composition of foliage, and the rapidity and products of litter decay. These in turn gradually influence the processes of soil development.

Though such gradual long-term changes are difficult to measure, several investigators have contrasted the surface effects of different trees on otherwise similar soils. For example, studies in both eastern and western United States have demonstrated that the surface soil beneath two genera of cedars (*Thuya* and *Juniperus*) contains more calcium and is less acid than beneath nearby hemlock or pine. These differences seem due primarily to relative calcium content of the fallen litter (*57*). One comparison indicates that the influence extends to a maximum depth of 1 foot in a period of 400 to 1,000 years (*1*).

Another striking effect discovered in western Oregon concerned 30- to 40-year-old stands of Douglas-fir and red alder, a nitrogen-fixing tree. The organic-rich mineral soil beneath the alder was higher in nitrogen but also more strongly acid (pH 4.3–4.4 versus 5.3) and lower in base content than under the conifer (*27*). Though unexpected, this difference is attributable to the high nitrate production and acid leaching under alder.

Again, a recent French study revealed that temporary water tables (which impair soil aeration) in ill-drained soils were both lower and of shorter duration under conifer stands than under comparable hardwood stands nearby (*50*). Greater rainfall interception and longer season of transpiration by the conifer crowns apparently accounted for the difference.

The studies mentioned above involve demonstrable mechanisms and close attention to the many sources of soil variation. The results also agree with the kinds and rates of change known from other studies of soil development. These characteristics are lacking in the earlier European observations that gave rise to the belief in rapid soil deterioration under spruce.

Even so, the German scientists of that time were far more cautious than the practitioners and, for that matter, than many present-day commentators. This is sad, for the point was well emphasized in a forest soils textbook published in 1946:

In 1925 Wiedemann published a second edition of his 1923 report and took occasion (p. 152) to indicate that the serious deterioration of the mineral soil had been overemphasized in the earlier publication. In his own words, the deeper he went into the question of soil deterioration, the less justification he found for extreme pessimism. Krauss (1928: 351), one of the foremost authorities on forest soils in Germany, stated that it was an exaggeration of the facts to say that the centuries of spruce culture had resulted in a clearly proven general deterioration of the forest soils in the Saxon state forests" (*57*).

In fact, many of the physical differences in soil profiles which the European forester attributed to the impact of spruce or pine were simply the normally occurring variations associated with unrecognized gradations in internal soil drainage. Other differences were the consequences of unknown earlier periods of tillage and soil movement. Both kinds of differences are easily found today in open fields, uninfluenced by contemporary forests. We view them now, however, with a perspective derived from almost half a century of intensive soil mapping and research in soil and land-form development.

A recent Danish review (*41*) points to many such misunderstandings in the earlier European literature. In Denmark, where spruce is not native, average growth of second and third generation plantations almost exactly equaled that of first generation stands. Soil properties appeared unaffected when allowance was made for somewhat higher clay content in the soils in which the first generation occurred (*41*).

Nevertheless, changes in the dominant tree species in forests must lead to some alteration in the structural or developmental features of the soil profile. Such changes are evidently small in relation to normal variability, however, and other modern attempts to describe and quantify them beyond reasonable doubt have made little progress thus far (*85, 112*).

The question of nutrient supply and nutrient depletion in Western European forests is far more complex. As would be expected, inherent nutrient supply rates vary with soil mineralogy, texture and weathering stage. But imposed upon this background are the impacts of a long and immensely varied history of land use, beginning with some intensity at least in Bronze Age times. The treatments included not only cutting, gathering, burning and pasturage, and later charcoaling, coppicing, and litter gathering, but also various forms of cultivation. Among these, as in the southern Appalachians of the United States, some favorable areas were repeatedly cleared, tilled, and allowed to revert to forest, but over a period of two millennia or more, rather than two centuries.

The full extent of this exploitation is commonly unrecognized even by European foresters, but is evident from the cumulative testimony of archeology, written history, and unwritten evidence in the soil itself. From the Middle Ages onward some communities protected the local wood supplies on which they depended. Nurenberg, for example, claims the first conifer sowings in 1368, and Berne codified its forest laws in 1592 (*38, 90*). But such protected or managed forests coexisted with more remote and vastly larger areas on which exploitive or changing land use prevailed into the 19th century, in the face of numerous laws and their intermittent enforcement.

The great development of forest management that began late in the 18th century in Germany thus had for its task the planting of unused open lands and depleted forests as well as regulation of timber cutting and other exploitive uses. The gradual but eventually vast increases in timber resources and watershed protection that followed, despite the prior history of land abuse, are striking evidence of the renovative capacity of forest ecosystems.

Not surprisingly, many soils with physical or drainage limitations were planted to the most valued, rather than best adapted species. Other soils inherently low or exhausted of available fertility could not provide the low but long-sustained nutrient requirements of the new forests. Numerous instances of growth disturbances and retardation occurred, and have attracted much attention. Actually, the concern for these emphasizes the generality of success. The areas of poor growth were diagnosed with the knowledge then at hand and a great variety of treatments were advocated or tried. Among them were different species and mixtures of species. An adequate account of the success or lack of success of these treatments and of the soil factors involved would be lengthy and largely inconsequential here. Modern knowledge of soil science and tree nutrition, and the results of numerous fertilization trials have made obsolete most of the speculation and deterioration literature prior to 1950 as well as some in the years following. One is driven to the conclusion that much of the famed European experience with rapid soil deterioration under conifers has little real meaning in modern Europe and still less in the United States.

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# appendix N

BY WILLIAM L. WEBB [1]

# Timber and Wildlife



## INTRODUCTION

It is unlikely that an absolutely definite statement can ever be made on the relation of timber and wildlife. Absolute conclusions are impossible because of the infinite variability, delicacy, and subtlety of the interplay between the forest—representing environment—and the ecology of wildlife. When hundreds of animal species interact with hundreds of plant species in a multiplicity of geographic locations, climates, geological formations, and soil types, each with a different history of development and use, it is not reasonable to expect either simple or absolute relationships.

This is not to say that little is known of the relationship between forests and wildlife. In fact, a great deal is known. Especially in the past 40 years a great deal of scientific effort has been devoted to the study of forest wildlife ecology. A

[1] The views expressed in this report reflect the views of the author and do not necessarily represent the views of the State University of New York College of Environmental Science and Forestry, nor those of the members of the President's Panel on Timber and the Environment.

significant proportion of that effort has been aimed at elucidation of the effects of man's use of the forest on wild animal species. Many papers have been published in scientific and professional journals reporting the results of this research and investigation.

The purpose of this report is not to attempt a summary and evaluation of all that literature. Instead, an attempt is made to sketch the basic principles which can be derived by careful analysis of that literature. Obviously, some personal judgment is involved in such an endeavor. On most issues the weight of evidence is so great that the general conclusions are not in doubt. On controversial issues where the evidence is not conclusive, a balanced review of the evidence is attempted.

## THE FOREST AS WILDLIFE HABITAT

Forests are unique wildlife habitats. The principal source of this uniqueness is the fact that forests are a three-dimensional environment. That is, they have considerably more height (or depth) than other terrestrial environments. A grassland is essentially a two-dimensional community. It has very little depth because solar energy is converted to organic matter very close to the ground surface. A mature forest, in contrast, intercepts solar energy many feet above the ground and much reduced amounts of light filter through the tree canopy to the ground. This is so obvious a characteristic that its significance is often overlooked in discussion of the forest ecosystem and thus the effects of this third dimension on wildlife is often not understood.

The third-dimensional structure of the forest has both a direct and an indirect effect on wildlife. The direct effect is creation of a great deal of habitat diversity. An ecologist says that a forest has more ecological niches; therefore, it has greater diversity of animal species than many other environments. Many animal species in a forest utilize vegetation growing near the ground in the same way ecologically equivalent species utilize the habitat near the ground in other terrestrial environments. In addition, some animal species are specialized to utilize trunks of trees as their niche. This tree trunk habitat may extend up to several hundred feet above the ground. Woodpeckers, creepers, and nuthatches have anatomical and behavioral characteristics which adapt them to find food and/or nesting habitat along the extended trunks of the trees. Still other animal species are specialized to utilize tops of tree crowns, often very high above ground level. When all these habitat specialists are combined, they are recognized as the animal components of the forest community. Because the forest habitat is diverse, it has many niches and more species than occur in environments with less height and less diversity.

The work of MacArthur and MacArthur (1961) indicates how diversity of plant species affects diversity of animals in a forest community. Their studies suggest that bird species diversity is related more to the height profile of foliage diversity than it is to plant species diversity. Forest stands composed almost entirely of a single tree species have as great a bird species diversity as forests of mixed tree species composition. A few animal species are so specialized that they are restricted to areas where a particular plant species occurs. However, most animal species are not limited to a single plant species but are specialized to exploit the resources of a particular type of place in a community (MacArthur, 1964).

Forest birds are specialists in their feeding habits. Each species is adapted to utilize the energy resources of a particular place in the environment, both with minimal expenditure of time and energy and with minimal competition between species. MacArthur (1958) studied five species of closely related warblers, all in the genus *Dendroica*, living in the same forest stand. All five are of similar size and all are insectivorous. These species reduce competition by concentrating their feeding activity in different portions of the canopy: One species feeds mostly in the lower portions of the canopy, one feeds largely in the middle portions of the canopy, and three species feed largely in the upper portions. Where a vertical overlap in feeding area occurs, a horizontal separation minimizes competition. One of the upper canopy species concentrates on the terminal portion of twigs, another focuses greater attention on the middle portions of branches, and the third concentrates on basal portion of branches near the trunk. In addition, competition between these five species is minimized because each has a different behavior when feeding and therefore tends to capture different species of insects. Also each has slightly different nesting dates which separate the period of greatest food use and this probably helps minimize competition.

The indirect effect of the three-dimensional structure of the forest on wildlife is the distribution of solar energy. Upper portions of the tree crown receive the greatest amount of solar energy, therefore, the amount of photosynthesis and energy conversion there is maximal. Leaves growing below the zone of greatest photosynthesis convert lesser quantities of solar energy to organic material. Reduction in available solar energy continues until in many forests the amount available at ground level is very low. Consequently, almost no vegetation grows on the forest floor under a dense closed canopy.

Usually productivity of animal life is directly related to this energy distribution gradient. However, some animal species are specialized to utilize stored energy in leaves, twigs, seeds, fruits, and buds which drift down from the canopy to the ground. In this respect there is a rough parallel between fauna of the forest community and that of the ocean. In both environments primary productivity is concentrated in a narrow photosynthetic zone where plants convert solar energy to organic material. Organisms living below depend on energy converted to organic matter in a narrow zone which eventually drifts down from above.

Diversity of animals in a community is not solely the consequence of plant diversity. Differences in climate and microclimate, competition between species with similar ecological requirements, predators, and parasites also cause diversity. These factors are at work in forest areas as well as in other type of communities.

Another basic ecological principle is the dynamics and ecological succession of a forest community. All natural communities are dynamic. They change from season to season, from year to year, and from century to century. These changes are especially noticeable in forests because the dominant organisms—trees—are long lived and seem to be "permanent" parts of the environment. But even the longest lived tree is only a temporary occupant of a particular space, and even the most stable forest is subject to constant change. Natural forces (wind, fire, storm, disease, insects) cause even the longest lived tree to die and be replaced in turn. In addition, every forest modifies the environment where it exists by changing soil characteristics and microclimate. In many cases these modifications accumulate and make the environment less suitable for existing vegetation and more suitable for other species. In every region a predictable sequence of communities occupies an area as the dynamic process of ecological succession develops.

These dynamic changes obviously affect animal populations. Loss of a single tree or a group of trees following a windthrow or disease outbreak starts the process of regeneration. Seedlings and shrubs close to the ground become dominant. In the resulting two-dimensional environment, animal species are significantly different from those in the original three-dimensional forest. As the seedlings grow into saplings the third dimension develops, diversity of habitats increases, and the animal organisms of the area again become those typical of the forest before disturbance. Each of the sequential stages of forest succession has its characteristic animal fauna. Major differences in both flora and fauna take place as the pioneer community is replaced to ultimately develop into a climax forest type.

No discussion of the effects of man's operations on forest wildlife can be meaningful unless these basic ecological principles are understood. An appreciation of the direct and indirect effects of the three-dimensional forest structure is vital to an understanding of the forest as wildlife habitat. Understanding the dynamics of ecological succession following forest disturbance is equally important.

## TOLERANCE TO DISTURBANCE

Animal organisms vary widely in their tolerance to environmental disturbance. Some species tolerate little disturbance while others find suitable habitat only following the most severe disturbance. This is another way of saying that every species is an environmental specialist. Some are specialists in utilizing undisturbed forest while others are specialists in utilizing disturbed stands.

When a single tree in a forest dies or is removed there is relatively little effect on the animal organisms of that area. The opening of the crown permits some light to reach the forest floor and results in some increase in vegetation near the ground. This results in increased food production for ground-dwelling species. But loss of canopy reduces food production for species specialized for life high above the ground.

Such a single tree change has a short-term effect. The remaining trees in the stand grow laterally to fill the space, and in a short time tree seedlings responding to the increased light replace the original tree. Such a small disturbance has a temporary and relatively insignificant effect on forest wildlife populations and on species diversity.

Where the disturbance is somewhat greater in size, the effect will be greater and somewhat longer lived. If a group of trees is killed by natural causes or removed by man's activities, the process described above is repeated. Trees on the edge of the area grow laterally to fill the void. Advanced growth and reproduction grow with increased vigor, and in a short time, the dynamics of the forest lead to a regeneration of a forest condition. Again the effects on wildlife are temporary although they may be more evident and somewhat longer lived than where a single tree is removed.

The basic principle is not altered by size of the disturbed area. When a three-dimensional forest habitat is reduced to an essentially two-dimensional environment by removal of tall forest trees, the effect on wildlife is improvement of habitat for those species specialized to live near the ground, but destruction of habitat for species specialized to live in the canopy. Regrowth normally restores the three-dimensional character of the forest in a short period of time. A low canopy is created in the sapling stage, organisms specialized for life in the canopy are soon reestablished, and the community again resembles the one which existed before disturbance.

Therefore, forest management operations can not be judged as good or bad for wildlife unless it is determined in advance which species they are good or bad for. This judgment must be based on habitat requirements of the species of animals involved and also on detailed information about the characteristics of the forest management operation itself. Some of the questions which need to be answered are: What is the nature of the forest management operation? What is the size of the operation? What is the relationship of these to the mobility of the animals? What is happening on surrounding areas since many animals require several habitat types? What is the timing of the operation? How long will effects of the operation last?

Uninformed people often seek prescriptions which will result in simple statements involving "thou shalt" or "thou shalt not" which they believe will prevent undue changes in environment for forest wildlife. This simplistic approach is not reasonable. The forest community is too complex and too variable to allow for such simple prescriptions.

Instead, forest management operations must be planned to create conditions which will achieve specific objectives. If the objective is to produce a habitat where a particular species of animal is abundant, this can be done. If the objective is to create conditions where a wide diversity of animals exists, this also can be achieved. In most cases, general or regional prescriptions will not be helpful in reaching a particular set of objectives. On-the-ground management must be accomplished by detailed knowledge of the specific area in question and the habitat requirements of the animal species desired, leading to development of a management plan which applies to that area alone.

The objective of this report is to try to elucidate the effects of forest management operations on wildlife. Because of the great number of animal species, each of which is a habitat specialist, and the wide variety of forest conditions, it is not possible to derive simple statements which will fit all species in all regions at all times. Instead, a number of examples will be given to illustrate some of the basic principles of wildlife habitat management and show the relation of these to management for timber production. Many other examples could have been chosen. The four selected are intended to show diversity and illustrate a wide variety of problems.

Professional wildlife biologists will recognize that these brief statements are very oversimplified. Only the most generalized outline of the ecology of these organisms and their management is presented. These simple statements are not management prescriptions. They are intended only to elucidate general principles.

## TOLERANCE TO DISTURBANCE

### Timber and Deer

The white-tailed deer is the most widely distributed and most important forest game animal of North America. Deer have high recreation value for both hunting and for viewing. Their economic value is also high since considerable sums of money are spent in their pursuit. In addition, their biological effect is great since deer damage crops and forests where their populations are high. In many areas their selective feeding may change forest composition significantly and result in drastic changes in environment.

As a result of this high value and biological significance, deer have been studied more than any other wild vertebrate species. Technical literature about them is voluminous. Taylor (1956) edited a book of over 600 pages which summarizes the life history, ecology, and management of the white-tailed deer and of the ecologically similar mule deer. Since that publication a flood of technical literature has added additional details, but the major substantive conclusions have not been drastically modified. The oversimplified review of the life history and ecology of deer given here is intended simply to provide a framework for discussion of deer management and the relationship of timber and deer. For the sake of simplicity emphasis is placed on habitat conditions in the northern portion of the range where management is most difficult because of the long, cold, and snowy winters.

The life and times of a northern deer herd can be divided into two seasons: Summer and winter. In the open summer season, life is relatively easy. A wide range of foods is available and utilized. Cover or shelter is not a limiting factor. The primary requisite is an adequate high-quality diet so the animals will gain the weight and vigor necessary to enter the cold season with high-energy reserves.

By contrast, the winter season is harsh for deer. Vegetation is dormant and in the northern parts of the range, low temperature and deep snow are crucial. Cold temperature is a serious factor since intake of food must produce enough energy to maintain body temperature and vigor. Deep snow is often a limiting factor because movement through it requires additional energy output to secure food which is partially covered by snow (Severinghaus and Cheatum, 1956).

Several studies have shown that in winter in the northern part of the range, the primary response of deer is to cover (Webb, 1948; Verme, 1965; Ozoga and Gysel, 1972). When temperature is low and snow is deep, the primary behavior response is to move to the densest cover available. Probably this is an innate response to minimize chilling from low temperature and wind movement; also snow tends to be less deep in dense cover. As a result of this primary response deer tend to concentrate, and these concentration or yarding areas often include as little as 10 to 30 percent of the total summer range.

Studies have also shown that in these concentration areas winter food production tends to be lower than in areas where deer do not concentrate. There are at least two major reasons for this. In areas of dense tree canopy, light penetration to the ground is low and productivity of food plants within reach of deer is low. In addition, food that is produced tends to be over-utilized because of the high number of deer which seek their entire food supply for an extended period on a limited area.

In these yarding areas the situation is often critical. Large numbers of deer are trapped, simply because they find protection from the elements in areas where food supplies are small and heavily utilized. In these areas winter mortality is often high. Throughout this critical period, female deer are carrying fawns which will be born the following spring. Females with limited food supply are known to produce fewer fawns, and young that are born have lower vitality than fawns produced on an area with adequate high quality foods (Verme, 1969; Julander, et al., 1961; Cheatum and Severinghaus, 1950).

This brief account barely outlines the life history and ecology of deer to provide a sketchy framework for understanding the development of management programs which will produce a vigorous deerherd within the carrying capacity of the range.

## Deer Management

Stripped of all detail, deer management must deal with two fundamental and equally important concerns:

(1) *Herd management.*—Management of the deer population so that herd size is limited to the carrying capacity of the range to prevent habitat deterioration. Concern for keeping herd size at or below the range carrying capacity has received a great deal of attention, but is outside the major concern of this report. However, the balance between herd size and carrying capacity is absolutely essential to the success of the habitat management efforts.

(2) *Habitat management.*—Management of the vegetation of the range to maintain and increase carrying capacity; especially to produce adequate high-quality winter foods in, or close to, areas where dense winter cover is maintained.

### Production of Food

Deerfood and the effects of forest disturbance on food are the most studied aspects of deer management. Hundreds of technical papers have been published and many unpublished reports and graduate theses are on file in game department offices and university libraries. Many of these are excellent scientific studies with complex experimental designs, excellent field techniques, and sophisticated statistical analyses. These studies include all types of canopy disturbance: Clearcuts and selective cuts; cutting in blocks, strips, and patches; intermediate cutting, thinnings, and weedings; and use of herbicides as well as the axe. They also treat canopy disturbance in many forest types in all regions of North America; in many forest sites on many different soils; and with cuttings made at all seasons of the year.

Any reviewer of this voluminous technical literature is forced to one conclusion: opening of the forest canopy results in an increase in production of food. This is not a startling conclusion. Earlier it was pointed out that a dense canopy concentrates the photosynthetic zone high above ground level and concentrates stored energy where it is not available to deer or other ground-dwelling species. Opening the canopy allows more sunlight to penetrate to the ground and results in an increase in the amount of stored energy within reach of animals living on the ground. Deer are selective in their feeding habits, but their preferences are fairly broad. Almost without exception the opening of the canopy results in a significant increase in quantity of food produced. Deer foods grown in full sunlight are also more nutritious than those grown in dense shade. Therefore, nutritional quality as well as quantity are significantly improved following an opening of the forest canopy.

### Production of Cover

Cover has been less studied than food production. The reason is probably that cover is not nearly so easy to measure quantitatively. There are enough data, however, in the wildlife management literature and in forestry literature to show how to produce and maintain the dense cover needed for winter yarding.

The principle of cover management is opposite from that of food production. The objective must be to maintain density of crown canopy, particularly of coniferous species. The denser the better! And here lies the paradox in deer management. How can the land produce dense stands needed for winter cover while at the same time food is produced under open crowns on the same limited land area?

### Food and Cover

This paradox is soluble. The key is extremely careful management of the yarding area itself, since maintenance of dense winter cover is paramount. If an entire stand of conifers is heavily cut at one time, deer winter range is eliminated for an extended time period. Eventually the conifer stand will regenerate and grow back to a condition where deer will again utilize the area as a winter yard. During this period when deer are virtually absent, food production is often quite high. However, since deer are absent this food is not utilized.

Selective cutting in the conifer stand usually does not solve the problem because small openings in the crown produce only a slight increase in quantity of food produced. Deer feeding pressure in many yards is so great that all new growth is quickly consumed—sometimes to the point where tree regeneration is prevented.

Clearcutting part of the area in strips or blocks seems the preferred management technique. Parts of the stand are left undisturbed to provide cover while the remainder is cut to produce food. When the logged portion has regrown into a dense cover area, the residual uncut portions may be logged to produce food, and in time, to regrow into cover. Properly designed, this establishes a rotation in the yarding area which correlates food and cover production in serial sequence throughout the stand. This is not a simple technique. One of the difficulties is to prevent overbrowsing of the logged areas during the early parts of the food-producing stage. Where herd size is excessive, that problem is insoluble until the number of deer is brought under control.

It is also extremely important to integrate management activities outside the yarding area. During mild periods when snow is not deep, deer will move out of the concentration area into adjacent forest stands to utilize available food. Coordination of cutting on the yarding area and in adjacent stands is an essential part of a well-devised deer habitat management program. Cutting in stands adjacent to a heavily used yard produces an immediate supply of food since deer browse the tops of felled tree. Shortly after logging, sprout



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growth and regeneration produce a large quantity of browse which deer will move some distance to utilize.

This brief sketch suggests that the major problem in deer management is not lack of knowledge of how to produce good food and good shelter. The real problem is to devise a management plan which times the operations in portions of the stands and in adjacent stands so that good range conditions are maintained in the area at all times. This timing does not always agree with timing of operations designed for timber production alone. Efficient and economical timber management generally requires a continuous harvest operation. Economics usually dictates the logging of an entire watershed or similar logging unit in the same operation. Dividing one stand into several cutting blocks usually results in loss of revenue from timber, but the returns in improved deer habitat are often substantial.

## TOLERANCE TO DISTURBANCE

### The Kirtland Warbler

The Kirtland warbler (*Dendroica kirtlandii*) is one of the rarest of North American warblers. It is one of the 23 species of this genus in North America. Winter range is in the Bahamas and nesting range is an area approximately 60 by 100 miles in the northern portion of the lower peninsula of Michigan. Within this very small range, nesting habitat is limited to areas of sandy soils where groves of young jack-pine 5 to 18 feet in height occur. In these stands ground cover is blueberry, bearberry, and sweetfern. Although nests are built on the ground, the open stands of young pine with living branches near the ground appear to be an absolute habitat requirement. In 1971 a census of known occupied habitat indicated a total population of only slightly more than 400 birds. Details of Kirtland warbler life history and ecology are given in the excellent monograph by Dr. Harold Mayfield (1960).

Management of Kirtland warbler habitat seems simple: maintain open groves of jack-pine between 5 and 18 feet in height with their associated ground cover. Simple perhaps, but requiring a very special kind of management. Prior to arrival of man on the scene, forest fires were the agent which created such stands. With the development of fire control methods, wildfire was virtually eliminated from this area, and some years ago it became evident that the Kirtland warbler would not survive unless man intervened to keep the jack-pine canopy from closing and growing too tall. The U.S. Forest Service, the Michigan Department of Natural Resources, and private citizens of the region cooperated in the development of a management program which has thus far been successful in maintaining suitable habitat and preventing extermination of the species.

Special Kirtland warbler management units have been established within the limited breeding range. The Michigan Department of Natural Resources has set aside over 7,000 acres and the U.S. Forest Service has reserved over 4,000 acres to be managed for this species. Removal of larger trees, controlled burning at appropriate intervals, and planting where needed are management practices being used to establish and maintain the very specific environmental conditions needed for survival of the Kirtland warbler.

In spite of these habitat management efforts, the status of the Kirtland warbler is precarious. A census in 1951 indicated a population of slightly more than 800 birds. This increased to over 1,000 in 1961. However, the 1971 census indicated only about 400 birds, a decrease of more than 50 percent (Reedy, 1971). Reasons for this decline are not known for certain. Part of the reason is undoubtedly that areas outside the special management units have grown too tall and crowns have closed so they no longer serve as nesting habitat. This is not the only reason, however, since at the time of the 1971 census some apparently suitable habitat was unoccupied or not fully occupied. Mortality on the wintering grounds or during migration, nest parasitism by cowbirds, and home construction in some formerly used habitat are additional factors which may have affected the population.

This species is introduced as an example in this report because it illustrates the intensive kinds of management methods that must be developed if certain animal species are to survive. Species with a small range need very special consideration because within that range the special requirements of the species must be provided in suitable abundance and arrangement. Where range is very small and habitat requirements very precise, there probably will always be need to dedicate specific land areas to intensive management to meet habitat requirements of that species alone. In the case of the Kirtland warbler, a substantial acreage must be virtually withdrawn from other uses. Timber production objectives must be either eliminated or drastically altered. Recreational uses also may have to be limited, perhaps even to the extent of restricting human use to a few people interested in observing the species. Concern for management of other animal species must be either eliminated or greatly reduced. In some cases this may require reduction of animal populations which compete with the species of major concern. In the case of the Kirtland warbler the drastic reduction of the cowbird population is undoubtedly justified as a management measure.

In all cases of this kind a very detailed biological knowledge of the ecology, behavior, life history, and physiology of the animal species is required. Equally important is the requirement that sophisticated habitat management methods be developed to create and maintain a suitable environment for the endangered species and thus prevent its extinction. It is not known how many species of animals require such intensive management. Certainly every species given in the "United States' List of Endangered Native Fish and Wildlife"[2] must be considered.

## TOLERANCE TO DISTURBANCE

### Wildlife of a Northern Hardwood Forest

Most animal species occur over a wide geographic range and most are not so specific in habitat requirements as the Kirtland warbler. Therefore, it is instructive to examine a more typical community of animal organisms to illuminate the effects of habitat disturbance on populations and species diversity. The community described in this section includes the birds and mammals of a northern hardwood forest type in the central Adirondack Mountains of New York State.

To form sound judgments on effects of forest disturbance, study of the response of a variety of species is essential. Also those studies must extend over a considerable time period to determine whether the effects are short term or long term in nature. Study of the response of a single species to disturbance has much less significance because a disturbance with a negative impact on one species may have a positive impact on another. In addition the responses must be followed for a considerable time period to identify short term population changes which are quickly overcome as the disturbance is obliterated by regrowth of vegetation.

Relative few long-term studies of effects of disturbance on a variety of animal species are reported in the literature. One of these is a study conducted on the Archer and Anna Huntington Wildlife Forest in the central Adirondack Mountains of New York State. Work was done by faculty and graduate students of the State University of New York College of Environmental Science and Forestry. Data from this investigation are not yet completely analyzed or published. However, sufficient results are available to draw major conclusions.

The study area is continuously forested with the northern hardwood type predominating. The stands are dominated by an overstory composed largely of sugar maple, beech, and yellow birch with an understory of beech. During the late 1800's, portions of the area were logged lightly for conifers. The hardwood vegetation had not been logged until this study was started. Although soils of the area are thin and relatively infertile, the old-growth hardwood trees are impressive in size.

The experiment utilized five separate old-growth northern hardwood stands, each occupying more than 500 acres and each separated from the other stands by a distance of more than one-half mile. One stand was in a dedicated natural area, not subject to disturbance by man. This served as the control area. One stand was logged by removal of 100 percent of the merchantable volume of timber under a contract logging. This left some residual trees standing (cull and smaller diameter trees) but the result was a very drastic opening of the previously closed canopy. The three other stands were logged with cuts of 75 percent of the merchantable volume, 50 percent of the merchantable volume, and 25 percent of the merchantable volume. The results summarized here deal only with comparisons between the uncut control stand and the most heavily cut stand since the intermediate levels of cutting appear to show intermediate levels of response by the animal species involved. Therefore, the comparisons given here are the most drastic possible.

[2] App. D to ch. 1 of the Code of Federal Regulations, Title 50: Wildlife and Fisheries, revised as of Jan. 1, 1972; pp. 61–62. Office of the Federal Register, National Archives and Records Service, General Services Administration. Washington, D.C.: U.S. Government Printing Office.

One of the primary objectives of the study was to determine the effect of logging on populations of insectivorous and other songbirds. More than 70 species of birds occur in this forest during the breeding season. The study continued for an 11-year period. Methods used are outlined in Webb and Behrend (1970). Counts of birds were made during the month of June when singing activity was at its height. Experimental design involved observations by several experienced persons, at several stations in each stand, on several days, and with several replications. Results are expressed in the form of an index so relative frequency of observation on one area can be compared with relative frequency on another.

On the uncut control area no significant trends in populations of the most abundant bird species occurred during the 11-year period. This indicates that the control area, with its stable habitat, had a stable bird population and was an adequate experimental control. A summary of the effects of logging on populations of the most abundant species is given in table 1.

Two of the 12 most common bird species decreased in population as an initial response to logging. Both these species showed an increasing population trend in the years following logging and had largely recovered their former levels when the study was terminated. Five species showed no significant change in population as an initial response to the heavy logging. However, there was an increasing trend in the population of all five of these species in the 11 years following. Logging benefited these species since they were evidently tolerant of the environmental disturbance and apparently found a better habitat in the logged stand during the period of vegetation regrowth. Five other species increased in population immediately following logging and several of these showed a very significant amount of increase. In the 11-year period following logging, four of these five decreased in abundance as the forest regrew and reestablished a low but dense crown canopy.

No experienced ornithologist would find these results particularly surprising. He would expect the decline in Ovenbirds and Black-throated Green warblers since these birds are characteristic of a densely forested environment. Equally he would expect the increase in Redstarts, Chestnut-sided warblers and White-throated sparrows since

**TABLE 1.—Response of Most Abundant Species of Songbirds to a Commercial Clearcut of Mature Northern Hardwood Forest on the Archer and Anna Huntington Wildlife Forest, Newcomb, N.Y. Initial Population Response Indicated by: X=Some Change; XX=Substantial Change. Trends Cover an 11-Year Period Following Logging. Statistically Significant Change at the 5-Percent Level of Probability=*; at the 1-Percent level=****

| Species | Initial response to logging | | | Trend of population after initial response |
|---|---|---|---|---|
| | Increase | No change | Decrease | |
| Ovenbird | | | XX** | Increase.** |
| Black-throated Green warbler | | | XX* | Do.* |
| Red-eyed vireo | | 0 | | Do.** |
| Black-throated Blue warbler | | 0 | | Do. |
| Olive-backed thrush | | 0 | | Do. |
| Woodpecker species | | 0 | | Do.* |
| Scarlet tanager | | 0 | | Do. |
| Redstart | XX* | | | Decrease. |
| Chestnut-sided warbler | XX** | | | Do. |
| Chimney swift | XX* | | | Do. |
| White-throated sparrow | XX** | | | Do. |
| Veery thrush | X | | | Increase. |

preferred habitat of these species is in forest edges and areas with low shrubby vegetation. He would not expect Red-eyed vireos, Olive-backed thrushes and woodpeckers to respond significantly to the habitat alteration since these species occur both in dense forest stands and in relatively open, brushy forest stands. Although this study simply confirms well-known habitat preference information, it does quantify the subjective observations of generations of ornithologists.

More important is the information regarding trends of populations following habitat disturbance. The population trends of 8 of the 12 abundant species increased during the 11-year post-logging period. Clearly these eight species found food, cover, and nesting sites improved as the vegetation regrew. The remaining four species which showed a decreasing trend in population level following logging are those characteristic of low-brush and open-canopy forests. The decline in their numbers is predictable and expected in a habitat where low brush is being replaced by a young closed-canopy forest.

The conclusion can certainly be drawn that even this heavy logging did not adversely affect songbird diversity or numbers. In fact, the evidence supports the hypothesis that the majority of these species was benefited by the logging. If a wildlife manager were charged with increasing diversity and raising population levels of songbirds of this forest type, he would be well-advised to initiate a logging operation which would remove a very substantial proportion of the crown canopy. Lighter cutting would neither produce as great a diversity of bird species nor as great an increase in population density.

If the wildlife manager were charged with producing Ovenbirds, however, he would certainly not recommend clearcutting. On the other hand, if he were charged with producing White-throated sparrows, he would certainly recommend clearcutting. These two species find ideal habitat in opposite management prescriptions.

The conclusion must be drawn that a commercial clearcut in the northern hardwood forest type in the Adirondack Mountains increases bird species diversity, does not permanently reduce the population level of any common species, and increases the population density of most species.

Krull (1963, 1964, 1970a, 1970b) reported on concurrent studies of population densities of other vertebrate species in the same forest stands. Census techniques involved track counts, trapping, dropping counts, strip censuses, and direct observation to determine relative population levels on the uncut control area compared with the heavily logged area. Seven of the eight species of mice and shrews showed no significant difference in population between the control and the logged area. Only one species had a slightly higher population on the uncut area and appeared to be somewhat affected by the logging disturbance. Chipmunks and red squirrels showed no significant difference in population between the uncut forest and the heavily cut stand. White-tailed deer used the uncut area more heavily in winter than they used the cut area. However, total year-round use by deer was greatest on the heavily logged area. The greater use of the control area in winter was attributed to the greater amount of cover during the period of low temperature and deep snow. Populations of ruffed grouse and snowshoe hare were significantly higher on the logged area than on the control. Ruffed grouse populations appeared to be three to four times as high on the logged area, and snowshoe hare populations were nearly as greatly affected.

How widely can this example be extrapolated to other forest types and to other regions? It is likely that this is not an uncommon case. It is reasonable to predict that a heavy crown canopy removal will increase species diversity and raise population levels of many species in many forest types. Following cutting, forest dynamics will promptly begin to alter these consequences and in time the canopy will again close. Ovenbirds will again replace White-throated sparrows.

The logged areas involved in this study were not beautiful following the cutting. In fact, they were as unattractive as a recently cut cornfield. However, animals respond to food and cover, not to esthetic considerations. It should also be pointed out that after a few years even the most heavily cut area had recovered much of its former attractiveness and many of the scars of logging had disappeared.

## TOLERANCE TO DISTURBANCE

### Timber Operations and Fish Habitat

Any disturbance of a watershed may have serious effects on quantity and quality of streamflow and on fish populations in streams and lakes downstream from the disturbance. Since logging is such an obvious environmental disturbance there is good reason for concern regarding effect on water leaving the area.

A substantial technical literature has developed on the effects of logging on streamflow and water quality. This literature is reviewed and evaluated in the paper prepared by Dr. Earl L. Stone for the President's Advisory Panel on Timber and the Environment (app. M). Highlights are presented here followed by a brief discussion of the effects of changes in streamflow and water quality on fish populations.

#### Water Quantity

Forest vegetation has a profound effect on water yield. This quantitative factor in turn has a profound effect on fish habitat. It is well known that the total quantity of streamflow is affected by amount and kind of vegetation present in the watershed. Maximum water yields are produced from watersheds where there is minimum infiltration or transpiration and minimum amounts of vegetation.

Increased streamflow following heavy cutting of forest vegetation has been documented in many studies. In a general way increase in streamflow appears to be proportional to intensity of cut. Conversely, regrowth of the forest following logging reduces water yield in proportion as forest vegetation is reestablished. Total water yield increases are greatest immediately following logging and diminish rather rapidly in the years which follow as vegetation becomes established.

There seems little evidence that changes in total water yield resulting from logging have a significant effect on fish habitat in larger streams. In small tributaries, fish spawning may be affected but the importance is probably not great.

### Regimen

The regimen of a stream is often a much more serious concern than total quantity of flow. If ability of soils to absorb moisture is changed by forest disturbance the result may be surface runoff. This creates flooding conditions at some times and a low flow or dry streambed at other times. Also removal of vegetation may affect the rate of snow melting and thus influence the time of peak runoff. Some studies indicate that these changes are relatively slight, but other studies suggest that runoff in the time immediately following a heavy cutting may result in a significant alteration of regimen.

Evidence suggests that generally the changes in regimen are not as much due to the removal of the trees as to related logging activities. Excessive runoff from logging roads, yarding areas, decking areas, skid trails, and other heavily disturbed areas appears to be the chief cause of changes in stream regimen. Surface runoff from logged watersheds is apparently sharply reduced when vegetation is reestablished, since often within a period of a few years the characteristic prelogging regimen is reestablished.

Changes in regimen may affect fish populations in two ways. During flooding periods, shifting of bottom materials and scouring of fish embryos in streambeds may seriously reduce natality, and survival may be reduced if fishfood organisms are swept downstream by floodwaters. During low water periods, fish populations and food organisms may be reduced because of inadequate streamflow.

In terms of long time effect on fish populations, it is likely that this is not a major concern in very many watersheds. It is clear, however, that attention must be devoted to the proper design, location, and maintenance of logging roads and yarding areas to prevent flooding and the consequent changes in stream regimen. This will be discussed later in this section.

### Water Quality

Logging and related forest operations may have a serious effect on several water quality characteristics. Especially important are changes in turbidity and sediments, changes in dissolved materials present in the water, and changes in water temperature.

*Turbidity and sedimentation*

The effects of turbidity and sediments are of obvious concern in fish management. Turbid water directly affects survival of fish species and also reduces light penetration which influences abundance of fish food organisms. When turbid materials settle out in slack water as sediments, they cover the bottom with an unstable and unproductive layer which may smother fish food organisms and cover gravel deposits used by many fish for spawning.

The evidence available seems quite persuasive that logging roads are the chief source of turbidity in stream water following logging. Studies of hydrology of the nonroad surfaces indicate little change in soil movement following logging except on steep unstable slopes, especially those areas subject to mass movement (Rice, et al., 1972). However, poorly constructed, poorly located, or poorly maintained roads result in serious increase in turbidity and deposition of silt. Vegetation is slow to establish on improperly designed road surfaces, cuts, and fills, and the soil surface remains bare and erosive for a long period of time. Reduction of this problem by proper design and management will be discussed later in this section.

*Dissolved materials*

Release of nutrients from logged areas has not yet been extensively studied, but under some conditions it is clear that nutrient cycling is changed when the forest is cut. Where nutrients are released into streams and lakes there may be important effects on fish populations because of increased nutrient levels and eutrophication. The status of knowledge on accelerated nutrient release after cutting has been reviewed by Dr. Earl L. Stone in his report to the President's Advisory Panel on Timber and the Environment (app. M). He points out that the majority experimental data available indicates that nutrient loss following cutting is not great and is probably not a serious problem.

However, results of recent studies on the Hubbard Brook experimental forest in New Hampshire are in sharp disagreement with findings from other investigations. On Hubbard Brook Watershed 2 all vegetation was cut (but not removed) and regrowth of vegetation was prevented by use of a herbicide (Likens et al., 1970). Under these drastic conditions, release of nutrients into stream water was very substantial: 5 to 45 times the normal release from undisturbed watersheds. The high-nutrient levels, plus the increased solar radiation and higher water temperatures (due to absence of shade) resulted in a dense bloom of algae during summer months while undisturbed streams were essentially devoid of algae.

Treatment of Hubbard Brook Watershed 2 was intended as a very radical and extreme experiment to establish basic hydrological and ecological data. Another study in the same geographic area evaluated the nutrient loss from forest lands recently subjected to clearcutting by "normal practices" (Pierce et al., 1972). Regrowth of vegetation was not prevented as in the experiment on Watershed 2. Records from eight small watersheds were evaluated and compared with nutrient losses from an undisturbed watershed and with data from the devegetated Watershed 2 at Hubbard Brook. Nutrient release patterns from the clearcut areas were similar to those of Watershed 2, but the magnitude of the loss was much less. However, there was apparently some growth of algae in the streams, although this point is not certain from the information published.

Effects of such nutrient releases on fish populations has not been evaluated. Streams in the White Mountains of New Hampshire are relatively low in dissolved nutrients and are not noted for being biologically productive. It is likely that some additional nutrients in these streams would be beneficial to fish because food production would be increased. However, accelerated eutrophication, if continued for an extended period of time, would probably result in undesirable changes in the aquatic ecosystem. Marks and Bormann (1972) indicate that vegetation regrowth probably makes such nutrient dumps a temporary phenomenon.

Further investigation is required before final conclusions can be reached on this important problem. The majority of information available, from several geographic regions, supports the belief that there is no significant increase in nutrient release from heavily cut areas, and that rapid regrowth of vegetation returns the cycling to a steady-state in a short time. However, the data from the New Hampshire experiments indicate that under some conditions of soil, climate, geology, and biology there may be a large release of nutrients following heavy disturbance. Investigation is needed to identify the causal factors and determine how widespread these conditions are. Also investigation is needed to determine the ecological consequences of these nutrient releases on fish and other aquatic organisms.

A related problem is the effect of water storage of logs on water quality. In some regions, logs are stored in water to prevent deterioration in the period between felling and milling. Effects of this practice on water quality of rivers and lakes has been studied recently by Schaumburg (1972) in 3 years of laboratory and field investigation. The general conclusion reached was that "* * * water storage of logs does not have a severe impact on water quality in the Pacific Northwest." Although leachates do contribute organic chemicals to both fresh and salt water they are present in such small quantity that they do not raise oxygen demand significantly. Some of these organic chemicals add color to the water, however, and may be esthetically objectionable. Only trace amounts of nitrogen and phosphorus are found in the leachates so there is probably no influence on rate of eutrophication of the bodies of water. Leachates are relatively nontoxic to salmon and trout fry.

Loss of bark was believed to be the only serious consequence of water storage. In some areas as much as 22 percent of the bark was lost from logs and much of this ended up in benthic deposits. These bark fragments exert an oxygen demand on overlying waters which in some cases may influence biological productivity. However, since benthic deposits naturally contain large amounts of partly decomposed organic materials, the effect of additional bark fragments is not likely to be significant. Schaumburg concludes that water storage of logs would not be a major water quality problem if bark loss were minimized by improved log-handling practices.

Dissolved oxygen is often a limiting factor to fish survival. Rapidly flowing stream water is well oxygenated but water in the spaces between coarse bottom materials where eggs of many fish are deposited and hatched may be low in oxygen. Hall and Campbell (1968) found significant decreases in dissolved oxygen in both flowing water and in intra-gravel water in a stream soon after logging of the surrounding watershed. Although this effect was not long lived, it could have an adverse effect on fish populations. Additional studies appear to be needed on this point.

*Water temperature*

Streams and lakes which are not protected by overhanging vegetation generally are warmer in summer and colder in winter than those which are shaded. The temperature change is often as much as 10° to 15° F (Brown et al., 1971). Such a change may have a serious effect on fish populations since many important species have a limited range of temperature tolerance. For this reason removal of vegetation along streams can seriously impair valuable fish habitat. This is especially true for smaller streams which serve as spawning grounds where removal of shade can warm the small water volumes significantly.

Relatively small amounts of vegetation are adequate to provide shade and prevent excessive increase in water temperature. Buffer strips of uncut forest and maintenance of shrubby vegetation along small streams can usually prevent significant variation in water temperature. These strips also protect streambanks from erosion and serve to filter silt from waters flowing directly into the stream. Logging contracts on most Federal and some State lands require maintenance of such buffer strips. The practice should be extended to private lands as well.

*Logging debris*

The damaging effects of logging debris dropped in streams and lakes has been well documented (Meehan et al., 1969; Brown, 1972). Treetops, branches, and logs left in stream channels prevent movement of fish, create sediment traps in slack water, add organic matter to the water, decrease stability of bottom materials, and increase streambank erosion by deflection of currents. In view of these harmful effects there seems no justification for permitting logging debris to be deposited in any stream or lake.

In many areas regulations have been established to reserve a buffer strip along shorelines to prevent disturbance of streamside and lakeside vegetation and the felling of trees into water. In most cases such regulations are made a part of the logging contract with penalties for noncompliance. In some cases these regulations have not prevented excessive damage because small streams are ignored and because inspection of logging operations has not been effective.

Width of effective buffer strips depends on character of soil, topography, and vegetation left in the strip. Narrow buffer strips, where tall trees are left standing, may be more harmful than beneficial if trees blow down after logging to clog the stream and create unstable banks. Very wide buffer strips may be justified in some cases. The Department of Fish and Game of the State of Alaska has recommended strips 3,000 feet wide on both sides of certain streams important for spawning of the King salmon. The Department believes the precarious status of this species justifies these wide strips.

### Logging Roads

Although logging roads have been mentioned previously, they deserve special attention because many studies show that they are a serious cause of stream deterioration following logging. The technology exists for locating, constructing, and maintaining roads so they will not damage the environment of the watershed (Thronson, 1971). Cost of applying this technology is minimal. This was apparently recognized by the water management committee of the Columbia River section of the Society of American Foresters which in its 1959 statement on recommended logging practices for western Oregon, devoted more than 90 percent of its recommendations to practices which will result in better road location, construction, and maintenance. The "Guidelines for Stream Protection in Logging Operations" written by Lantz (1971) lists only 6 practices for stream protection involving harvesting operations, streamside vegetation methods, and logging operation controls; while a total of 33 practices are listed dealing with road location, design, construction, and maintenance.

### Logging and Fish Populations

It is relatively easy to observe many of the effects of logging operations on streams and lakes because the consequences are tangible and measurable. However, evaluation of the effects of those changes on fish populations is not easy. Changes in fish natality and mortality are not as evident as sediment and slash. Also changes in population may take place some time after logging. Especially for anadromous species, population changes may be the consequence of off-site factors not connected with logging in any way.

There is a temptation to interpret all obvious signs of habitat destruction as deleterious to fish populations. However, all habitat changes do not result in declining populations. In several recent studies it has been shown that salmon populations increased in streams flowing through logged watersheds over a several year period following completion of the logging. Sheridan and McNeil (1968) found an increase in salmon spawners and salmon fry during a 7-year period after logging in two streams in southern Alaska. They believed some of these increases may have been due to changes in the streams not related to the logging operations. However, populations were not drastically reduced in spite of the fact that there was a temporary increase in turbidity and sedimentation. Sheridan, Weisberger, and Wilson (1965) studied 12 salmon streams in Alaska that had been visited immediately after completion of logging operations 14 years earlier, and concluded that none of the 12 streams was producing fewer fish than before the logging took place. In one stream logging had apparently increased stability and productivity by channeling the water and making bottom materials more stable.

It is clear that many stream and lakeshores have been damaged and damaged severely both by logging and road building connected with logging. There is no evidence, however, that such consequences are necessary or inevitable. There is adequate knowledge of how to prevent major deterioration of quality of stream or lake environments. Timber sale contracts on public and private land should be written to specifically require practices such as buffer strips which will prevent shoreline damage. Especially important are proper location, design, construction, and maintenance of logging roads. Where damage results from improper practices severe penalties should be imposed on logging contractors. These penalties might be either enforced restoration of the environment to an acceptable level, or financial penalties severe enough to permit restoration by other agencies.

The guidelines for stream protection in logging operations prepared by the Oregon State Game Commission (Lantz, 1971) and those issued by the U.S. Department of Interior, Federal Water pollution Control Administration, Northwest Regional Office (1970) appear to be concise, practical guidelines which should be acceptable to logging contractors. Such general guidelines are not an adequate prescription for every area and circumstance, however. At times drastic and extreme measures are needed because of the nature of the soil, topography, and vegetation, and in some cases fish species involved must be given special consideration.

This is another case where the only valid conclusion is that no general management prescription is universal. Qualified fishery biologists should be given responsibility for evaluating consequences of logging when logging sales are being planned. They should be responsible for setting a reasonable standard tailored to the particular watershed with full consideration given to local geography, geology, vegetation, soils, physiography, and exposure. When such trained persons are involved in planning and when adequate supervision of logging is provided, there will be little likelihood of serious or long-term deterioration of fish habitat resulting from logging.

## MULTIPLE-USE—TIMBER AND WILDLIFE

Multiple-use forest management—as a concept—is logical and apparently simple. The human mind conceives multiple use as a natural principle since forests naturally produce trees, wildlife, forage, and water. Therefore, it is intuitively recognized that management of forest land should involve all these products and services which the forest is able to provide. However, application of the multiple-use concept is not simple. Difficult judgments must be made on needs for and relative values of the many products and services of the forest. Trade-offs between these products and services requires the judgment of an expert and the wisdom of Solomon.

One fundamental difficulty in inclusion of wildlife in multiple-use management is that the true value of wild animals is impossible to measure in units such as dollars, or pounds, or acres. Timber value can be measured in such tangible terms as board feet, dollars, and jobs; forage value in pounds of livestock or days of grazing; water value in gallons or acre-feet. However, wildlife values are not easy to quantify. Wildlife values are largely unmeasured and immeasurable, except for some related to hunting and fishing. The biological value of wildlife in an organic community is considerable, but nobody has succeeded in stating this value in tangible terms. The recreational and esthetic values of wildlife are understood by many humans, but they cannot be adequately expressed in quantitative terms for comparison with board feet of lumber, tons of forage, or acre-feet of water. As a result there is a tendency to emphasize tangible products and services of the forest in implementing the multiple-use concept.

As a result of the difficulty in quantifying values, wildlife has too often been incorporated in the multiple-use concept with simple prescriptions and cliches. For many years one of these simplified dogmas has been "* * * good silviculture is good wildlife management." This is obviously a "copout." Aldo Leopold, more than 40 years ago (1930), pleaded for an end to the use of such generalized prescriptions in the solution of specific management problems. He pointed out that "progress in any field may be measured by the rate at which generalizations are broken down and reformulated." Wildlife considerations will be adequately included in multiple-use management only when there is an end to the use of broad generalizations to solve complex biological problems. Simple solutions are dangerous because they give the illusion that wildlife considerations are included in the planning when, in fact, the operation is designed to produce a maximum tangible return of one product or service with wildlife simply a byproduct.

On privately owned lands in the United States, wildlife can seldom be justified as a major management objective simply because private landowners can seldom benefit directly from wildlife management investments. This is because wild animals are "owned" by all the people—in their role as sovereign—rather than being the property of the individual landowner. All other natural resources are the property and responsibility of the person who holds the deed. Vegetation, soil, and minerals are private property which can be used as the property owner desires, subject only to minimal governmental control. Wild animals are public property even when they live on private land, and the landowner is very much restricted in what he may do in the use of those animals which occur on his property.

This unique arrangement eliminates most of the incentive for private landowners to preserve, protect, and manage wildlife. Consequently multiple-use management on privately owned forest land will not emphasize wildlife until laws and regulations can be modified so landowners can justify investments, or until public opinion and pressure force the landowner to assume responsibility for a resource from which he does not derive a tangible benefit.

On publicly owned lands there is no such constraint. Timber, forage, water, and wildlife are all the responsibility of the owner; i.e., the Public. Nevertheless, establishment of management priorities is not easy. The Public does not speak as one voice on the question of what products and services the People need and want from publicly owned lands.

In recent years it has become clear that there is increasing public support for inclusion of wildlife in multiple-use management. This support has resulted in an increase in concern by both State and Federal agencies involved in land management. This trend is proper and should be expanded in the next decade. Funding is needed to develop and implement positive action programs which will include forest wildlife as an important management objective.

Even on public lands it is clearly impossible to include the needs of every animal species in a multiple-use management plan. There are too many species, with too many widely differing ecological requirements. As indicated earlier in this report, a practice which benefits one species will be destructive to habitat of others. On all publicly owned forest areas there is need to establish a group of indicator species which are recognized as objectives of the management program for that area.

A well conceived management program would require that these indicator species be at three levels of priority. Highest priority would be given to endangered species. These are animal species whose populations are critically low and which require the most careful management if they are to survive. Endangered species lists are now published in response to an action by the U.S. Congress. Management of these species would have priority over other management objectives. In some cases substantial amounts of land would be dedicated and managed for their exclusive use. The Kirtland warbler is an example of this kind of management objective.

The second level of priority would be given to rare species. These are vulnerable organisms not yet considered endangered. They would be given special attention to prevent their being added to the endangered species list. Generally these are species with very special habitat requirements and often with limited range. The Spruce grouse is an example of such a rare species. It requires conifer stands and is generally believed to prefer dense old-growth forest. However, the only recent study of habitat selection by the species suggests that fairly open younger stands may be utilized (Robinson, 1969). In many regions such stands will eventually be eliminated or very drastically reduced by intensive short-rotation management of conifers for pulpwood production. When that happens the Spruce grouse may be added to the endangered species list. This consequence should be recognized before the crisis moment and some areas devoted to maintenance of Spruce grouse habitat. Spruce grouse management areas should be identified and dedicated to long-rotation management with Spruce grouse as the primary objective and sawlogs as a secondary objective. This does not mean removal of these dedicated areas from timber production. It probably does mean a shift from pulpwood to sawlogs.

At the third level of priority would be the great bulk of animal species of the forest. At this level several indicator species would be designated. Game animals would be among the species chosen, simply because they have been more thoroughly studied and their habitat requirements are better known than for nongame species. However, each group of indicator species should include some nongame species with a range of habitat requirements to insure maintenance and improvement of habitat for a diversity of organisms. At this level of priority, habitat diversity would often be a major management objective. Treatment of extensive areas in a uniform way will result in a relatively monotonous environment. The objective should be creation of diversity of plants and animals to make the environment varied and interesting as well as productive.

A recently announced management program for the Clark and Mark Twain National Forests in Missouri outlines a step forward in multiple-use management for timber and wildlife. The plan results from cooperative effort between the U.S. Forest Service and the Missouri Department of Conservation which will modify timber management procedures and result in substantial improvement in wildlife habitat. The brochure which outlines this management program recognizes that timber production will be somewhat reduced. The authors state "* * * we have to pay for wildlife just as we pay for anything else—and our payments are long overdue." (U.S. Department of Agriculture, 1972.) This management plan has not been put into effect because it will require appropriation of a substantial sum of money. Since wildlife values are largely subjective, the cost-benefit analysis cannot be used to prove that the expenditure is wise. If we could quantify the value of every animal—songbird, fish, mouse, deer, wild turkey—it would probably be evident that the investment was sound.

## CLEARCUTTING AND WILDLIFE

Public concern about the environment has put the issue of clearcutting on the front page, partly for its effects on wildlife. Therefore, it is necessary to face the wildlife-clearcutting issue directly. Most of the concerned citizens seek an answer to what appears to be a simple question: "Is clearcutting good or bad for wildlife?" This question has been considered in several places in this report. The answer is not simple, nor is it possible to give a categorical statement which will be correct for every species in every circumstance. The wildlife biologist must reformulate the question and deal with it much more specifically. He would ask: What wildlife species? What community of wildlife species? What geographic region? What forest type? What site quality? What age and size of stand? What size of clearcut? What shape of clearcut? What relation of clearcut to surrounding vegetation? What forest operations on adjacent areas? What relation of timing of those operations?

Careful reading of the examples given previously in this report will clearly indicate that clearcutting as a wildlife management measure can not be categorically approved for all species, times, and places. Certainly not for Ovenbirds! However, for many species, in many regions, in many forest types, a properly located and timed clearcut will improve wildlife habitat. Since no management practice will simultaneously improve habitat for all species under all circumstances, the "good" or "bad" judgment can never be made as an absolute. Any person who makes such a categorical judgment is relying on emotion, not ecology.

The fundamental difference between clearcutting and selection cutting is a matter of size. Removal of a single tree or a small group of trees is a selection cutting. Removal of all of a large group of trees is clearcutting. Distinction between what is small and what is large is not easy to make, and the source of much controversy.

From a wildlife ecology point of view, clearcutting small areas is generally a desirable practice for many species. Clearcutting a very large area is not generally so desirable a practice. Where the division between small and large lies depends on species, forest type, and region.

Decision on how a harvest cutting should be conducted should not be based solely on whether it is good or bad for wildlife any more than the decision should be made on the sole basis of how the timber can be extracted at lowest possible cost. No simple prescription will fit all situations. The forest is an extremely complex community—infinitely variable and exquisitely responsive to change. If multiple use is more than an empty phrase, many factors must enter into the decision-making process: Wildlife, timber, water, and forage; environmental impact, economics, and esthetics; regeneration and recreation. Minckler (1972), has presented this in an especially lucid article.

## PESTICIDES AND WILDLIFE

The use of chemicals to control unwanted plants and animals has become a major environmental issue. Effects of these chemicals on nontarget organisms—wildlife and man—is a matter of major concern. Discussion of this problem may be divided on the basis of the function of the toxic chemicals: (*a*) Those used to control populations of vertebrate animals—rodents and predators; and (*b*) herbicides, fungicides, and insecticides which may affect wildlife which ingest the chemicals with their food.

On February 8, 1972, a major step was taken in the long controversy regarding propriety of use of poisons to control predators. On that date the President of the United States issued an Executive Order barring the use of poisons for predator control on public lands. The Environmental Protection Agency has also suspended and canceled registration for the major chemicals used for predator control (Council on Environmental Quality, 1972). Eloquent support for this action is contained in the President's message on the environment (Feb. 8, 1972):

> Americans today set high value on the preservation of wildlife. The old notion that the only good predator is a dead one is no longer acceptable as we understand that even the animals and birds which sometimes prey on domesticated animals have their own value in maintaining the balance of nature.
>
> The widespread use of highly toxic poisons to kill coyotes and other predatory animals and birds is a practice which has been a source of increasing concern to the American public and to the Federal officials responsible for the public lands.
>
> Last year the Council on Environmental Quality and the Department of the Interior appointed an Advisory Committee on Predator Control to study the entire question of predator and related animal control activities. The Committee found that persistent poisons have been applied to range and forest lands without adequate knowledge of their effects on the ecology or their utility in preventing losses to livestock. The large-scale use of poisons for control of predators and field rodents has resulted in unintended losses of other animals and in other harmful effects on natural ecosystems. The Committee concluded that necessary control of coyotes and other predators can be accomplished by methods other than poisons.
>
> Certainly, predators can represent a threat to sheep and some other domesticated animals. But we must use more selective methods of control that will preserve ecological values while continuing to protect livestock.

The same principles apply to the control of rodent populations. It seems likely that in the near future a similar step will be taken to prevent the widespread use of rodenticides except under unusual circumstances.

As a result of the DDT debacle the general public has become apprehensive of all chemical treatments and there is growing suspicion that all declines in animal populations are caused by reckless use of inadequately tested chemicals. Evidence indicates that some chemical pesticides can be used effectively without causing serious environmental consequences. Conversely some chemicals cannot be used because of their adverse effects on the complex organic community. The use of pest control chemicals has been extensively reviewed by Dr. David M. Smith in his report to the Panel (app. L).

Two basic requirements must be met to avoid another DDT-type disaster. The first is to require that all chemical agents be tested carefully and thoroughly before they are widely used in control programs. The second is that all applications of tested chemicals be made carefully to prevent misuse and overuse. The testing program is especially important to the ecology of wildlife. In addition to studying effects on target organisms, the testing program must determine the effect on other living organisms besides the target species. It is especially important to know whether a chemical compound is cumulatively toxic to other organisms and whether it is selectively accumulated in particular organisms because of their food habits or physiology.

A number of recent studies have indicated how these investigations should be conducted. The work of Giles (1970) is a good example. His study covered an extended time period and involved use of radioactive tracers and the censusing of a large number of animal species, from simple organisms living in the soils to highly evolved species of vertebrate animals. When such information is available it becomes clear whether the chemical treatment has an impact on wildlife and wildlife habitat.

Pest management without use of toxic chemicals holds much promise for the future (Holcomb, 1970). This involves such strategies as use of predators and parasites and the disruption of reproduction by use of pheromones. A few of these methods are already in use and others are at the stage of pilot testing in the field (Beroza and Knipling, 1972). Development of such methods will require substantial research support and will take time to develop and test because the control is species-specific. Also it is likely that such strategies will always involve greater cost than the use of inexpensive broad-spectrum chemicals such as DDT.

## FIRE AND WILDLIFE

It is easy to predict that the next controversy—or one of the next—will be the use of fire as a forest and wildlife management tool. Objections are already being heard on use of controlled burning (prescribed burning) because the smoke contributes to air pollution. Since these fires are intentionally set by man, some uneasy citizens see this as thoughtlessness which contributes to unnecessary pollution of the atmosphere. Prescribed burning does contribute to air pollution, although the amount and significance is not known (Komarek, 1970).

If prescribed burning is prohibited, forest management will lose an extremely valuable tool. In many areas fuel accumulations will greatly increase the hazard of wildfire (Dodge, 1972). Prohibition of prescribed burning would also mean loss of a very valuable wildlife management method. Properly used (right time, right place, right intensity), a prescribed burn has great value for improving habitat for a number of animal species. The Kirtland warbler population would be seriously jeopardized if burning were prohibited. That species evolved as a part of the post-fire community. Without fire it would soon be extinct. This is an especially dramatic example, but it is not unique.

Fire is used to improve and maintain habitat of many animal species. The pioneering work of Stoddard (1932) on use of fire to improve habitat for Bobwhite quail is well known. His research led to development of highly sophisticated management in many parts of North America, and for many species loss of this valuable tool would be unfortunate.

Perhaps the only thing that can be hoped is that emotion will not be the basis for the decision on the propriety of prescribed burning when that issue comes to center stage of public concern and debate. Certainly air pollution is a major environmental problem. However, as in all complex matters there are many sides to the question. The judgment needed to resolve this issue must be whether advantages outweigh disadvantages. When properly used, prescribed burning has tremendous advantages and the air pollution disadvantage is of lesser importance.

## RECOMMENDATIONS

1. *The Federal Government should significantly increase its involvement in research and management of forest wildlife.*—The people of the United States—in their collective role as sovereign—are the sole owners of wild animals, whether those animals occur on public or private lands. This is a unique public responsibility. All other natural resources are the property and responsibility of the landowner and can be used as the owner desires, subject only to minimal governmental control. The trees of a forest, for example, belong to the property owner, while the animals of that forest are public property owned collectively by all citizens. Strict State and Federal laws and regulations control uses of all wildlife and leave property owners no responsibility and little authority except by controlling trespass.

This unique ownership arrangement requires that Government agencies (representing all the People) assume full responsibility for wildlife regardless of whether that wildlife lives on publicly or privately owned land. Federal involvement is especially important because many animal species migrate across State and national boundaries. These animals are the responsibility of all citizens of the Nation, not those of a particular State or region.

Federal involvement should be especially expanded in the finance and conduct of wildlife research on nongame species. In the past, wildlife research has been largely limited to research on game animals and sport fish. This was justified because the funds were derived from special taxes on hunters and fishermen; fees collected by the States for hunting and fishing licenses, and the Federal excise tax on sporting arms, ammunition, and fishing tackle. Because American hunters and fishermen paid these special taxes, the funds have been properly used for research on game animals and sport fish. Very little money has been available from either State or Federal sources for research on nongame species. This must be changed to build scientific knowledge of the ecology and management of nongame species to provide a database for sound conservation programs involving the entire ecosystem.

In addition to encouraging and conducting research, Federal Government agencies must work with State governments to seek ways to encourage private landowners to protect and manage wildlife—both game and nongame. New approaches are needed to provide property owners an incentive to maintain and create habitat for publicly owned animals living on private land. This is vitally important for endangered species. In addition, attention must be given to species which are rare or which have special habitat requirements so they do not become endangered.

2. *Rare and endangered species of wildlife must be given highest priority in planning and execution of land use programs.*—Prompt and affirmative action must be taken by Federal agencies to acquire or withdraw specific areas from all other uses to preserve the habitat and protect populations of rare and endangered species. In some cases these dedicated land areas must be used exclusively for management of rare and endangered wildlife, with all other uses being eliminated. For other species of wildlife, not currently classified as rare or endangered, specific concern must be devoted to maintenance of environmental conditions to prevent excessive alteration of habitat or reduction of populations which may result in a species becoming rare or endangered.

3. *On Federally owned forest lands each agency must be responsible for development and execution of a wildlife management program which includes both game and nongame species.*—Objectives of management programs should include a wide spectrum of animal species. They must include, but not be limited to, those which have direct and tangible value for commercial or recreational uses such as hunting or fishing where the animal is captured and consumed in the process of use. Equal emphasis must be given to the management of animal species which are valuable for nonconsumptive purposes; that is, where the use is for recreational, esthetic, or biological purposes and the animal is not captured or consumed in the process of use. These nonconsumptive uses have long been ignored. In the future they will be of much greater significance.

4. *Wildlife management programs on Federal lands must be positive in nature and not be limited to preventing habitat destruction.*—Simply preventing excessive destruction of habitat is not enough. Forest management plans must include positive action programs designed to create and improve habitat which will maintain and increase diversity of wildlife populations. These plans must be based on the most complete and detailed ecological data available. Simple prescriptions are not acceptable. For example, the dictum—good silviculture is good wildlife management—is not an adequate response.

Federal agencies involved in forest land management must develop closer cooperation with State government agencies both in planning and execution of wildlife management programs. This cooperation is often hampered by State laws and regulations which prevent application of sound management principles. The executive and legislative branches of the Federal Government should take leadership to seek new relations between State and Federal agencies which will result in improved coordination and cooperation leading to resolution of these complex political issues.

5. *The concept of multiple-use management must be strengthened by recognition that generalized management prescriptions do not result in adequate on-the-ground management programs.*—Because of the large number of organisms classified as wildlife and the diversity of their habitat requirements, no universal prescriptions regarding good or bad land use practices or techniques are possible. There are few—if any—"thou shalt" or "thou shalt not" regulations which can be prescribed to fit all, or even a majority of situations.

Instead it is necessary to develop a specific prescription for each unit of land which will create and maintain habitat conditions for a wide variety of wildlife species, and which will maintain populations at a level where those species will not be threatened with extirpation or extinction.

Inclusion of wildlife in multiple-use management requires establishment of specific indicator species as management objectives. Highest priority must go to endangered species which often require dedication of land to maintain habitat for that species alone. Rare species often require special management consideration where other management objectives are subordinated. In the majority of areas, diversity of wildlife populations should be the management objective, and the group of indicator species selected must represent a wide variety of habitat requirements.

6. *Impact of forest management operations on wildlife should be carefully considered along with impact on other aspects of environmental quality.*—Chemical treatments of forested land may have significant effects on wildlife populations because in some cases the herbicide and pesticide compounds are concentrated in specific portions of the food chain in the biological community. Before chemical treatments are used their effects on the entire plant and animal community must be thoroughly studied. Only those treatments which can be shown to have no long term or cumulative detrimental effects should be authorized for large-scale application.

Harvest logging, intermediate cuttings, controlled use of fire, and other forest management tools affect all of the forest community. They can and must be used effectively to "construct" and maintain wildlife habitat to make the forest environment more interesting and more valuable.

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BY PANEL STAFF [1]

# Forest Recreation: An Analysis With Special Consideration of the East



[1] Acknowledgement is due Mr. John Milton who prepared the material relating to "Eastern Forest Recreation and Land Use Conflicts" while a member of the professional staff of the Panel, March–June 1972. The remainder of this paper was prepared by several staff members after Mr. Milton left to commence his fellowship at the Woodrow Wilson International Center for Scholars, Washington, D.C. The staff authors assume responsibility for the contents of this report. The analyses, interpretations, conclusions, and recommendations expressed are not necessarily those of the President's Advisory Panel on Timber and the Environment.

The objective of this paper is to evaluate the current recreation supply-demand situation as it relates to use of public forest land. A recreation inventory is compiled from Bureau of Outdoor Recreation published sources. This inventory encompasses statistics on recreational land acres, activities, and ownerships. Demand is analyzed by considering trends and projections in recreation activities, user attitudes, and economic indicators. The constraints on recreation supply are discussed in terms of competing uses for a limited land base. The timber supply and outdoor recreation debate will be dealt with in an effort to identify practical approaches that help to resolve it.

A serious obstacle to increasing the Nation's supply of timber is the rising demand for outdoor recreation. A resolution or minimizing of the competition for use of national forests is necessary to insure the needed flow of wood products over the next three decades. This report also deals with the opportunity to increase public recreation on industrial and other private lands and the constraints involved in achieving this. The imbalance between public recreation lands, mostly in the West, and population concentrations, mostly in the East, will be dealt with. The concept of a recreational network or matrix linking many types of public and private lands is presented.

## IMPORTANCE AND SCOPE OF FOREST RECREATION

Outdoor recreation occurs primarily on forest or wooded land. Neither extensive grassland nor extensive desert are popular unless water is present or special scenic features are the major attraction. It is trees that lend character to the landscape, provide shade from the midday sun, shelter from wind, and provide a vertical component to an otherwise two-dimensional habitat for wildlife, thereby adding variety and enhancing the pleasure of visitors.

### Outdoor Recreation Surveys

#### Outdoor Recreation Resources Review Commission

In 1962, after 3 years of study, the Outdoor Recreation Resources Review Commission (ORRRC) reported its findings to the President. The report, based on 27 study reports, laid the foundation for a comprehensive national outdoor recreational policy. The first part of the report described the role of outdoor recreation in America, the demand, the resources available and the economic and social importance of outdoor recreation. Finally, the report discussed future outdoor recreation needs and made recommendations to meet those needs.

The ORRRC report defined the role of both the public and private sectors in meeting the outdoor recreation needs of the Nation:

> The private sector of the economy can play an important role in allowing the use of private lands, under proper safeguards, for such activities as hunting and fishing, and also by providing recreation facilities of varying degrees of elaborateness from simple picnic grounds to luxury hotels and dude ranches. Our national policy should encourage private enterprise to provide outdoor recreation opportunities and services whenever feasible * * *.

Government, the Commission reported, has three basic responsibilities: (1) To insure either directly or in cooperation with the private sector, that Americans have access to the outdoor environment and an opportunity to benefit from such activities as enjoyment of scenery and wildlife, picnicking and hiking; (2) to recognize the importance of recreation in the management of its own lands; and (3) to preserve certain outstanding resources for future generations. The report also suggested roles for each level of government in supplying outdoor recreation.

### Public Land Law Review Commission Report

The Public Land Law Review Commission (PLLRC) report was published in 1970 after 7 years of study built on the work of the ORRRC with respect to recreation. It recommended that the ORRRC recommendations be fully implemented as they related to the public lands. The PLLRC report briefly summarized the policies and programs that have emerged as a result of the ORRRC report and made 11 primary and 39 secondary recommendations of its own in its chapter on "Outdoor Recreation."

A great deal of controversy surrounds the PLLRC report. It focuses on whether or not the report favors economic exploitation of public land natural resources by private industry. The National Resources Council of America has criticized the report, publishing its views in an analysis entitled "What's Ahead for Our Public Lands." However, it states:

> In general, the chapter on October Recreation is one of the better chapters in the report. The chapter is well prepared, it reflected reasonable understanding of the problems faced in administering the recreational aspects of public lands, and it is possible to subscribe to the majority of the recommendations.

### Nationwide Outdoor Recreation Plan

The Bureau of Outdoor Recreation is in the process of writing the nationwide outdoor recreation plan that is required by law. The plan will build on and update the 1962 Outdoor Recreation Resources Review Commission Report. It will reconsider the role of the private sector and of each level of government in meeting the Nation's outdoor recreation needs. The supply-demand studies associated with the plan will show the number of persons that can be expected to participate in selected outdoor recreation activities at several specific cost levels. The major thrust of the plan will be directed toward providing outdoor recreation opportunities close to where the people live and work. A 5-year nationwide policy for outdoor recreation based on a ranking by priority of the Nation's outdoor recreation needs will also be established.

## Recreation Supply Inventory

Table 1 shows the areas of both public and private land by regions that are available for outdoor recreation as inventoried by the Bureau of Outdoor Recreation. Public recreation lands dominate the supply picture with 490.5 million acres, approximately 94 percent of the total inventory. Federal ownerships comprise 91 percent of this public ownership. These lands include all national forests and selected public domain lands. While national forests and Bureau of Land Management land is available for outdoor recreation, in reality most of it does not meet the current needs of most of the outdoor recreationists and thus is not used primarily for recreation purposes.

Total private lands encompass approximately 30 million acres (table 2). Approximately 72 percent of it is located east of the Rocky Mountains whereas only 15 percent of the Federal lands is in the East. In terms of the total recreation supply inventory (public and private), only 18 percent is east of the Rocky Mountains. The remaining 82 percent is located in the mountain (55 percent) and Pacific (27 percent) regions.

The Bureau of Outdoor Recreation (BOR) classifies public recreation lands into six categories (table 3). The high density and historic and cultural categories occupy only a small fraction of

## TABLE 1.—Recreation Lands, 1965

[In thousands of acres]

| | Total | Total private | Total public | Federal [1] | State | County and local [2] |
|---|---|---|---|---|---|---|
| North | 46, 375 | 5, 394 | 40, 981 | 18, 598 | 19, 412 | 2, 921 |
| South | 50, 203 | 16, 250 | 33, 952 | 23, 232 | 10, 177 | 543 |
| Mountain | 285, 387 | 5, 623 | 279, 764 | 277, 010 | 2, 454 | 299 |
| Pacific | 138, 579 | 2, 758 | 135, 821 | 127, 726 | 7, 658 | 437 |
| U.S. total | 520, 544 | 30, 025 | 490, 518 | 446, 616 | 39, 701 | 4, 201 |

[1] Includes selected BLM lands and all national forest lands.
[2] Includes most municipalities with 50,000 or more inhabitants in 1960, approximately 33 percent of those with 25,000 to 50,000, and approximately 15 percent of those with 10,000 to 25,000.

NOTE.—Because of rounding, details may not add to total.

Source: Department of the Interior, Bureau of Outdoor Recreation.

## TABLE 2.—Private Lands Devoted to Various Recreation Activities, 1965 [1]

[In thousand acres]

| Primary activity | United States | North | South | Mountain | West |
|---|---|---|---|---|---|
| Swimming beach | 111 | 73 | 13 | 2 | 22 |
| Picnicking | 332 | 154 | 119 | 14 | 45 |
| Nature study | 1, 023 | 316 | 570 | 21 | 116 |
| Hunting | 33, 830 | 1, 806 | 10, 489 | 2, 395 | 160 |
| Golf | 628 | 421 | 87 | 33 | 45 |
| Camping | 1, 724 | 198 | 1, 356 | 149 | 21 |
| Ice skating | 213 | NA | NA | NA | NA |
| Sledding | 31 | NA | NA | NA | NA |
| Skiing (snow) | 21 | NA | NA | NA | NA |
| Playfield | 109 | 71 | 13 | 18 | 7 |
| Archery range | 19 | 12 | 5 | 0. 3 | 2 |
| Lodging | 80 | 47 | 18 | 2 | 10 |
| Organized camps | 198 | NA | NA | NA | NA |
| Shooting range | 130 | 8 | 3 | 1 | 1 |
| Field trials—dogs | 88 | NA | NA | NA | NA |
| Air activities | 36 | NA | NA | NA | NA |
| Points of interest | 22 | NA | NA | NA | NA |
| Drive-in movie | 18 | 10 | 3 | 2 | 3 |
| All other | 487 | 77 | 26 | 304 | 58 |
| U.S. Total | 30, 025 | 5, 394 | 16, 250 | 5, 623 | 2, 758 |

[1] Components may not sum to totals due to independent estimation of United States and regional data, to incomplete data, and to rounding of figures.

Source: Department of the Interior, Bureau of Outdoor Recreation.

## TABLE 3.—Distribution of Public Recreation Areas by Class and Region 1965 [1]

[Percent by region]

| Region | Total | High density | General outdoor | Natural environment | Outstanding natural | Primitive | Historic and cultural |
|---|---|---|---|---|---|---|---|
| North | 100. 0 | 1. 1 | 14. 1 | 79. 6 | 1. 1 | 3. 6 | 0. 5 |
| South | 100. 0 | 1. 2 | 17. 5 | 72. 8 | 2. 6 | 5. 5 | . 3 |
| Mountain | 100. 0 | . 1 | 4. 3 | 80. 5 | 5. 6 | 8. 9 | . 6 |
| Pacific | 100. 0 | 0 | 3. 3 | 80. 2 | 3. 6 | 12. 3 | . 6 |
| U.S. total: | 100. 0 | . 2 | 6. 4 | 80. 6 | 3. 9 | 8. 5 | . 4 |

[1] Includes selected BLM lands and all national forest lands.

Source: Department of the Interior, Bureau of Outdoor Recreation.

the total public recreation land base. The natural environment category dominates in all regions with approximately 80 percent of public recreation land in this category.

### Outdoor Recreation Demand

The fact that most outdoor recreation areas are open to public use for no charge or at most a nominal fee permits us only a rough estimate of demand in the economic sense of how much would be purchased at a given price. However, use statistics do give an indication of the popularity of outdoor recreation and the urge of a substantial proportion of the people to engage in it.

Table 4 includes BOR statistics on use of private recreation facilities. The statistics show that approximately 60 percent of the private recreation facilities were underused in 1965. Presumably a fee to cover the cost of providing the facilities was charged the users in this case.

While similar figures are not available for public lands, it can be assumed that the majority of these lands may also be underused since three times more public than private land exists in the East, but these lands receive only about twice the visits. However, such an assumption should be refined by considering the type of uses made of the public lands, land intensive or extensive use, the distribution of use within the region and the inflated acreages due to the nature of Forest Service and Bureau of Land Management data. Unfortunately detailed statistics are not available.

**TABLE 4.—Outdoor Recreation Use, by Region and Land Ownership, 1965** [1]

| Region | Use in thousands of visitor days | | | Degree of use of private lands (percent) | | |
|---|---|---|---|---|---|---|
| | All lands | Public lands | Private lands | Underused | Overused | Used to capacity |
| North | 2, 229 | 1. 4 | 0. 8 | 66. 3 | 9. 3 | 24. 4 |
| South | 868 | . 6 | . 2 | 55. 4 | 22. 4 | 22. 2 |
| Mountain | 253 | . 2 | . 1 | 67. 2 | 7. 5 | 13. 6 |
| Pacific | 615 | . 5 | . 1 | 62. 9 | 6. 7 | 25. 6 |
| U.S. total | 3, 966 | 2. 8 | 1. 3 | 62. 4 | 13. 5 | 24. 1 |

[1] Inconsistencies in totals are due to rounding of figures.

Source: Department of the Interior, Bureau of Outdoor Recreation.

A different classification of recreation areas and their uses is given in table 5. Two interesting observations may be made from this table: The national forests account for approximately four times the number of visitors as the national parks; and the State parks account for more than half of all visitor use, inasmuch as the preponderance of State parks are located in the East. This points to the importance of having recreation areas located within travel distance of population centers. It also indicates that much visitor satisfaction is realized from lands subject to relatively heavy use. For example, in 1970 each acre of national forests accounted for but 0.8 visitor days of use; corresponding values for national and State parks were 3.2 and 48.0, respectively.

Further evidence of the popularity of areas established and administered for park and recreation use is afforded in table 6. It also shows the im-

**TABLE 5.—Large Outdoor Recreation Areas and Their Use, 1970** [1]

| Type of area | Number | Area thousand acres | Number of visits (millions) |
|---|---|---|---|
| National parks (1) | 35 | 14, 464 | 45. 9 |
| National monuments (1) | 85 | 10, 223 | 16. 0 |
| National recreation areas (1) | 13 | 3, 809 | 11. 5 |
| National forests (2) | 154 | 219, 826 | 172. 6 |
| Wilderness areas (3) | 85 | [2] 10, 258 | 5. 8 |
| Wildlife refuges (4) | 320 | 29, 000 | 18. 0 |
| State parks (5) | 3, 202 | 7, 352 | 354. 8 |
| Total | 3, 894 | 284, 674 | 624. 6 |

[1] Prepared by Neil Stout, USDI, Bureau of Outdoor Recreation for use by Hardy L. Shirley in "Forestry and Its Career Opportunities," 3d edition, McGraw-Hill Book Co., New York, 1973.
[2] 9,925,000 acres included in national forests. Remainder in wildlife refuges.

Sources: (1) National Park Service; (2) Forest Service (visitor days); (3) Wilderness Society and Forest Service (visitor days); (4) Bureau of Sport Fisheries and Wildlife; and (5) Bureau of Outdoor Recreation (data as of 1967).

portance of forests and natural resource areas as the second and third most rapidly growing in popularity by users.

These three types of areas together receive approximately 90 percent of total public visits, excluding data on municipalities. Between 1960 and 1965, public recreation use increased 52 percent. Park and recreation, and historical agencies showed the smallest increases: 37 and 32 percent, respectively. Indicative of the trends between 1960 and 1965 is the fact that all agencies experienced large increases in recreational use—a reflection of rapidly increasing demand. Participation percents within the four regions of the country are fairly uniform indicating no distinct trends in demand by region (table 7). Instead, the demand for rec-

**TABLE 6.—Visitation at Public Recreation Areas by Type of Administering Agency, 1960 and 1965 [1]**

| Type of agency | 1960 thousand visits | Percent of total | 1965 thousand visits | Percent of total | 5-year increase (percent) |
|---|---|---|---|---|---|
| Park and recreation | 367, 906 | 48 | 503, 043 | 44 | 37 |
| Forest | 118, 719 | 16 | 192, 362 | 17 | 62 |
| Fish and wildlife | 24, 027 | 3 | 36, 032 | 3 | 50 |
| Natural resources | 191, 596 | 25 | 296, 716 | 26 | 55 |
| Historical | 3, 646 | 1 | 4, 823 | (2) | 32 |
| Other | 54, 011 | 7 | 118, 874 | 10 | 120 |
| Total | 759, 905 | 100 | 1, 151, 850 | 100 | 52 |

[1] Municipal data not available.
[2] Less than 0.5 percent.

Source: Department of the Interior, Bureau of Outdoor Recreation.

**TABLE 7.—Percent of Population 12 Years and Over Participating in Selected Activities**

| | United States | | By region—1965 | | | |
|---|---|---|---|---|---|---|
| | 1960 | 1965 | North | South | Mountain | Pacific |
| Bicycling | 9 | 19 | 20 | 17 | 21 | 18 |
| Horseback riding | 6 | 10 | 10 | 8 | 14 | 13 |
| Playing outdoor sports or games | 30 | 41 | 44 | 32 | 43 | 48 |
| Fishing | 29 | 33 | 29 | 39 | 37 | 34 |
| Canoeing | 2 | 4 | 4 | 3 | (1) | 3 |
| Sailing | 2 | 3 | 3 | 2 | (1) | 5 |
| Other boating | 22 | 26 | 27 | 23 | 25 | 30 |
| Swimming | 45 | 49 | 50 | 42 | 41 | 60 |
| Water skiing | 6 | 7 | 6 | 6 | (1) | 9 |
| Camping | 8 | 14 | 10 | 11 | 33 | 29 |
| Mountain climbing | 1 | 1 | (1) | (1) | (1) | (1) |
| Hiking | 6 | 9 | 8 | 6 | 19 | 13 |
| Walking for pleasure | 33 | 51 | 53 | 42 | 56 | 62 |
| Birdwatching | NA | 6 | 6 | 4 | (1) | 8 |
| Wildlife and bird photography | NA | 2 | 2 | 2 | (1) | 3 |
| Nature walks | 14 | 16 | 15 | 11 | 21 | 25 |
| Picnics | 53 | 60 | 62 | 52 | 68 | 66 |
| Driving for pleasure | 52 | 59 | 61 | 51 | 68 | 66 |
| Sightseeing | 42 | 54 | 55 | 45 | 62 | 67 |
| Attending outdoor sports events | 24 | 42 | 42 | 38 | 46 | 45 |
| Attending outdoor concerts, plays | 9 | 14 | 14 | 9 | 17 | 18 |
| Hunting | NA | 13 | 12 | 15 | 18 | 10 |
| Ice skating | NA | 9 | 15 | 2 | (1) | 4 |
| Snow skiing | NA | 4 | 5 | (1) | (1) | 6 |
| Sledding | NA | 13 | 18 | 5 | 12 | 13 |

[1] Indicates insufficient sample size.

Source: Department of Interior, Bureau of Outdoor Recreation.

reation appears to be a function of absolute population size and its concentration within the various regions.

Thus when analyzing recreation demand the primary indicator to consider is population. Consumers create demand. Bureau of the Census figures indicated that the U.S. population increased 13 percent between 1960 and 1970 (table 8). While this increase is lower than that of 1950 to 1960, it indicates that zero population growth will not be a reality in the near future. Department of Commerce projections indicate continued population growth with an increase of 11 percent by 1980 and an increase of 31 percent by 2000 assuming the series E, the lowest level, projections. Under series B the increase by 1980 and 2000 would be 12 to 58 percent, respectively. This projected growth in the population is a prime prognosticator of increasing demands for outdoor recreation in the future.

Another indicator of future demands for recreation is the location of the population. In 1970, 82.9 percent of the population was located east of the Rocky Mountains. This is a slight decline from 1960 and would indicate the westward migration of the total population. However, it also indicates the intense recreation pressure that can be expected on the eastern land base. In terms of urban versus rural population, the urban segment of the population has increased from 64 percent in 1950 to 73.5 percent in 1970 (table 9). This urban migration indicates an increasing need for recreation facilities in and close to the large urban centers.

Future recreation demands must also be considered in terms of national wealth. The wealthier a nation becomes, the more money its population has to spend on the nonnecessities of life such as recreation. Per capita GNP increased 153 percent between 1950 and 1970 (table 10). In terms of disposable personal income the increase was 144 percent. In 1950, 5.8 percent of personal consumption expenditures were for recreation and these expenditures increased to 6.3 percent by 1969 (table 11). Along this same line, the average workweek of nonagricultural production workers declined 7 percent between 1950 and 1970 (table 12). These facts indicate a population which has more money to spend and more time to enagage in recreation. These trends are expected to continue in the near future.

Given the trends outlined above and several other indicators not considered in this brief discussion, the Bureau of Outdoor Recreation projected participation occasions of the population, 12 years and over, for selected summertime activities (table 13). These projections indicate that recreation participation will increase 56.4 percent between 1965 and 1980. Between 1980 and 2000 the

**TABLE 8.—U.S. Population, 1960–70**

[In thousands]

| | 1960 | Percent | 1970 | Percent | Percent increase (1960–70) |
|---|---|---|---|---|---|
| North | 96, 296 | 53. 7 | 105, 577 | 52. 0 | 9. 6 |
| South | 54, 973 | 30. 7 | 62, 798 | 30. 9 | 14. 2 |
| Mountain | 6, 855 | 3. 8 | 8, 284 | 4. 0 | 20. 8 |
| Pacific | 21, 198 | 11. 8 | 26, 526 | 13. 1 | 25. 1 |
| U.S. total | 179, 322 | 100. 0 | 203, 185 | 100. 0 | 13. 3 |

Source: Department of Commerce, Bureau of the Census.

**TABLE 9.—U.S. Population, Urban and Rural—1950, 1960, and 1970**

| | 1950 | Percent | 1960 | Percent | 1970 | Percent |
|---|---|---|---|---|---|---|
| Urban | 96, 847 | 64. 0 | 125, 269 | 69. 9 | 149, 325 | 73. 5 |
| Rural | 54, 479 | 36. 0 | 54, 054 | 30. 1 | 53, 887 | 26. 5 |
| Total | 151, 326 | 100. 0 | 179, 323 | 100. 1 | 203, 212 | 100. 0 |

Source: Department of Commerce, Bureau of the Census.

**TABLE 10.—U.S. Per Capita Income, 1950, 1960, and 1970**

[Current dollars]

| | 1950 | 1960 | 1970 |
|---|---|---|---|
| Gross national product | 1, 877 | 2, 788 | 4, 754 |
| Personal income | 1, 501 | 2, 219 | 3, 900 |
| Disposal personal income | 1, 364 | 1, 937 | 3, 334 |

Source: Department of Commerce, Office of Business Economics.

**TABLE 11.—Recreation Personal Consumption Expenditure, 1950, 1960, and 1970**

| | Percent of total consumption expenditure | Per capita expenditure |
|---|---|---|
| 1950 | 5. 8 | $74 |
| 1960 | 5. 9 | 108 |
| 1970 | 6. 3 | 179 |

Source: Department of Commerce, Office of Business Economics.

**TABLE 12.—Average Weekly Hours of Production Workers on Private Nonagricultural Payrolls, 1950, 1960, and 1970**

| | Average weekly hours |
|---|---|
| 1950 | 39. 8 |
| 1960 | 38. 6 |
| 1970 | 37. 1 |

increase will be another 66.3 percent. These projections reemphasize the fact that recreation demand will be increasing substantially between now and the year 2000.

The BOR recreation survey of 1965 reported five major reasons given by people for not participating in desired summer activities. First, 29 percent reported that they had insufficient leisure time. The declining average length of workweek appears not to have satisfied fully the demand for leisure time. Second in importance with 22 percent reporting, was inadequacy of facilities and resources, distance from home, or crowded conditions. This is unfortunate when the supply date of table 4 indicate considerable underuse of facilities. The central issue brought out was the need for increased recreation supply near the population concentrations.

For 19 percent of respondents lack of skill, age, problems of health or physical condition, or fear of participating, were listed. These reports emphasize that greater variety in recreation opportunities is needed to meet the demands of a diverse population. Lack of money and lack of equipment were the last two reasons given, comprising 12 to 10 percent, respectively, of respondents. Here the trends in national wealth appear to be reducing these two problem areas. The central issue is again making recreation opportunities and facilities available to all segments of the population.

**TABLE 13.—Projected Participation Occasions of Population 12 Years and Over for Selected Activities, 1960–2000**

| | 1965 participation occasions | Percentage increase | | |
|---|---|---|---|---|
| | | 1960–65 | 1965–80 | 1980–2000 |
| Bicycling | 467 | 104. 8 | 32. 1 | 39. 4 |
| Horseback riding | 77 | 40. 0 | 44. 2 | 61. 3 |
| Playing outdoor games or sports | 929 | 96. 0 | 71. 6 | 84. 4 |
| Fishing | 322 | 23. 9 | 31. 1 | 36. 0 |
| Boating | 220 | 38. 4 | 75. 9 | 79. 3 |
| Swimming | 970 | 44. 4 | 72. 3 | 78. 5 |
| Water skiing | 56 | 43. 6 | 121. 4 | 108. 9 |
| Camping | 97 | 61. 7 | 78. 4 | 89. 6 |
| Hiking | 50 | 47. 1 | 78. 0 | 78. 7 |
| Walking for pleasure | 1, 030 | 82. 0 | 49. 4 | 67. 7 |
| Nature walks | 117 | 19. 4 | 47. 9 | 58. 4 |
| Picnics | 451 | 61. 7 | 48. 1 | 53. 0 |
| Driving for pleasure | 940 | 7. 8 | 51. 4 | 50. 8 |
| Sightseeing | 457 | 59. 2 | 54. 3 | 65. 8 |
| Attending outdoor sports | 246 | 43. 0 | 43. 1 | 52. 0 |
| Attending outdoor concerts, plays | 47 | 74. 1 | 70. 2 | 80. 0 |

Source: Department of the Interior, Bureau of Outdoor Recreation, Outdoor Recreation Resources Review Commission.

If the recreation demand indicators are correct the constraints on demand will become less important in the future. The demand projections for recreation can probably be considered conservative even if population growth rate is overestimated.

Another factor that may have to be taken into account will be the changing recreation demand resulting from an older population. The closer the United States comes to zero population growth, the older the median age will become. It is now about 28 years. Under zero population growth, it would be about 37. This could result in quite different recreation needs than are reflected currently.

## Forest Recreation Continuum

Outdoor recreation actually constitutes a continuum from walking the dog in a city park to



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exploring the most remote regions of the Brook Range in Alaska. So forest recreation varies from stopping at a developed campsite having such modern conveniences as electrical, water, and sewage outlets for a modern motor camper to backpacking through the Bob Marshall Wilderness Area (table 14). A great many people seem to be best satisfied with a well developed facility with an attendant in charge to whom they can go for information and help. Paths are desired by most people, even those who visit wilderness areas. Evidence exists, however, that a growing number of people are coming to appreciate simplicity in outdoor recreation activities. This is exemplified in figure 1, in which visits to unimproved areas appear to be growing at a very rapid rate compared with visits to developed picnic sites and campgrounds. After all there is much satisfaction to be gained by stepping aside from a woodland trail a few yards to sit on a stump while looking for birds and other wildlife or meditating and enjoying solitude. If such a visitor leaves no litter behind him, one may use the same stump the next day unaware that it has ever served another. It is in this broad middle ground area that most of the values of solitude and wilderness can be enjoyed by the reflective visitor even though he recognizes that man has come before and left his mark on the land. Man's mark in fact can be just as constructive on forest land as it is on agricultural land or on city architecture. Studying how the forest responds to man's constructive care may be just as rewarding in the long run as trying to understand how nature plants, nourishes, destroys, and recycles forests in her own, often heavyhanded way.

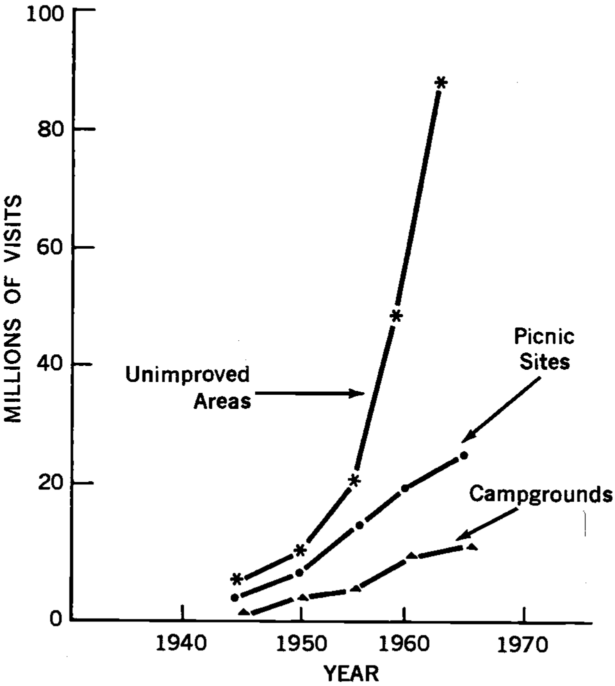
It is for such an understanding approach of man to his environment as he modifies nature to supply his own needs that Pulitzer Prize winner, Rene

**TABLE 14.—Recreational opportunities as a continuum from high density to primitive types**

| | *HIGH DENSITY* ←— | | ——→ | *LOW DENSITY PRIMITIVE* |
|---|---|---|---|---|
| Space requirements | Ratio of participants to acreage usually high at a specific time | | | Ratio of participants to acreage must be low over a period of time |
| Ownership | Activity on both public and private lands | Public acquisition of near natural land owned by forest industry and other private owners | | Activity usually limited to public land due to large costs of land acquisitions and the abundance of land in a natural condition |
| Participant interaction | Simultaneous participation permitted or desirable | | | Simultaneous participation minimized |
| Participant [1] | Activity A | | | Activity Z |
| Demands and objectives | Challenge A | | | Challenge Z |
| | Social interaction | | | Solitude |
| | Nature appreciation A | | | Nature appreciation Z |
| Aesthetics | Landscaping may be permitted or desirable | | | Natural environment only |
| Timber harvesting | Permitted if shielded by buffer zones | | | Not permitted |
| Sites and facilities | High development necessary or desirable | Moderate development | Primitive only | None |
| Cost of development and maintenance | Usually high | | | Usually low but maintenance dependent on intensity of use |
| Access | Easy | Moderately difficult | Generally difficult | Very difficult |
| Mode of transportation | Autos and common public transportation | 4-wheel drives, trucks, and campers | Special aerial trams | Primitive horse, canoe and foot |
| | Snowmobiles and trail bikes ——→ | | | |
| | Motorized boats and canoe ——→ | | | |

[1] Recreational opportunities as a continuum from high density to primitive types . . . note subscripts A and Z indicate important differences in types of activity.

FIGURE 1.—Recreational visits to National Forests by type of area.




Source: "Dispersed Versus Concentrated Recreation as Forest Policy", (Lloyd, R. Duane and Fisher, Virlis L., Oct. 4–18, 1972. Published by the Forest Service)

Dubos, so eloquently argues in his recent writings. Dubos and Barbara Ward pursue this theme, for example, in the book "Only One Earth" prepared for the 1972 Stockholm Conference on the Environment. Surely mankind has far more to gain by following the philosophy of Dubos and Ward rather than that of the doomsday-minded ecologist who can foresee ahead nothing but ultimate destruction of the productive capacity of our planet by man's use of it. Man has used the forests of the United States intensively in the past and will be obliged to do so with increasing intensity in the future if he is to enjoy living in comfortable houses and having the advantages available through generous use of wood products. The total land that can be reserved under the Wilderness Act will have to be limited though it can be greater than at present. But certainly man can gain much of the solitude and the opportunity for reflection, meditation, and communion with nature in forests managed for timber just as well as he can in wilderness. Thoreau, John Burroughs, and Aldo Leopold did so, and they each used sawn wood to construct their wilderness retreats.

## FOREST MANAGEMENT AND RECREATION

The tolerant-minded forest manager finds the sharp debate between the timber industry on the one hand and the wilderness preservationists on the other to have a large element of irrelevance. The forest resources of the United States are generous enough to provide far greater timber supplies than the Nation now uses and at the same time to make substantially greater use of forests for recreation than currently is the case. Wilderness withdrawals now total about 15 million acres or 2 percent of the total forest area of the Nation; but the impact of this withdrawal on timber for industry is much less than that. Approximately half of the land so far withdrawn has been steep mountainous land that is marginal or submarginal for commercial timber production in any case. Considerable additional areas of the same type can be withdrawn for wilderness use without significantly interfering with timber production. At the present time only 4 percent of the productive forest land of the United States is reserved for purposes other than timber production. Likewise, relatively little land on which timber harvesting is excluded has been set aside in the East for forest recreation and the same is true in Europe. Yet, the forests in both cases are used extensively by the public for recreation.

The forest manager fully recognizes the desirability of forests being used for recreation along with other multiple-use purposes and recognizes also that conflict in use need not be serious. It does however, require some degree of understanding on the part of the public and willingness on the part of the forest manager to be patient with the public as he communicates how the forest functions as a biologic community producing both timber and recreation opportunity.

Increasingly the forest industries are adopting the attitude that their lands should be made available for legitimate public recreation activities and they are opening their lands for such use. The forest industry is however confronted with obstacles that tend to restrict it from making all the lands available for recreation use. On industry owned land, damage from fires, whether carelessly or maliciously set by public users, vandalism and other forms of misuse are the main deterrents restricting opening lands to recreationists. Such misuse probably could be minimized provided fees sufficient at least to cover the cost to the landowner of making the land available for public recreational use were charged for recreational use on both public and private lands. Merely keeping a record of names of visitors and car licenses and having a custodian on the property does much to discourage misuse. Private owners have been reluctant to impose fees as long as nearby public areas are open at no fee or at most a nominal one unrelated to the cost of the services the public enjoys.

Industry spokesmen have expressed fears of the growing recreation use of national forests. They believe timber use is not as clearly defined by either administrative regulation or law on the national forests as are other uses; as a result land available for timber use seems to the industry to be constantly whittled away by recreation and other special uses. They would like to see some assurance that interest in the timber supply from national forests be adequately protected.

The continuum concept of forest recreation which was treated earlier, however, would seem to offer plenty of area for compromise and adjustment; fortunately the land base of the Nation is still adequate to accommodate both types of demand. Actually we still have but limited firm data available on what it is the public does seek in forest recreation and how it reacts to various types of timber use. Some ideas in broad terms are emerging as students of forest recreation develop research approaches to recreation needs and use. For example, some of the thrills enjoyed and annoyances encoutered by canoeists are revealed in table 15. However, the greatest opportunity for reconciling outdoor recreation with forest use lies in continuum concept of forest recreation permitting large numbers of people to be accommodated with but limited withdrawal of highly productive land for exclusive recreational use (table 14).

## FOREST RECREATION IN THE EAST

The Nation, with over 520 million acres of land for outdoor recreation (more than half of which is forest land), has roughly 2 acres for recreational use per inhabitant (table 1). This is a generous allowance by any standard. It is only when we look at the regional situation that the imbalance appears. Eighty-two percent of the recreation lands are located in the Rocky Mountain region and west of it, whereas 83 percent of the people live east of the Rockies. As has been repeatedly emphasized, it is people who need access to outdoor recreation lands and people that determine demand and use.

**TABLE 15.—Canoeists' Attitudes Toward Their Trip**

| High point mentioned [1] | Canoeist interviewed (percent) | Low point mentioned [1] | Canoeists interviewed (percent) | Improvement suggested [1] | Canoeists interviewed (percent) |
|---|---|---|---|---|---|
| Rapids | 34 | Litter | 16 | Clean up litter | 24 |
| Scenery | 24 | Too many people | 9 | Leave natural | 21 |
| Camping | 11 | Obstructions to canoeing. | 7 | Remove canoeing obstructions. | 11 |
| Tipping over | 8 | | | | |
| Companionship | 7 | Rowdy or drunk canoeists. | 5 | More intermediate facilities. | 5 |
| Nature | 7 | | | | |
| Solitude | 5 | Not enough rapids | 4 | More campsites | 2 |
| Swimming | 5 | Insects | 3 | Limit private development. | 2 |
| Clean, cold water | 5 | Too few or poor campgrounds. | 3 | Control erosion | 1 |
| Narrowed stream | [2] 5 | | | | |
| Eroding banks | 4 | Intermediate facilities | 3 | More sand beaches | 1 |
| Obstructions | 4 | Tipping over | 2 | Limit canoes | 1 |
| Watching other canoeists | 2 | Stronach Dam | [2] 1 | Remove Stronach Dam | [2] 1 |
| Stronach Dam | [2] 2 | No reply | 47 | No reply | 35 |
| No reply | 26 | | | | |
| Total comments [3] | 118 | Total comments [3] | 53 | Total comments [3] | 68 |

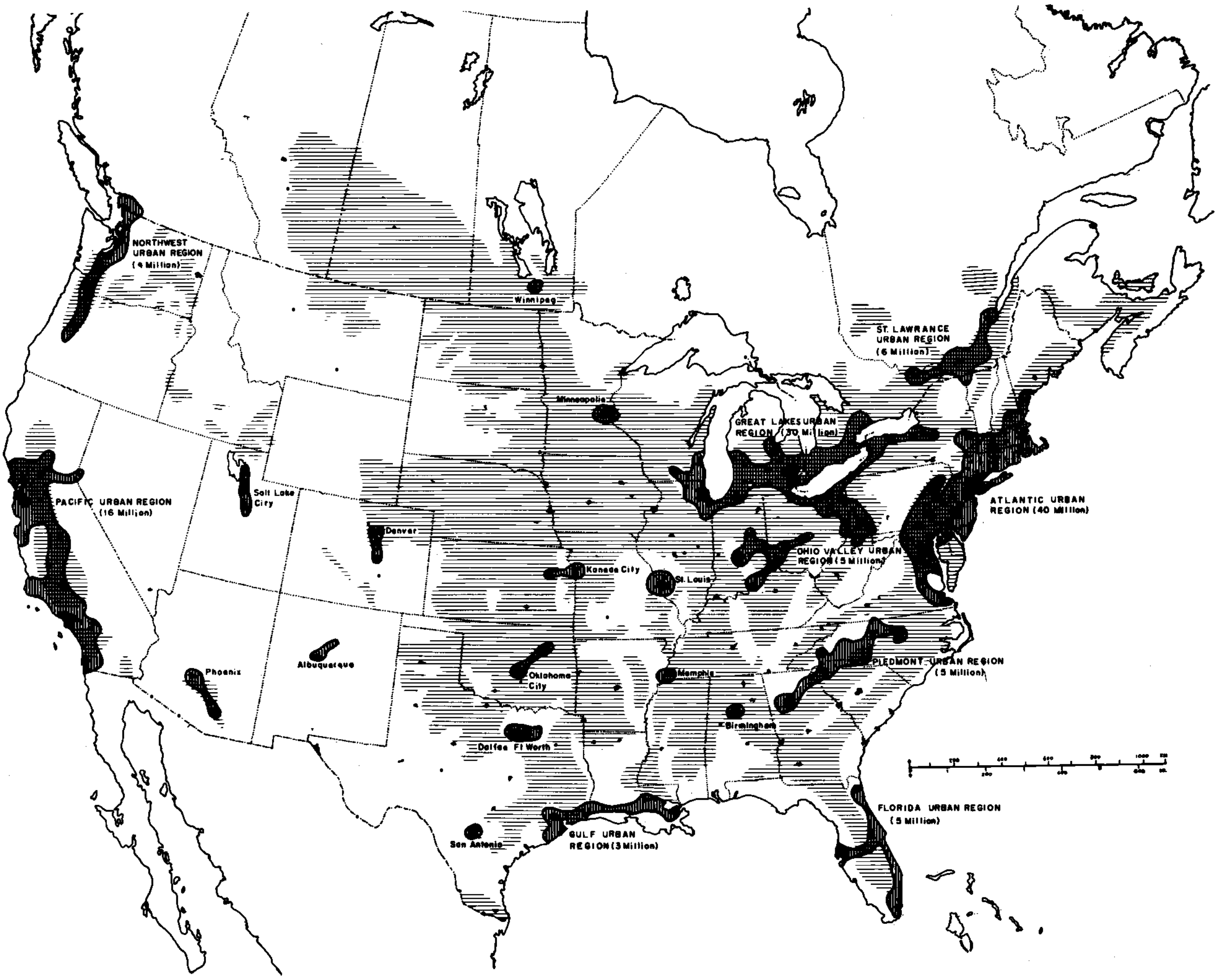
[1] All items mentioned by 2 percent or more of the canoeists are shown. Only selected items are shown that had less than 2 percent response.
[2] Based only on responses from canoeists who passed these features.
[3] Some respondents listed several items under "high points," "low points," or "improvements."

Source: USDA, Forest Service, Solomon, Michael J., and Hansen, Edward A., Paper NC-77, 1972.

## Population Features of the East

Perhaps the overriding and critical feature of concern with those lands east of the 100th meridian is the size and concentration of the human population. Map 1 graphically portrays the relative national concentration of urbanization in the East. The Nation's two largest urban regions are the Atlantic urban region stretching from extreme southeast Maine to Norfolk, Va. (containing approximately 50 million people), and the Great Lakes urban region the reaches from the west shore of Lake Michigan across to Detroit, Cleveland, Pittsburgh, and Buffalo (containing approximately 35 million people). Lesser urban areas include the St. Lawrence urban region (8 million people), the Piedmont urban region (7 million people), the Gulf urban region (4 million people) and Florida urban region (7 million people). These impressive population aggregations are all the more significant when compared to the rest of the Nation. The only other two significant urban regions are along the Pacific coast. California's Pacific urban region now contains approximately 20 million people and the Northwest urban region adds about 6 million.

**MAP 1**




**Major urban regions of North America: black indicates densely urbanized areas and dark crosshatching the areas of their immediate influence; horizontal shading shows the main agricultural areas.**

From: Tunnard, C. and B. Pushkarev. 1963. *Man-made America: Chaos or Control.* New Haven: Yale University Press, p. 37.

## Eastern Recreation Demand

In all cases, these urban areas are focal points for recreational demand; the greatest outdoor recreational demands come from those who live in these intensively developed areas and who require recreational sites for daily, weekend, and vacation use. A number of experts have analyzed rising outdoor recreational demand and found it closely correlated to increasing leisure time, rising per capita incomes with improved income distribution and greater mobility. Another factor that may now also be contributing to accelerated demand is the heightened cultural consciousness of environmental quality and a widespread desire to get away from it all. In this case, "it all" seems to be the cities and suburbs.

Demand is particularly intense for daily and weekend recreation sites. Daily sites are limited largely to parks and open space within the cities and suburbs. Weekend use allows an expansion of the recreational range to within 3 or 4 hours driving time from the major urban centers. Several new factors will in all probability contribute to an expansion of this weekend territory. First, with the gradual adoption of the 4-day work week (see Doughty, 1972), it will become possible to drive 6 or more hours for a 3-day weekend; also, demand within the 3-hour core area can be expected to grow intense. Second, as the World War II "baby boom" generation enters its most economically productive period over the next 20 years, mobility, income, and weekend outdoor recreation demand can probably be expected to accelerate as this relatively large population begins to affect overall recreation demand. Lastly, vacations in the future will probably be longer; this will also tend to increase demand, particularly for prime recreational areas of high quality: national parks, wilderness areas, wild rivers, scenic trails, and national recreation areas and seashores.

In the East, due to its relatively high concentration of urbanites, total recreational demand will probably be the highest in the country relative to available areas.

## Eastern Recreation Land Supply

The supply of recreational land is low in the Eastern States in comparison with that in the Western States. Urban and State park and forest lands are in relatively good supply in the East. Several of these States, particularly Florida, Georgia, Maine, Massachusetts, Michigan, Minnesota, New Hampshire, New York, Pennsylvania, Vermont, and Wisconsin have considerable land used for recreation under State ownership. Another important category in the East is privately owned recreation and second-home land. A significant amount of recreation in this region occurs on such privately owned and managed sites.

The land in shortest reserved supply in the East is high-quality national park, wilderness and wild river land. Map 2 shows the remaining U.S. wilderness areas, defined as sites over 5 miles from the nearest railroad, highway, or navigable commercial waterway. Some of Minnesota, Wisconsin, New York, New Hampshire, Maine, and a few areas in Pennsylvania, West Virginia, North Carolina, Georgia, Florida, Louisiana, and east Texas are all that remain unroaded in the East. By contrast, substantial acreages of the West are still in "de facto" or reserved wilderness.

From this situation emerges a major wildland problem: The Western States, particularly in the Rocky Mountain Region, have substantial acreages in reserved and de facto wilderness; yet population concentrations and demand are lower than in the East, where both designated and de facto wilderness is scarce.

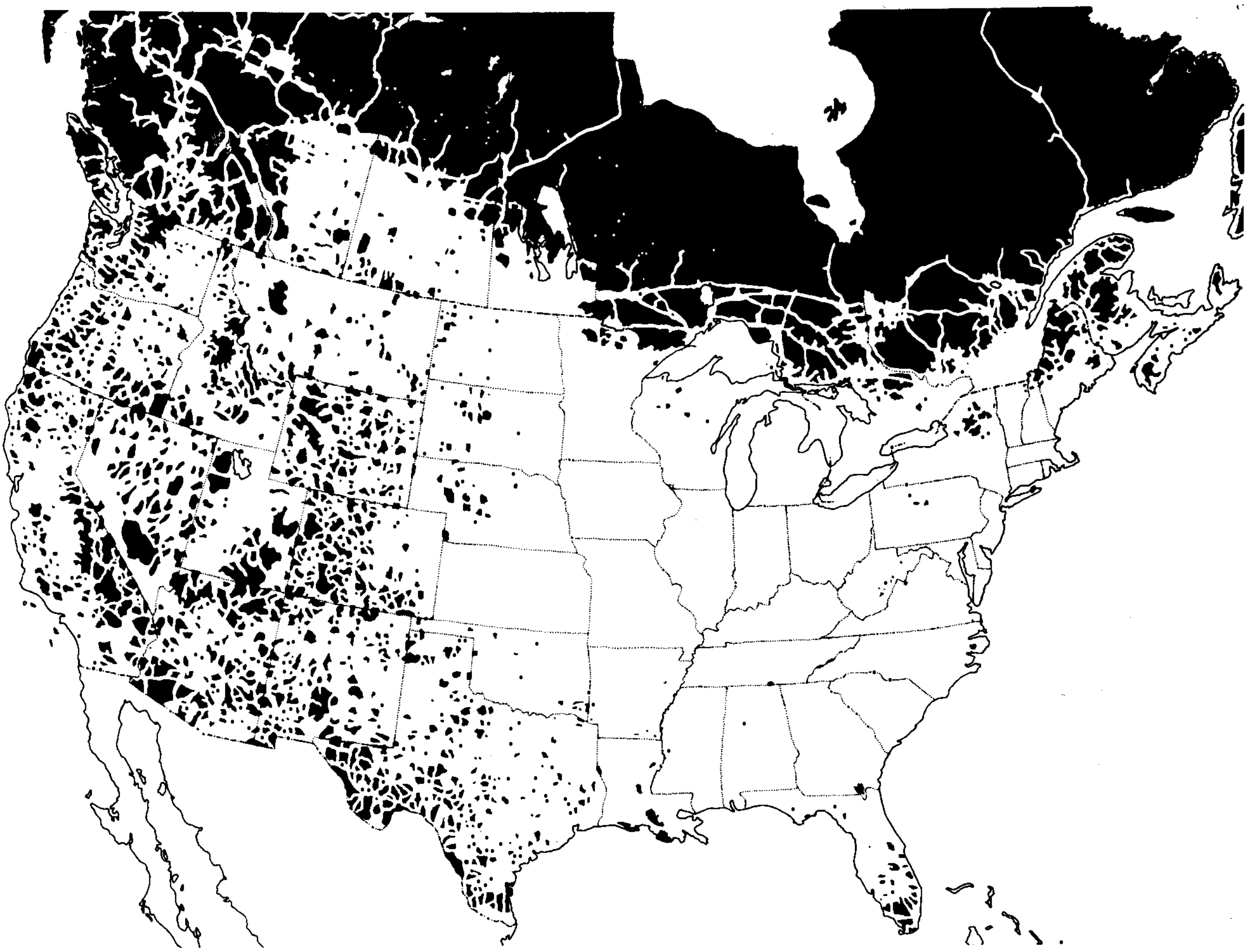
There are six major wildland recreation types in the East: National and State forests, and wilderness areas; national and State parks; national seashores, lakeshores, and recreation areas; national and State wild rivers; protected trails; and selected national and State wildlife refuges. Most of these areas, both existing and projected, involve withdrawal of forest land from wood production in favor of allocation to recreation. The major exceptions are national and State forests and wildlife refuges. The recreation area types having least applicability to forest withdrawals are national seashores and lakeshores and those Federal and State wildlife refuges largely composed of fresh or saltwater marshes.

### National Park Service Areas

National parks have met a large share of past rising recreational demand in the United States. Because these areas contain unique geological, biological, or historical features of national significance, visitation has risen dramatically as mobility, income, and vacation time have increased.

The National Park Service in 1971 managed 4,226,000 acres located in 32 States east of the

MAP 2



Remaining "wilderness" in North America: areas in black are more than 5 miles from the nearest railroad, highway, or navigable waterway.

From: Tunnard, C. and B. Pushkarev. 1963. *Man-made America: Chaos or Control.* New Haven: Yale University Press. p. 29.

Rockies. States having more than 100,000 acres of lands under Park Service administration were: Florida, Michigan, North Carolina, South Dakota, Tennessee, Texas, and Virginia.

One of the most difficult policy questions posed by this rapid acceleration of use, is how to manage national parks to maintain both the physical character and psychological feel of an uncrowded, wildlands recreation experience. Although numerous significant possibilities still exist in the East to expand National Park System lands, the supply is ultimately limited; problems, both ecological and perceptual, of management for levels of use that do not destroy the unique recreational qualities of park system areas will be considerable over the coming decades. Careful study and trials of alternative strategies are badly needed to define use-level criteria, and to stay within carrying capacity limitations of these areas, special features of which can be irreparably damaged by overuse.

### National Wilderness System Areas

The Wilderness Act of September 3, 1964, provided a legal mechanism to protect initially 9 million acres of wilderness in 54 units on national forest lands (formerly wilderness, wild, and canoe areas). In addition, lands managed by the Bureau of Sport Fisheries and Wildlife, and the National Park Service, as well as all then extant national forest primitive areas were to be reviewed and studied to determine those areas suitable for later inclusion in the system.

The system in the East now includes four areas on national forest lands: Boundary Waters Canoe

Area in Minnesota, Shining Rock and Linville Gorge in North Carolina and Great Gulf in New Hampshire. Of these the Boundary Waters Canoe Area totals 1,029,257 acres and the other three 26,471 acres. In addition, 11 wilderness areas have been established on national wildlife refuges located in seven Eastern States. These total 29,403 acres. They vary in size from 2 to 25,150 acres. Only two exceed 5,000 acres in size, the minimum area specified in the Wilderness Act of 1964 for nonisland areas.

There were no additional agencies reporting established eastern wilderness areas in 1972.

### National Forest System Lands

National Forest System lands are found in 30 Eastern States and total approximately 26,570,000 acres. This includes the four wilderness acres of 1,056,000 acres mentioned above. Most of the National Forest System lands are open to public recreation.

### Fish and Wildlife Service Lands

The Fish and Wildlife Service manages wildlife refuges for migratory waterfowl and other wildlife in 32 Eastern States. Their total area was 2,751,000 acres in 1971. Most of these are open for use by recreationists except for critical nesting and brood-rearing periods. Some have visitor centers with exhibits and folders for wildlife enthusiasts.

### Scenic Trails

Scenic trails are another recreation feature of significance in the East. The Long Trail, the Appalachian Trail, the Kittatinny Trail, the North Country Trail, the Potomac Heritage Trail, and the Natchez Trace Trail are among the most important of these. Although nationwide reservation of land for such trails has little impact on national wood supply, these scenic paths provide many major recreation benefits and can help link together otherwise unconnected parks, wilderness areas, urban parks, and urban centers.

### Other Federal Lands

Other Federal agencies having substantial areas of land in Eastern States open to public recreation include the Department of Defense. The total area under the jurisdiction of the Corps of Engineers, Civil Works Division, in 1968 was 7,148,150 acres in 49 States. Some lands along permanent reservoirs are choice sites for recreational use.

The Corps encourages recreational use where appropriate. The land held by other defense agencies, only part of which is open to public recreation, was in 1968 as follows:[1]

| | *Acres* |
|---|---|
| Department of the Air Force | 8, 563, 599 |
| Department of the Army | 11, 400, 109 |
| Department of the Navy | 3, 601, 425 |

### State and Other Public Recreation Areas

The two largest forest recreation areas now withdrawn from timber harvest in the East are the Adirondack and Catskill Forest reserves in New York State. In their size and recreational importance, these two reserves are unique in the Eastern United States. Other State park systems in forest regions are found in most Eastern States; however, Maine's Baxter State Park and New Jersey's Wharton Tract are among those few others of substantial size. Most State parks (and many State forests) are subject to intensive recreational use, particularly on weekends by populations from adjacent urban centers.

State, county, and local park systems are under pressure of rapidly rising demand. Allocation of more land for such parks will be critical over the next few decades. Forest areas close to major urban centers are subject to the most intense recreation use patterns, are the most expensive to purchase for parkland, and often are in critically short supply relative to nearby urban centers. Although beyond the scope of this paper to explore in detail, it is worth noting that in 1970, 355 million visits were made nationally to the country's State parks. This is nearly double the visitation to all Federal areas combined. Yet all State parks accounted for only 7,352,000 acres of land against a Federal recreation land total of 277,322,000 acres (see table 5). These figures underscore the need for substantial expansion of day and weekend recreation use areas close to urban centers.

### Private Recreation Lands

The Eastern States have a large majority of commercial forest land in farm and miscellaneous private ownerships. Much of this forest land is held for some form of recreation as well as for timber harvest. Relatively little is known about the motivations and intentions of the small forest owner holding land for recreation use. In the

[1] "One-third of the Nation's land," Public Land Law Review Commission Report. 1970.

North 127,882,000 acres are held by these private owners out of a total 177,901,000 acres. In the South 139,938,000 acres are held by small private owners out of a total 192,542,000 acres.

Most of these owners allow some form of timber harvest on their land, while still using it for erosion control, hunting, and various forms of recreation. Little data is available on the amount of land completely withdrawn from harvest. One U.S. Forest Service study completed by Robert N. Stone (1969) entitled: "A Comparison of Woodland Owner Intent With Woodland Practice in Michigan's Upper Peninsula," reported that forest owners studied tended eventually to market their timber even though they had expressed earlier an intent not to harvest. Due to the relatively large amount of eastern commercial forest land owned by small private holders, much more study of user motivation, actual behavior, recreation potential, and timber value is needed for these eastern lands.

## Suggested Additions to Eastern Federal Recreation and Preservation Land Systems

### National Park System

The National Park Service has made studies of a number of areas for consideration as additions to the system of lands it manages. Some have advanced far enough to be recommended to the Congress; others are still under study. These are listed in table 16.

### Wilderness Area System in the East

Demand for wilderness recreation in the East is high, and continues to rise. Because wilderness demand is high, designated wilderness supply is low, and the relative importance of hardwood timber to national wood needs (on both existing and potential designated wilderness) is relatively low, opportunity exists for expansion of areas in the East for wilderness type recreation.

The President's February 8, 1972, message on the environment recognized this need for preserving additional eastern wilderness and directed the Secretaries of Agriculture and Interior to accelerate the identification of eastern areas having wilderness potential. Both agencies are currently reviewing such potential areas.

In response to the President's directive on eastern wilderness, several legislative alternatives have been proposed. These include: an amendment or supplement to the Wilderness Act to define a new category of eastern wild lands; new basic legislation to establish a system of wild lands and achieve their restoration; and individual legislative actions to establish units deserving wilderness designation. Possible administrative actions include: Wilderness classification by the Secretary of Interior or Agriculture, and Executive order classification, as often used in the creation of national monuments.

Each of these possible actions, or a possible combination, deserves careful study. The Wilderness Act criteria appear to cover a number of potential eastern wilderness areas suitable for inclusion in the National Wilderness Preservation System without requiring either amendment or new wild areas legislation. Such areas could quickly be identified and included in the system. New wild areas legislation holds some promise for those sites considerably modified by man, but which have potential to be restored to wilderness conditions as defined by the 1964 act.

The National Park Service lists 10 potential wilderness areas totaling over 3 million acres located east of the Mississippi that were under study in 1971 (table 17). The Forest Service listed three areas located east of the Rockies in their study program for release in early 1973. These are the Joyce Kilmer-Slickrock of 14,935 acres in North Carolina, the Brandwell Bay of 22,000 acres in Florida and the El Cacique of 8,488 acres in Puerto Rico.

Other lands under the Departments of Agriculture and Interior were under study for addition to the system. In total, however, the existing lands, plus probable additions to the wilderness system, will represent a very small fraction of all eastern forest lands.

### Arguments For and Against Creating Large Additional Wilderness Areas in Eastern National Forests

Today the most important commercial forest lands in the East are in the southern softwood region. The majority of this region's wood is produced on private forest lands (table 18). More than 35 million acres of land in the South are in forest industry ownership. In 1970, these same lands accounted for 10.5 percent of the total U.S. softwood harvest and 8.8 percent of the total hardwood harvest. On the 139,938,000 acres in the South owned by private farmers and other small owners, 27.2 percent of the total U.S. softwood

**TABLE 16.—Suitable and Suggested Areas in the East, National Park Service**

| Name | State |
|---|---|
| A. Suitable areas.—Studies indicate that these areas possess national significance and are suitable for authorization as units of the National Park System | |
| 1. Allegheny Parkway | West Virginia, Virginia, and Kentucky. |
| 2. Big Cypress National Fresh Water Reserve [1] | Florida. |
| 3. Cape Fear National Monument | North Carolina. |
| 4. Connecticut River National Recreation Area [1] | Connecticut, Massachusetts, New Hampshire, and Vermont. |
| 5. Cumberland Island National Seashore [1] | Georgia. |
| 6. Florida's Frontier Rivers National Cultural Park | Florida. |
| 7. Gateway National Recreation Area [1] | New Jersey and New York. |
| 8. Potomac National River | Maryland, Virginia, and West Virginia. |
| 9. Suwannee National River | Florida and Georgia. |
| 10. Upper Mississippi River National Recreation Area | Missouri, Illinois, Iowa, Wisconsin, and Minnesota. |
| B. Suggested areas.—These areas have been suggested for inclusion in the National Park System | |
| 11. Abraham Lincoln Parkway | Illinois, Indiana, and Kentucky. |
| 12. Appalachian Parkway | Virginia to Maine. |
| 13. Big South Fork of the Cumberland River | Tennessee and Kentucky. |
| 14. Boston Harbor Islands | Massachusetts. |
| 15. Cape Cod Islands [2] [3] | Do. |
| 16. Cedar Swamp [2] | Ohio. |
| 17. Chattahoochie Recreation Area | Georgia. |
| 18. Coal and Recreation Area | Pennsylvania. |
| 19. Delware River [3] | New York and Pennsylvania. |
| 20. Dismal Swamp [2] | Virginia. |
| 21. El Camino Real Trail | Florida. |
| 22. Golden Isles [2] | Georgia. |
| 24. Guano River | Florida. |
| 23. Hutchinson Island | Do. |
| 25. Huckleberry Finn National Recreation Area | Arkansas, Maryland, Illinois, Kentucky, Tennessee, Mississippi, and Louisiana. |
| 26. Lake Erie Lakeshore | Ohio. |
| 27. Lake Michigan Lakeshore | Wisconsin. |
| 28. Maine Islands | Maine. |
| 29. North Vero Beach | Florida. |
| 30. Ohio Canal and Cyuhoga River | Ohio. |
| 31. Ohio River Parkway | New York, Pennsylvania, Ohio, Indiana, West Virginia, Kentucky, and Illinois. |
| 32. Raystown Reservoir | Pennsylvania. |
| 33. Tennessee River Parkway | Tennessee, Alabama, and Georgia. |
| 34. Thousand Islands | New York. |
| 35. Virginia Barrier Islands | Virginia. |
| 36. Wabash River Parkway | Indiana. |
| 37. Wakulla Springs and River [2] [3] | Florida. |
| Interest areas.— | |
| Lincoln Homestead National Recreation Area | Illinois. |
| Obed River | Tennessee. |
| Southern Appalachian Highlands | South Carolina and Georgia. |
| Youghiogheny River | Maryland and Pennsylvania. |

[1] Indicates desirability of such action has been established by a legislative report to the Congress.

[2] Indicates area or portion thereof is eligible for natural landmark.

[3] Indicates area or portion thereof is eligible for historical landmark.

**TABLE 17.—Areas of the National Park System Included in the Wilderness Study Program**

[East of the Mississippi]

| Area | Gross acres [1] |
|---|---|
| 1. Buffalo National Reserve, Ark | 95, 730. 00 |
| 2. Cumberland Gap National Historic Park, Ky.-Va.-Tenn | 20, 176. 49 |
| 3. Great Smoky Mountains National Park, N.C.-Tenn | 516, 626. 02 |
| 4. Mammoth Cave National Park, Ky | 51, 354. 40 |
| 5. Shenandoah National Park, Va | 193, 536. 91 |
| 6. Sleeping Bear Dunes National Lakeshore, Mich | 71, 068. 00 |
| 7. Voyageurs National Park, Minn | 219, 431. 00 |
| 8. Isle Royale National Park, Mich | 539, 341. 01 |
| 9. Gulf Islands National Sea, Miss | 125, 448. 00 |
| 10. Everglades National Park, Fla | 1, 325, 909. 99 |
| Total acreage | 3, 158, 621. 82 |

[1] As of June 30, 1971, no wilderness acres had then been designated.

harvest was taken in 1970, and 44.9 percent of the hardwoods. By contrast, in the same year southern national forests (14,277,000 acres in commercial production) produced only 2.3 percent of the total U.S. softwood harvest and 1.5 percent of the hardwoods. The percentage taken from all other public commercial lands in the South (6,515,000 acres) is even lower: 1.0 percent of the softwoods and 1.4 percent of the hardwoods.

The northern region is different from the South in that it ranks relatively low in national importance for commercial softwood production. It is similar to the South in that the relative national importance of public lands for timber production (largely of hardwoods in the North) is quite low. The largest single commercial forest ownership category in the North is made up of farm and nonindustrial private owners. Together they hold 127,822,000 acres that in 1970 produced 32.6 percent of the Nation's hardwoods and 3.7 percent of the softwoods. Forest industry lands in the North total 18,168,000 acres producing (in 1970) 3.8 percent of the Nation's hardwoods and 1.8 percent of the Nation's softwoods. Northern commercial Forest Service lands include 10,458,000 acres; these forests contributed only 1.7 percent of the Nation's 1970 hardwood harvest and 0.5 percent of the softwood cut. Lastly, all other public owners (Federal, State, county, and municipal) of commercial forest lands in the North total 21,453,000 acres. They contribute 2.8 percent of the national hardwood cut and 0.5 percent of the softwood harvest.

Against this background of wood uses, it is important to analyze the other values of eastern forest lands and the changing pattern of demands

**TABLE 18.—Softwood and Hardwood Growing Stock Removals From Major Forest Ownerships in the East, 1970 [1]**

[Thousand cubic feet]

| Ownership and type | National forests | Other public | Forest industry | Other private | All ownerships |
|---|---|---|---|---|---|
| North: | | | | | |
| Softwoods: | | | | | |
| Northeast | 2. 9 | 9. 3 | 139. 7 | 282. 0 | 434 |
| North Central | 29. 3 | 44. 5 | 29. 3 | 91. 7 | 195 |
| Hardwoods: | | | | | |
| Northeast | 18. 9 | 36. 4 | 90. 9 | 583. 7 | 730 |
| North Central | 39. 2 | 84. 4 | 71. 8 | 880. 3 | 1, 076 |
| Total | 90. 3 | 174. 6 | 331. 7 | 1, 837. 7 | 2, 435 |
| South: | | | | | |
| Softwoods: | | | | | |
| Southeast | 35. 2 | 53. 4 | 362. 5 | 1, 348. 3 | 1, 799 |
| South Central | 74. 7 | 39. 2 | 651. 6 | 1, 431. 2 | 2, 197 |
| Hardwoods: | | | | | |
| Southeast | 25. 7 | 20. 0 | 161. 9 | 851. 5 | 1, 059 |
| South Central | 9. 7 | 43. 2 | 219. 0 | 1, 155. 8 | 1, 428 |
| Total | 145. 3 | 155. 8 | 1, 395. 0 | 4, 786. 8 | 6, 483 |

[1] Discrepancies in totals are due to rounded figures.

Source: Taken from "Forest Statistics for the United States, By State and Region, 1970." Forest Service U.S. Department of Agriculture, 1972. Table 21 pp. 61-62.

now affecting them. The rapidly rising demand for further recreational and wildland withdrawals in the East requires particular attention. The great majority of these withdrawals are proposed for already existing Federal lands (largely national forests) and for areas in hardwood forest types.

Eastern forests serve a complex combination of needs; timber production (as outlined above), a wide array of recreational pursuits, grazing, mining, watershed erosion protection, streamflow stabilization and flood control, wildlife conservation and production, protection of endangered species, and research and education activities. Some of these resource needs, such as game production, are compatible with timber production. These partially incompatible competing uses of forest lands deserve particular attention where lands may have to be withdrawn from commercial production to satisfy other forest resource use demands. The potentially major recreational acreages involved are large and those allocated for wilderness would be withdrawn from timber harvest.

Against the above argument for withdrawing large areas from commercial timber production in the East are the following. As the old-growth timber from the West is gradually replaced by young timber stands the relative importance of the East and West as timber-growing regions will inevitably shift, with the East gaining in importance as growing stock is built up and increased markets for hardwoods for pulp manufacture continue to develop. A good market for such material opens up the possibility of gradually converting hardwood forests to softwoods, and in preventing present softwood stands from being replaced by hardwoods such as has occurred over extensive areas in the past. Eastern forest lands are generally better supplied with rainfall than those in the West and hence have a higher growth potential. They also are located better with respect to domestic and foreign markets.

One, therefore, should not dismiss the future timber productive capacity of eastern forests as unimportant based on the present contribution of these lands to current timber supply. It may in fact prove feasible some two or more decades hence to convert substantial eastern hardwood forests to conifers, because of the relatively high potential productivity of the lands which hardwoods now occupy. Cultural measures that make such a practice feasible are being rapidly developed.

### Wild and Scenic Rivers

The Wild and Scenic Rivers Act of October 2, 1968, established a National Wild and Scenic Rivers System designating all or portions of eight rivers as initial components (see map 3). The eastern rivers under the act, including those designated for further study to determine their possible addition to the system, are listed in table 19 below.

The total forest acreage that might be withdrawn for this system is relatively small. The significance of wild and scenic rivers to recreation, however, is very high. Among those recreational activities common to wild river sites boating, canoeing, hunting, fishing, swimming, and walking in or near water bodies rank high. All these

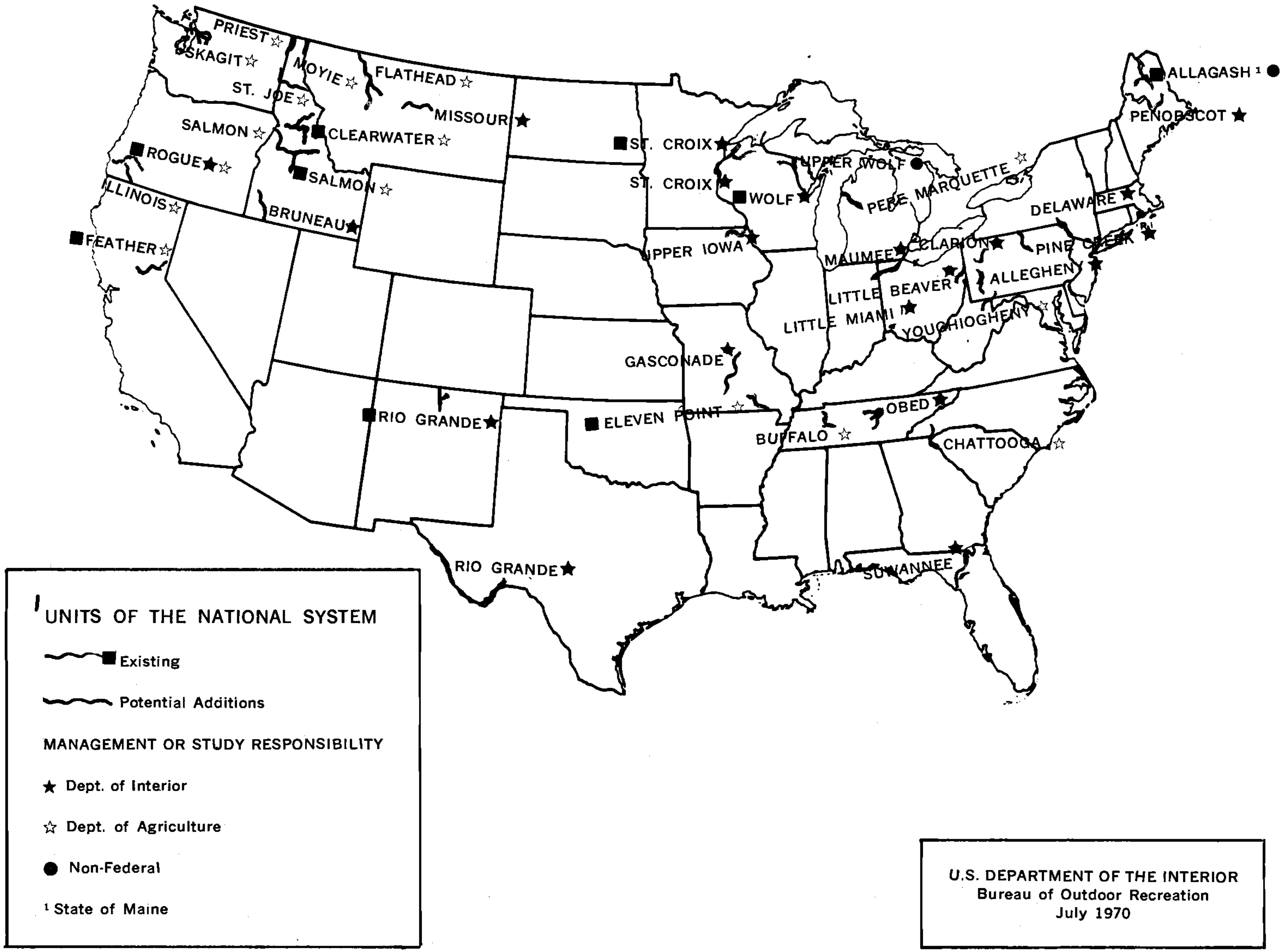
**TABLE 19.—National Wild and Scenic Rivers System**

| River | Acreage | River mileage |
|---|---|---|
| A. Initial eastern components of wild and scenic rivers system designated under sec. 3(a) of Public Law 90-542 | | |
| Eleven Point, Mo | 14, 191 | 44. 4 |
| Wolf, Wis | 7, 680 | 25 |
| St. Croix, Minn | 64, 000 | 200 |
| Total | 85, 871 | 269. 4 |
| Allagash Wilderness Waterway (administered by the State of Maine) | 167, 000 | 85 |
| B. Approximate mileage of eastern rivers designated for study under sec. 5(a) of Public Law 90-542, and land acreage proposed for preservation [3] | | |
| Allegheny, Pa.[2] | | 70 |
| Buffalo, Tenn.[1] | | 120 |
| Clarion, Pa.[2] | | 90 |
| Delaware, Pa. and N.Y | 14, 700 | 72 |
| Gasconade, Mo.[1] | | 270 |
| Little Beaver, Ohio [1] | | 45 |
| Little Miami, Ohio | 9, 900 | 65 |
| Maumee, Ohio and Ind.[1] | | 300 |
| Obed, Tenn | 23, 000 | 98 |
| Penobscot, Maine [1] | | 175 |
| Pine Creek, Pa.[1] | | 45 |
| Suwannee, Ga. and Fla | 26, 533 | 285 |
| Upper Iowa, Iowa | 14, 300 | 80 |
| Youghiogheny, Md. and Pa | 15, 759 | 49 |
| C. Eastern rivers designated for study by the Forest Service Department of Agriculture | | |
| Chattooga, Ga.-N.C.-S.C | | |
| Pere Marquette, Mich | | |

[1] Study not completed; however, the maximum acreage to be preserved probably would not be greater than an average of 320 acres per river mile.
[2] Preliminary report will recommend that the river does not meet the criteria for inclusion in the Wild and Scenic Rivers System.
[3] List includes only rivers being studied by the Department of Interior.

**MAP 3.—National Wild and Scenic Rivers System**

AS AUTHORIZED BY P.L. 90–542



pursuits are associated with wild and scenic rivers. For this reason, protection and reservation of such streams is of high recreational priority. The number of natural, free-flowing rivers are limited in number in the East, and under the twin pressures of land development and pollution, the few qualifying rivers remaining are dwindling in number rapidly. Paradoxically, as the supply of this critically limited wildlands recreation type drops, the demand for recreation in such areas is rising quickly.

High priority is deemed desirable to accelerating the study and protection of both national and State-managed wild and scenic rivers in the East. Of particular importance are:

(*a*) Expansion of the list of rivers under study;

(*b*) Moratoriums on development and freezes on land price escalation for rivers under study; and

(*c*) Provision of increased funds through the land and water conservation fund and State bond issues to accelerate purchase of land, easements or covenants along rivers of high recreational value, particularly those identified as suitable for inclusion in the National Wild and Scenic Rivers System.

### Wildland Planning and Comprehensive Land Use Planning

An integration of planning for national and State parks, units of the wilderness system, wild and scenic rivers, and scenic trails is suggested for eastern forest areas to maximize recreation potentials. Most integrated planning for wildlands recreation to date has been done by the Bureau of Outdoor Recreation in close cooperation with State agencies to prepare comprehensive State recreation plans. There is an additional need, however, for regional plans that cross State boundaries and that integrate planning for a broad spectrum of recreation area types and uses.

The accompanying generalized recreation matrix (fig. 2) is drawn to show how such integrated regional planning for wildlands recreation might be designed in a typical eastern area. Parks, wilderness areas, and other forest withdrawals for wildland recreation are located largely in mountainous regions. Scenic trails connect many of these reserves and lands adjoining these important trails are also added to lands withdrawn from harvest. Scenic and wild rivers flowing through and out of the mountains are also reserved for recreation, with care to reserve whole watersheds in mountainous areas, particularly where such withdrawals form continuous boundaries with parks, wilderness areas, and other wildland recreation sites. Lands withdrawn for river recreation run in corridors out into lowland areas, often linking up with urban parks in cities. Thus, they form recreational corridors linking intensively used urban parks with low-intensity wildland recreation sites in the mountains. Another factor favoring establishment of such riverine corridors is the very high demand for water-based recreation.

The remaining lands not in wildland or urban recreation reserves (and those not allocated to reservoir, city, suburban, and transportation use) are available for private recreation land, timber production, farming, mining, and various other land uses.

Obviously, this model is highly generalized and must take into account the need for comprehensive land use planning that considers many other resource needs. Nevertheless, in the East where Federal forest ownerships are concentrated in the mountains, where most timber production comes from private lands, and where public forest land is under high and rising demand for recreation use from large urban populations, it may help define planning priorities.

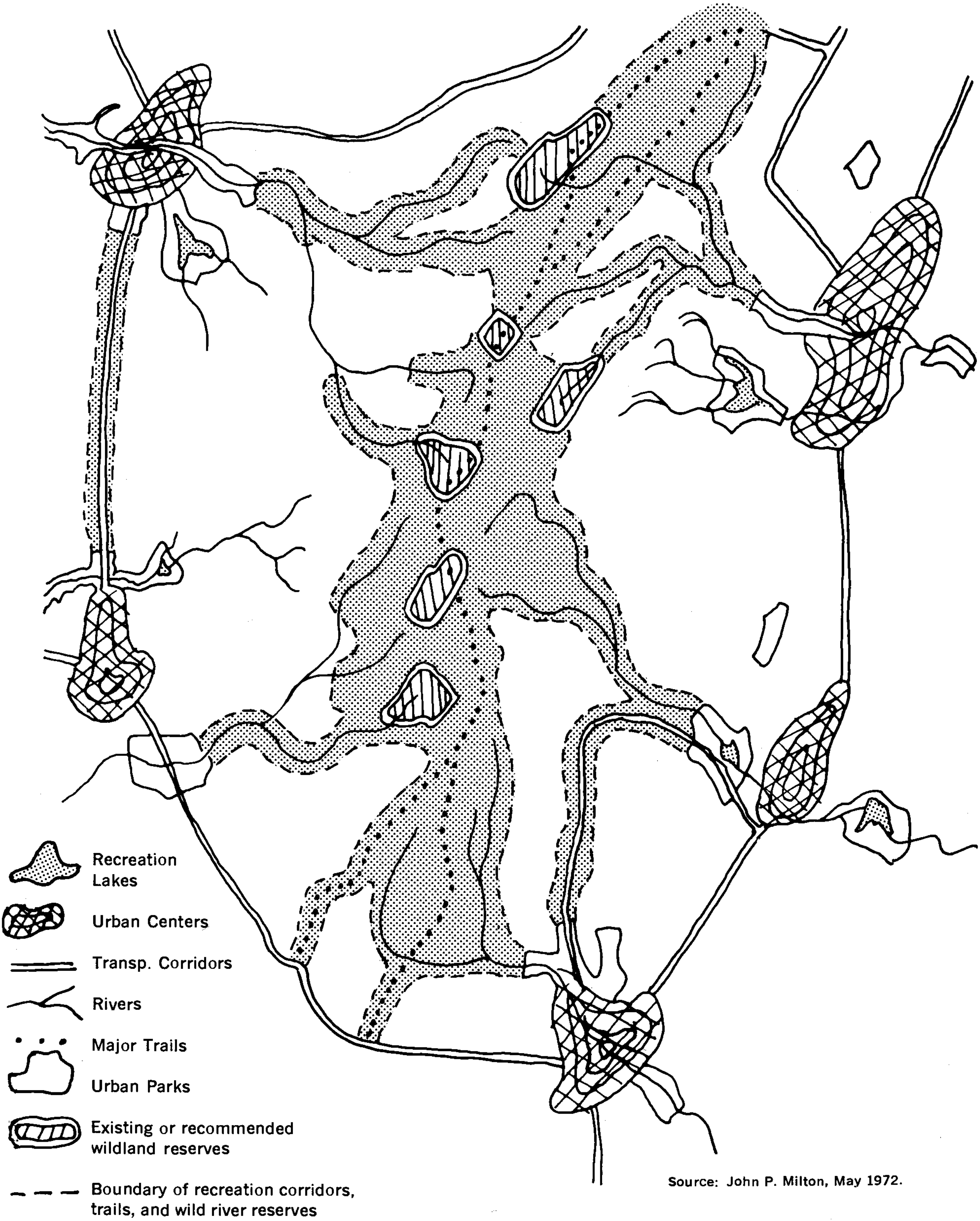
In addition, other compatible land uses, such as wildlife production, protection of endangered species, natural area reservation for science and education, and watershed protection may also be enhanced. The matrix also assumes that private commercial, farm, and small forest landowners now control the bulk of important eastern timber producing lands, and that efforts to increase timber production and supply (particularly of softwoods) should be increased on these lands.

## REVIEW OF OUTDOOR RECREATION FUNDING LAWS AND POLICIES

The land and water conservation fund (LWCF) was established to earmark funds for outdoor recreation development and for land acquisition. Revenue for the fund is derived from Federal recreation fees, sales of surplus Federal real property, and the Federal motorboat fuel tax. To assure that the $300 million annual funding level is met, additional funds are appropriated for the Outer Continental Shelf mineral receipts

**FIGURE 2.—Wildlands Recreation Matrix**

(Generalized Example)




Source: John P. Milton, May 1972.

or from the U.S. Treasury. The Department of the Interior's Bureau of Outdoor Recreation administers the fund.

Sixty percent of the fund's revenues are apportioned by law on a 50–50 matching basis to the States for land acquisition and recreation development. The other 40 percent is earmarked to Federal agencies only for land acquisition. Until 1970, the President had the option of deviating by as much as 15 percent from the 60–40 ratio.

Since the program's inception in 1965, about 1 million acres have been purchased. Of this, about 600,000 acres have been acquired since January 1969. The States have received about $785 million and the Federal agencies about $572 million (map 4).

The open space program administered by the HUD was established by Congress to satisfy the need for outdoor recreation in American cities. The authorized annual funding level for the open space program (OSP) is $200 million.

Under the Nixon administration's Legacy of Parks Program, the LWCF has been increased from $200 million to $300 million and the OSP has been held at $100 million. The Legacy of Parks Program is aimed at bringing parks to the people.

Under the Legacy of Parks Program, the President has instructed the Federal Property Review Board to give special emphasis to coordinating transfer of unused and underused Federal property to State and local governments for recreational development. About 26,000 acres of Federal property valued at more than $3.5 million has been returned to the cities where parks and recreational areas are scarce.

The Legacy of Parks Program has also placed emphasis on land acquisition near the cities. The President recently signed bills to create the Gateway National Recreation Area, encompassing 23,000 acres of land around New York's Jamaica Bay and Breezy Point and New Jersey's Sandy Hook, and to establish a 24,000-acre Golden Gate National Recreation Area along San Francisco Bay and the Pacific Ocean.

The Bureau of Land Management under the recreation and public purposes can sell and lease certain public domain lands to State and local government for recreational purposes. However, rather strict limitations are set forth in the law that limit annual recreational purchases by States to 6,400 acres and local governments are limited to 640,000 acres.

The concepts embodied in the Legacy of Parks Program, placing highest priority on bringing outdoor recreation opportunities closer to the majority of the American people or the population pockets is believed to be sound and long overdue. Continued establishment of national recreation areas under this program is deemed desirable. This program should be implemented through an expanded land and water conservation fund.

The following adjustments are suggested for the land and water conservation fund, which is the Federal Government's major source of funds for land acquisition and outdoor recreation development.

(*a*) That Congress consider that LWCF revenues be increased to $500 million;

(*b*) That Congress evenly divide allocation of revenues from the fund between the States and Federal agencies, with the President given authority to deviate from this guideline by perhaps 20 percent to meet unexpected State and Federal demands; and

(*c*) Money allocated to the States through the LWCF should be used to develop properties that are already in public (State and Federal) ownerships close to or in population pockets, and then for land acquisition only if land is not available. Much land is already available near population centers for outdoor recreation, but development programs have not adequately utilized these lands to keep pace with recreation demands.

The PLLRC has soundly recommended that:

> The Bureau of Outdoor Recreation should be directed to review and empowered to disapprove, recreation proposals for public land administered under general multiple-use policy if they are not in general conformity with statewide recreation plans.

Public attitudes at the moment make it unrealistic to believe that land established for recreational and park purposes can be either converted to other uses, or exchanged or transferred out of public ownership when it is not being fully used for outdoor recreation. However, such possibilities should not be overlooked. For instance, it is possible to limit programs on already developed, but underused, properties to primitive recreation activities. In other cases, previously preserved land might best be opened up to development, possibly even by private interests. Such changes might be paramount for altering previously misallocated recreational resources. Thus, the idea of reviewing

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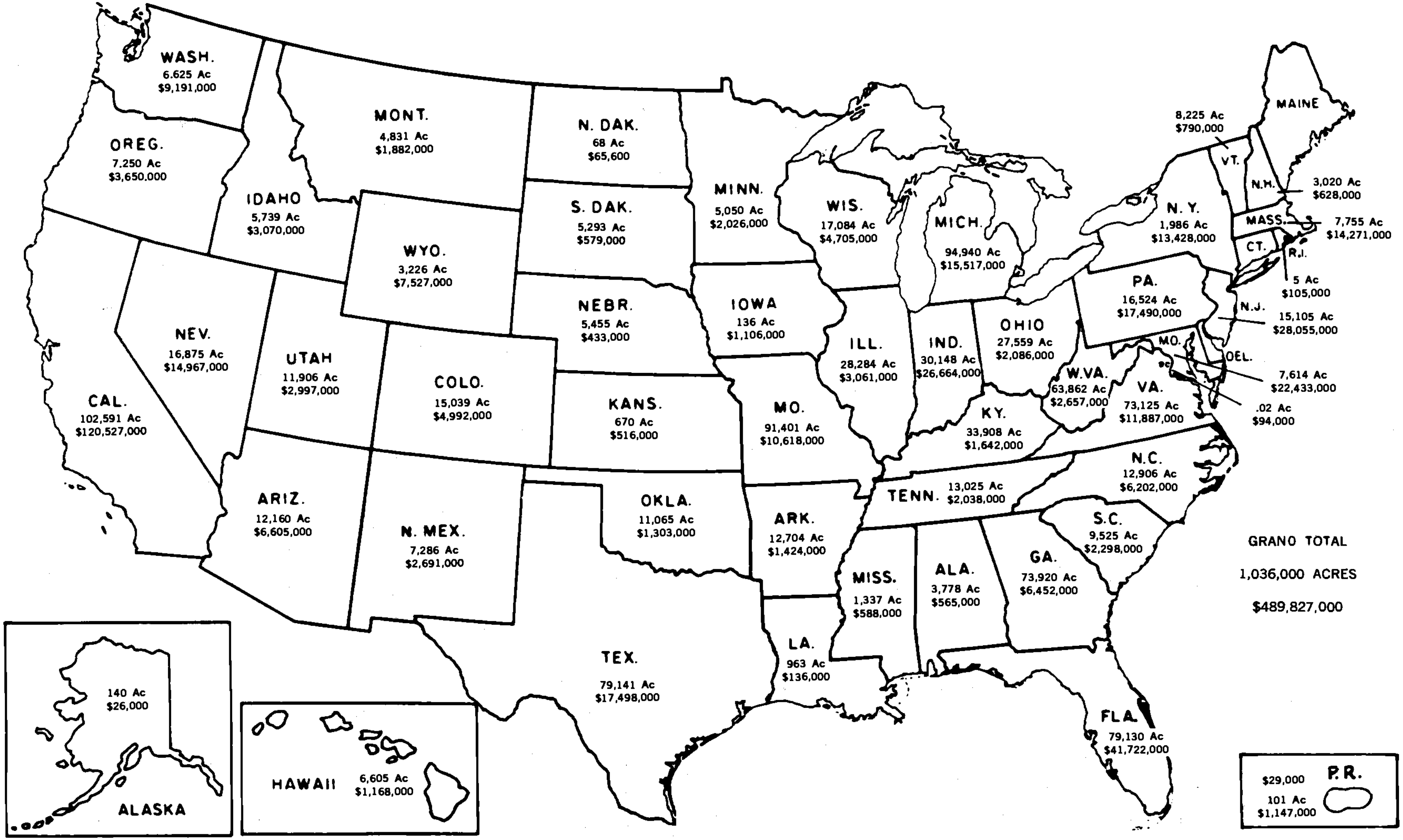
## MAP 4.—Federal Land and Water Conservation Fund Acres and Dollars

President Nixon's Legacy of Parks as of June 30, 1972



all current land use designations deserves public debate and official consideration.

There has been a lack of communication and understanding among recreation suppliers and users—within both the public and private sectors and between them in particular. This lack of communication has been a major contributor to the imbalances and confusion in efforts to meet recreation supply demands.

The BOR is now in a position to suggest ways to solve these problems. In developing its 1973 recreation plan, the BOR has sought public participation and recreation industry input. We approve of these methods, encourage their expanded use, and hope the BOR's efforts bear fruit.

Use conflicts and unsatisfied recreation demands are largely the result of misallocation of available land, facilities and/or programs. For instance, consider the misallocations of public recreation within the national forests. The Federal Government established recreation facilities to help meet a recognized national recreation demand. Yet each facility tends to be established on the basis of local pressures and availability of public land rather than under any nationwide policy or plan which considers how each piece fits in the recreation jigsaw puzzle.

Overall, although more developed recreation programs are located in the East than in the West, they are still far short of accelerating demand, since over 83 percent of the Nation's population is located east of the Rocky Mountains. As for primitive recreation lands and programs, nearly all are located in the West in proportions that do not appropriately reflect demands. The eastern Federal and State lands, along with the millions of private ownerships which control most of the forests in the East, offer opportunities for primitive walk-in recreation program coordinating with tree-growing efforts in addition to developed recreation potential. In the West, possibly more emphasis could be made on improving timber supply potential in forests where recreation demands are lightest.

The problems of misallocation, and the problems posed in the development of appropriate allocation guidelines, are of critical importance in the resolution of the recreation issue. Current inequities must be confronted as soon as possible and coordinated solutions developed.

The lack of a procedure for allocating land for recreation, timber and other uses on lands administered by Federal agencies is a major problem. It leads to uncertainty and insecurity on the part of the users of these lands, particularly in the national forests.

Realistic methods must be found for allocating public land among various users. The process must have three basic ingredients:

(*a*) It must be consistent and give clear direction;

(*b*) It must permit periodic review and at the same time give assurance that once a decision is made it will be carried out fully; and

(*c*) It must be easy for the public to understand.

Achievement of these basic objectives will by no means resolve the philosophical arguments between user groups. However, this process will establish parameters so that remaining differences can be decided through legal channels and the courts in compliance with such laws as the National Environmental Policy Act of 1969.

A wide variety of approaches are possible for putting this process into effect. The PLLRC and others have attempted to establish a national land-use policy and planning procedure. But the PLLRC recommendations in this area have been attacked since they criticize the Multiple Use Act and promote the dominant use philosophy. The national land-use policy proposals in the Senate present another opportunity. But, as yet, the Senate has been unwilling to include the public lands in these proposals in a significant way, thus making them inadequate. The Multiple Use Act provides another vehicle for accomplishing land-use planning through either Executive order, congressional amendment, or through departmental and agency action.

The Executive order approach might well be the quickest, most practical, and effective way to translate the Multiple Use Act into a positive, clear and ongoing national land-use policy and planning procedure for public lands. The Multiple Use Act is an accepted policy for administration of the national forests. A similar law could also be enacted for public domain lands. However, this administrative policy must be given substance and direction, whether accomplished by congressional or executive branch action.

For a specific management unit or perhaps a national forest, the Multiple Use Act can be implemented by any or all of three basic management approaches:

(*a*) The simultaneous and continuous use of the various resources in an area for activities that are compatible or have been modified to make them compatible;

(*b*) Arranging uses in a time sequence or rotation of uses over time to eliminate use conflict; and

(*c*) Arranging different uses in adjacent subareas which together form a composite or mosaic multiple-use area.

No matter which of the three management approaches is used, and no matter who puts it into effect, a procedure for allocating land among the various users must be formally established. And this procedure should have several components:

(*a*) A detailed management plan should be made readily available to both the public and Congress. Public hearings, formal and informal, should be held and at least 60 days allowed for formal comment prior to final publication of the proposed management plan summary in the Federal Register.

(*b*) A management plan should include for each management unit:

(1) Maps and illustrations;

(2) The length of the review period;

(3) A general description and classification;

(4) Special problems that need attention during the effective period of the plan;

(5) Policies and procedures for management;

(6) Objectives for the plan period; and

(7) An environmental impact statement.

(*c*) The planning procedure should also include a method to be followed for identifying areas that need special protection by the Congress.

(*d*) There must also be a procedure for administrative appeal and access to the courts.

Except for the access to the courts, the procedure and management approaches spelled out above do not include anything that is not already being done in some form in the development of management plans for the national forests. However, a formalized and publicized approach would give the Forest Service, the public, and every user of the national forests a highly visible set of rules that must be followed in managing these public lands. Such guidelines are not available at the present time.

Another way to solve current public land allocation problems would be to amend every wilderness and recreation proposal as they are acted on by Congress to include the administrative procedures outlined above.

The PLLRC recognized the need for a better coordination of Federal natural resource programs and recommended that a Department of Natural Resources be established—a super Department embracing all Federal resource agencies and coordinating their activities under one banner. In terms of recreation, the coordination was to be achieved through the BOR. In this same vein the BOR should be given greater authority in the allocation of public recreation resources and coordination of the total Federal and private recreation effort. Both creation of a DNR and a greater BOR authority deserve careful consideration, as do any proposals which can produce a coordinated recreation resources allocation process.

As for private recreation resources, the allocation process in this sector has often worked better than in the public sector. For instance, note how most of the private recreation facilities are located in the East where demand is greatest. But the duplication of effort within and between the public and private sectors is another unfortunate part of the misallocation process. Not only should private recreation efforts be coordinated among themselves, they should be alined with public efforts as well. Here, again, the BOR might well prove to be the clearinghouse needed.

As solutions evolve for the Nation's recreation and land-use problems, increasing efforts must be directed to the ways these solutions are initiated and enforced. If a superagency is devised to coordinate, allocate, and maintain recreation efforts on public lands, its regulatory powers must be carefully reviewed, and consideration given to those laws and precedents which would apply to controversies where legal action results. If it is deemed best for State and private recreation efforts to also be coordinated by such a superagency, the regulatory questions grow in importance and complexity. Incentive measures might also provide the means for effecting the necessary changes in, and expansion of, recreation programs, particularly at the private level. Whatever courses of action are finally devised to meet our Nation's recreation objectives, they must have the appropriate powers to guarantee success.

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appendix P

**BY WILLIAM C. JOLLY**

# Statutory and Administrative Restrictions on Forest Land Use



## INTRODUCTION

Restrictions on the kind or degree of specific uses of land may be imposed on private as well as on public lands. The Public Land Law Review Commission (PLLRC, 1970) concluded:

The amount of forested public land reserved from harvesting or placed under special cutting limitations more than doubled between 1957 and 1967. Although data are not available to show the extent of the continuing pressure on private forests, land is being cleared for many uses such as residential, commercial, and highway construction.

Because forest land use with respect both to environmental quality considerations and to timber utilization is a primary focus of the Panel's Presidential charge and of its deliberations, an explicit examination of the status of forest land restricted as to use was desired. The Panel wished to assess the nature and the degree of present and probable restrictions of forest land uses and determine the impacts of such restrictions on the Nation's ability to meet its timber needs. As will become apparent later, critical information necessary to accurately assess such impacts is inadequate. This information gap will be examined in more detail farther on.

In general, the term "withdrawal" is applied to forest lands statutorily restricted in some way as to permitted land uses. The term "restriction" applies broadly to administrative actions which limit management options but which may not be directly mandated by statute. Lands placed by Congress in the National Wilderness Preservation System are an example of "withdrawn" lands. Lands which the Forest Service has designated as experimental forests, research natural areas, and primitive areas are examples of "restricted" use lands, but not "withdrawn" lands. Frequently, however, "withdrawal" is used more broadly in reference to any public land the use of which is officially restricted in some way relative to the uses of its congeners.

It is also useful to classify forest land uses or land use restrictions by degree to which other potential uses are protected or destroyed. Such a classification conceives a continuum with biologically destructive uses such as highway cutting, filling, grading and paving at one end, and integrated forest resource management toward the opposite pole. In the ecologically well-managed forest the ability of the system to sustain a yield of forest goods and services in perpetuity is assured to the limits of present knowledge.

It should be recognized that such a classification is imperfect and does apply to a continuum of generally nonexclusive categories. Wilderness is ecologically rich in potential for many uses but exists only in the *potential* state for most of them. Much managed forest land retains the option of becoming ecological wilderness, but not of ever becoming the intellectual, philosophical wilderness of the absolute purist for whom mere knowledge of man's previous activity suffices to tarnish the ideal.

## Uses Tending Toward the Consumptive/Destructive Pole

Some productive forest land is taken each year for man's urban (including suburban) industrial, transportation, and energy transmission systems. Urban land amounted to over 21 million acres in 1960 and is expected to double or more by the year 2000. At present over 25 million acres of land are taken up by highway and railroad rights-of-way alone. By the year 2000 an additional 4 million acres may be taken for these uses and for airports and landing strips (Landsberg, 1964). Some loss of forest land to power lines occurs each year; it may be a significant amount. Present information systems do not permit identification of the fraction of these takings which are forested land nor of the timber volumes which may have been or may be present. It seems likely, however, that much commercial forest land is lost to production in this way.

The major cause for concern with consumptive/destructive taking of land from production, whether agricultural or forest land, is not so much that such taking is extremely extensive as that the loss is irretrievable and usually is of the more highly productive land. When land is used in development, is scraped, torn up, and paved, the option of future biological productivity may be irreparably foregone. Accordingly, to the greatest feasible degree, development which impairs future biological productivity should be shunted to lands of lowest site quality. This is an especially valid policy when land is used as mere surface or space; functional substitutability of one area of land surface for another is often high. Ecologically destructive use of forest land for mineral exploitation, for example, is less easily avoided since functional substitutability of land is low.

## Uses Tending Away From the Consumptive/Destructive Pole

By far, the greatest forest land use restrictions and withdrawals which concern the wood products industries, the public and the Nation's public policymakers, fall into this broad category. Concern here is not with loss of the land to highways and homes, to pipelines and parking lots, but rather with conflicts between and among the multiple products and services of which forest lands are capable of sustaining a yield.

While at various times in American history the Federal Government has held title to about four-fifth's of the Nation's gross area, about one-third is presently in Federal ownership. Of lands once in Federal ownership, title to approximately 1.1 billion acres has been conveyed to citizens, businesses, and non-Federal governmental organizations under various land laws. In the process, all these Federal lands were withdrawn from prior status and often from prior use.

In addition to withdrawals of Federal land from Federal ownership, there have been and continue to be various withdrawals of Federal land from certain uses or from the jurisdiction of some agencies in favor of others. It is worth noting that whereas today much controversy rages over withdrawals of national forest land from commercial timber production in favor of noncommodity uses, America has the richness of its National Forest System only because forest lands were earlier reserved or "withdrawn" from threatening and destructive uses or land management practices. The point of greatest note is that withdrawal or reservation is not a one-way nor entropic process. Land is not only withdrawn "from" a use or status but equally is withdrawn "for" expressed alternatives. Total societal benefits over the long run are presumably increased as a result.

Over the years Congress and the Executive have dedicated public lands as parks, forests, wildlife refuges, and defense units—among others—for specific purposes such as protection of watersheds, preservation of outstanding scenery and natural wonders, assurance of adequate raw materials for the future, protection of migratory waterfowl, and defense of the country. Perhaps the earliest withdrawals occurred in 1817 when the Secretary of the Navy reserved 19,000 acres of live oaks from the Louisiana Purchase to provide for the future needs of the Nation's Navy (Gates, 1968). These and later defense-related withdrawals, withdrawals for the National Park System, the National Forest System, and certain other withdrawals largely came at the "expense" of previously unreserved public domain land. The decade of the sixties, however, saw an upsurge in secondary withdrawals as, for example, when land in the National Forest System was transferred to the National Park System with the creation of the Redwood and North Cascades National Parks.

Also increasing at this time were land use restrictions, including withdrawals imposed by Congress, as well as restrictions by the Executive at various administrative levels. While such restrictions did not alter agency jurisdiction of the affected lands, they did constitute a further land reservation, in effect, to a more limited or defined use than was the case prior to the restriction. The paramount examples are ecosystem protection-oriented and recreation-oriented: the National Wild and Scenic Rivers System, the National Scenic Trails System, the National Wilderness Preservation System, and Research Natural Areas.

## INVENTORY OF PUBLIC FOREST LAND PRINCIPALLY DEDICATED FOR USES OTHER THAN COMMERCIAL TIMBER PRODUCTION

### National Park System

As of 1972, the national parks of the United States numbered 38 and totaled over 15 million acres. Five of these, incorporating nearly 1 million acres, were established since 1960 and two others of over 300,000 acres total have been authorized but not yet established pending satisfaction of authorizing conditions (CEQ, 1972). While some of the original Mount Olympics National Monument (established in 1909) was placed in a national forest when the Olympic National Park was created from but a part of the original monument in 1938, the more usual pattern is for forest land to be taken from the national forests to meet other purposes or uses. The establishment of the North Cascade and Redwood Parks alone involved withdrawal of over 560,000 acres of predominately forest land, much of it of prime commercial quality. Timber harvesting is not, of course, permitted on National Park System lands, and so is permanently foregone on these lands.

Over 100,000 acres of National Forest System lands have been withdrawn from timber production and are administered by the Park Service as part of nearly a dozen national monuments. The quality of this withdrawn land for commercial timber production is not determinable from the public literature. Thus, one cannot clearly equate such changes in use with any necessarily adverse impacts on commercial timber production.

### The National Wilderness Preservation System

This system consisted, as of August 30, 1972 (Wilderness Society, 1972), of nearly 10½ million acres of land in 85 distinct national wilderness areas. Sixty-two of these areas and 98.2 percent of the acreage are administered by the U.S. Forest Service. Under the terms of the Wilderness Act, all areas designated by the Forest Service as "primitive" at the time of the act's enactment into law automatically are reviewed for suitability as statutory wilderness and appropriate recommendations made to Congress for possible action. The same provisions apply to certain roadless areas administered by the Bureau of Sport Fisheries and Wildlife and the National Park Service. As of August 30, 1972 (Wilderness Society, 1972), gross acreage under review by either the administering agencies or by the Congress for possible inclusion in the National Wilderness Preservation System totaled 56.8 million acres on 157 separate areas. Twenty-seven of these areas and 4.3 million of these acres were administered by the U.S. Forest Service.

The charter acreage in the National Wilderness Preservation System as designated by Congress when the Wilderness Act was passed was 9.1 million acres. Since that time, Congress has received 78 wilderness proposals from the executive branch which involve 5.8 million acres over and above the original acreage. Congress had acted as of September 21, 1972, on 35 proposals, approving 1.7 million acres for inclusion in the system. Thus, 43 wilderness proposals encompassing 4.1 million acres remain pending. Of these wilderness proposals which are now pending, 16 were proposed by President Nixon on September 21, 1972. If approved, they alone will add 3.5 million acres to the wilderness system, potentially the largest single incremental increase in the System since its creation. None of these last 16 involves National Forest System lands, however.

Areas of a wilderness character which have not been reviewed under the terms of the Wilderness Act or have not been proposed for inclusion by the administering agency (or, if so proposed, have been excluded from the President's proposals to the Congress) but which have been proposed by congressional delegations in response to demands of constituents, number 27 and involve 1.9 million gross acres of land as of August 30, 1972 (Wilderness Society, 1972). All of these others are within the National Forest System. Finally, the Forest Service in January 1973 completed its review of all roadless areas over 5,000 contiguous acres which were not required for review by the Wilderness Act to determine which among them should also be studied in detail for possible inclusion in the National Wilderness Preservation System. There were 1,442 areas involved in this roadless area review. Their cumulative gross acreage was 55.3 million acres; their cumulative commercial forest acreage, 18.3 million acres (table 1). On January 18, 1973, the Forest Service announced its selection of 235 of these areas, containing about 11 million acres as candidate wilderness areas which will now receive more comprehensive study

**TABLE 1.—Summary Data—All Roadless Areas**

| Region [1] | Number of areas | Gross acres | CFL [2] acres | Potential yield (thousand board feet) | Annual allowable harvest (thousand board feet) |
|---|---|---|---|---|---|
| 1 | 273 | 7, 865, 738 | 4, 710, 745 | 1, 899, 429 | 463, 760 |
| 2 | 250 | 5, 517, 615 | 2, 240, 256 | 531, 607 | 118, 654 |
| 3 | 88 | 1, 188, 426 | 160, 314 | 53, 776 | 47, 246 |
| 4 | 437 | 11, 465, 283 | 3, 641, 821 | 497, 147 | 174, 892 |
| 5 | 128 | 3, 070, 460 | 717, 849 | 209, 110 | 209, 110 |
| 6 | 256 | 5, 585, 776 | 3, 150, 265 | 763, 730 | 696, 330 |
| 8 | 2 | 36, 935 | 23, 321 | 1, 858 | 360 |
| 9 | 0 | 0 | 0 | 0 | 0 |
| 10 | 7 | 20, 553, 910 | 3, 647, 700 | 1, 169, 030 | 579, 589 |
| ITF | 1 | 8, 488 | 422 | 359 | 0 |
| Total | 1, 442 | 55, 292, 631 | 18, 292, 693 | 5, 126, 046 | 2, 289, 941 |

[1] Region 1 is the Northern Region; 2, the Rocky Mountain; 3, the Southwestern; 4, the Intermountain; 5, California; 6, the Pacific Northwest; 8, the Southern; 9, the Eastern; 10, Alaska; and ITF, the Institute of Tropical Forestry in Puerto Rico.
[2] CFL: commercial forest land.

Source: From U.S. Forest Service, special communication to the President's Advisory Panel on Timber and the Environment, Oct. 13, 1972 (preliminary data).

and assessment. Much, if not all, of such acreage is likely to ultimately be added to the National Wilderness Preservation System. In 1972, the Sierra Club, the Environmental Defense Fund, and other conservation organizations sued the Forest Service to prevent any activity on these roadless areas which might adversely affect their wilderness character until each area had been reviewed and its fate determined by the Congress vis-á-vis inclusion in the Wilderness System. By the end of the year the suit was dropped when the Forest Service agreed to comply with all NEPA impact statement provisions before undertaking any operations which might detract from extant wilderness values present on those lands. This could have the effect, according to the Forest Service,[1] of decreasing the total national forest timber acreage base by 20 percent since this is the estimated impact on that base should the 18 million acres of commercial forest land involved in the roadless area inventory be reclassified to exclude timber harvesting. The associated drop in allowable annual harvest would be over 2 billion fbm.

[1] From U.S. Forest Service, special communication to the President's Advisory Panel on Timber and the Environment, Oct. 13, 1972 (preliminary data).

The number of areas and acreage involved in these various categories are summarized, by agency, in table 2. From inspection one can see that the present system of over 10 million acres is very likely to be doubled or more in the future as action on pending proposals and reviews is completed.

Of the 14.5 million acres in either wilderness or primitive area categories which the Forest Service administers, 6.7 million acres are classified as commercial forest land. These 14.5 million acres constitute nearly 8 percent of all National Forest System lands and nearly 10 percent of all National Forest System lands in the 14 States in which these forest wilderness lands are located (Seventh Joint Annual Report of the Secretaries of Agriculture and the Interior, 1971).

**TABLE 2.—Present and Potential Units of the National Wilderness Preservation System [1]**

| Status | Administering agency | Number of areas | Gross acreages | Net acreage | Commercial forest acreage |
|---|---|---|---|---|---|
| In National Wilderness Preservation system. | Forest Service | 62 | 10, 258, 036 | | |
| | National Park Service | 2 | 93, 503 | | |
| | Bureau of Sport Fisheries and Wildlife. | 21 | 93, 609 | | |
| Total | | 85 | 10, 445, 148 | | |
| Under review by agency or Congress | Forest Service | 27 | 4, 331, 156 | | |
| | National Park Service | 59 | 27, 219, 288 | | |
| | Bureau of Sport Fisheries and Wildlife. | 71 | 25, 233, 003 | | |
| Subtotal | | 157 | 56, 783, 447 | | |
| Subjects of proposed legislation but not recommended by an agency or the President. | Forest Service | 27 | 1, 890, 010 | | |
| | National Park Service | | | | |
| | Bureau of Sport Fisheries and Wildlife. | | | | |
| Subtotal | | 27 | 1, 890, 010 | | |
| Total | | 184 | 58, 673, 457 | | |
| Grand total | | 269, | 69, 118, 605 | | |
| Roadless area review of Forest Service.[2] | Forest Service | 1, 442 | 55, 292, 631 | | 18, 292, 693 |

[1] From the Wilderness Society, 1972, as of Aug. 30, 1972.
[2] From U.S. Forest Service, Special Communication to the President's Advisory Panel on Timber and the Environment, Oct. 13, 1972 (preliminary data).

The acres in, or being considered for inclusion in, the National Wilderness Preservation System are not equally dispersed throughout the country. Only 16 of the 85 official wilderness areas are in the East. Their acreage is but 10.5 percent of the total acreage in the system and fully 94 percent of this eastern wilderness system acreage is in one area, the Boundary Waters Canoe Area in Minnesota. Only four of the eastern wilderness areas are on National Forest System land.

Of the 56.7 million acres in the 157 areas presently under review by agencies or Congress (and exclusive of the 55.3 million acres of roadless areas reviewed by the Forest Service), only 3.9 million acres (in 39 areas) are located in the East. This is but 6.7 percent of all such lands now under review and no eastern National Forest System lands are included in this review category.

Of the nonagency proposed, "de facto" areas now before Congress, 11 percent of the acreage and 11 of the 27 areas are in the East and all are on National Forest System lands.

Alaska presently has six official areas and 0.5 percent of the acreage in the wilderness system. However, 15 areas totaling 26 million acres are under agency or congressional review and this acreage constitutes over 46 percent of all acreage presently receiving such wilderness system review. None of these areas is in the National Forest System (Wilderness Society, 1972). Forest system lands, especially in the Tongass National Forest, are being evaluated now by Forest Service and wilderness advocates with respect to possible future proposals for study. Regional Forester Charles Yates, in a presentation to the Panel in Juneau, estimated that the 2.1 million acres in four areas under study for possible wilderness designation contained 3.5 million fbm of commercial timber.

Stankey (1971) has attached propected assumptions of percentage of wilderness study areas he considered likely to be ultimately placed in the wilderness system. His estimates are liberal and of the 88.5 million acres under Forest Service, National Park Service, Bureau of Sport Fisheries and Wildlife, and Bureau of Land Management jurisdiction which he classifies as "being under" study, he assumes 71.5 million acres will constitute a completed wilderness system. This would be well over a five-fold increase over the present wilderness system acreage. It may be presumed that the 42.6 million acres Stankey assumes will be classified as wilderness from NPS and BSF&W wilderness lands will have no effect on national timber supplies. A significant, but undetermined, fraction of the 11 million acres Stankey lists as under review on forest system lands will indeed be commercial forest land, the loss to timber production of which might be notable. Also, the non-Alaskan BLM lands which Stankey assumes will be classified as wilderness (1.4 million acres) may be presumed to carry timber of significant volume. It is worth noting that his article appeared over a year ago, that some of his data are outdated or otherwise inaccurate and that some of his figures are at variance with others presented elsewhere in this report. Nonetheless, the usefulness of Stankey's attempted projections is not lost entirely. (Table 1 of Stankey is reproduced here as table 3.)

Stankey's estimates are undoubtedly unrealistically liberal. Nonetheless, they provide a likely upper limit for the size of the wilderness system against which to project impact of wilderness withdrawals on the nation's public commercial timber producing base. Thus, with respect to National Forest System lands, Stankey projects an ultimate 21 million acres withdrawn for statutory wilderness. Regrettably one cannot evaluate the fraction of this acreage which is commercial forest land nor, more importantly, the fraction which is of high commercial forest quality. It is in fact likely that much of the projected 21 million acres is not prime commercial forest land.

To recapitulate, there are 10½ million acres presently in the National Wilderness Preservation System, most of which is National Forest System land. There are over 58 million acres of land presently being considered by agencies or by Congress for possible wilderness status; only a little over 6 million acres of this is National Forest System land. There are over 55 million acres of National Forest System "roadless" lands recently reviewed for selection of possible wilderness study areas, and about 11 million acres of them are being proposed by the Forest Service as wilderness candidate study areas.

Of the 14.5 million acres in either wilderness or primitive area categories which the Forest Service administers, 6.7 million acres are considered commercial forest land (though it is not known at what level of quality). This, then, constitutes a commercial acreage impact to date of the Wilderness System on the National Forest System commercial timber base.

**TABLE 3.—Potential Dimensions of the National Wilderness Preservation System** [1]

| Agency | Acreage under study as wilderness (millions) | Assumptions regarding eventual wilderness classification (percent) | Acreage assumed to be classified as wilderness (millions) |
|---|---|---|---|
| Forest Service: [2] | | | |
| Wilderness (currently in National Wilderness Preservation System) | 9.9 | 100 | 9.9 |
| Primitive (awaiting review) [3] | 4.4 | 100 | 4.4 |
| De facto (48 States) | 7.0 | 67 | 4.7 |
| De facto (Alaska) | 2.5 | 75 | 1.9 |
| Total | 23.8 | | 20.9 |
| National Park Service: [4] | | | |
| 54 units in 48 States and Hawaii | 19.8 | 67 | 13.3 |
| 3 units in Alaska | 7.5 | 90 | 6.8 |
| Total | 27.3 | | 20.1 |
| Bureau of Sport Fisheries and Wildlife: [5] | | | |
| Acreage to be reviewed, exclusive of Alaska | 3.1 | 50 | 1.6 |
| Acreage to be reviewed in Alaska | 22.6 | 90 | 20.3 |
| Acreage already reviewed, exclusive of Alaska | 1.1 | 50 | .5 |
| Acreage already reviewed in Alaska | .1 | 100 | .1 |
| Total | 26.9 | | 22.5 |
| Bureau of Land Management: [6] | | | |
| Study areas in 48 States | 2.2 | 67 | 1.4 |
| Study areas in Alaska | 8.8 | 75 | 6.6 |
| Total | 11.0 | | 8.0 |
| Grand total | 88.5 | | 71.5 |

[1] Reproduced from: Stankey, G. H. 1971. "Myths in Wilderness Decision-Making." J. Soil and Water Conservation. 26(5): 184–188.
[2] Assumptions regarding the percentage of Forest Service "de facto" acreage to be classified as wilderness are arbitrary ones that attempt to take into account the demands for a growing wilderness-user population, other resourced emands, and the availability of lands to meet this demand.
[3] Additions to primitive areas in the reclassification process have acreaged about 25 percent. However, these additions are taken from land classed above as "de facto" wilderness.
[4] The ⅔ assumption for national park units outside Alaska is probably an overestimate. Of the 17 units studied to date, preliminary wilderness proposals have averaged 54 percent. The 90-percent assumption for Alaska was made in light of the low level of development and light use pressures.
[5] The Bureau of Sport Fisheries and Wildlife has reviewed 30 areas in the United States, exclusive of Alaska. At present, wilderness recommendations average 45 percent of gross acreage. In Alaska 76,000 acres have been reviewed; virtually all (99.9 percent) have been recommended for wilderness. It has been assumed that prior developments and wildlife management needs would allow for a 90-percent withdrawal of the remaining acreages.
[6] There is virtually nothing available from which assumptions regarding Bureau of Land Management withdrawals for wilderness proposals could be made. The ⅔ figure for the 48 States and 75 percent for Alaska attempt to recognize, as do the assumptions on "de facto" Forest Service acreage, the competing resource demands and the alternative sources of supply for these sources.

Of the 55 million acres of National Forest System lands involved in the just completed roadless area review, 18 million acres are judged by the Forest Service to be commercial forest land bearing an annual allowable harvest volume of over 2 billion fbm. This volume is unevenly distributed by region and by quality, however (table 1) such that 17 percent of the acreage bears over 30 percent of the annual harvestable volume (in the Pacific Northwest), but nearly 20 percent of the acreage bears less than 8 percent of the annual harvestable volume (in the intermountain region). Obviously, wilderness withdrawals in the latter region would have proportionately far less impact on the national forest commercial timber base than would withdrawals in the former region. At any rate, in the unlikely event that all commercial forest land under roadless area review were withdrawn, the loss in annual allowable cut would be 2 billion fbm by Forest Service estimate. It is reasonable to presume that significant acreage of noncommercial quality will be recommended for wilderness status and that significantly less than all of the commercial forest land will be, also. As of this writing (March 1973), the site quality of the lands selected by the Forest Service as wilderness candidate study areas remains publicly unidentified. Thus, the impact on commercial timber production of withdrawal of these areas remains speculative.

### National Wild and Scenic Rivers System

The Wild and Scenic Rivers Act of October 2, 1968, established a national system designating all or portions of eight rivers as initial components (fig. 1). This system presently involves nearly 60,000 acres of National Forest System lands. The creating legislation (Public Law 90–542) provides for study of other candidates for inclusion in the System. The total forest acreage that might be withdrawn for this System is not known but is not likely to be great. Much of these forest lands are in bottom hardwood forest types in the East and more frequently in conifers in the West. While the overall contribution of such lands to national timber production may not be high, their study for withdrawal to the Wild and Scenic Rivers System should not be taken lightly. Many eastern hardwoods, for example, are important to the fine furniture trade.

### National Scenic Trails System

Forest Service land in four national forest regions is involved but no acreage or volume data are presently available on these forest system lands. Acreage data are expected to be available within a year. Designation of forest land under this System's provisions is not likely to be of consequence to national timber production.

### National Game Refuges

In addition to the wildlife refuges and game refuges administered by the Department of the Interior, there are approximately 1.3 million acres of national forest land administered by the Forest Service as national game refuges. These refuges, situated within the national forests, were designated by proclamation or by special act of Congress for the protection of game. Over half of this national forest game refuge acreage is in the Grand Canyon Game Reserve in Arizona; over 500,000 acres are in the East (Forest Service, 1971).

There are no data available on timber inventories on these restricted lands which are under Forest Service administration. However, timber harvesting, *per se*, is not prohibited. It is merely subordinated to wildlife interests.

### National Recreation Areas

Nearly half a million acres of National Forest System lands are in four national recreation areas and constitute 78 percent of the total land in these four areas (Forest Service, 1971). The Forest Service information system does not carry data on the acreage involved which is classified as "commercial" nor does it carry timber volume data by reserved area. Timber harvest is subordinated to recreation values on these areas, however.

### Research Natural Areas

> A research natural area is an area where natural processes are allowed to predominate and which is preserved for the primary purposes of research and education. These areas may include:
>
> (*a*) Typical or unusual faunistic and/or floristic types, associations, or other biotic phenomena.
>
> (*b*) Characteristic or outstanding geologic, pedologic, or aquatic features and processes. Research Natural areas have these objectives:
>
> 1. To assist in the preservation of examples of all significant natural ecosystems for comparison with those influenced by man.
> 2. To provide educational and research areas for scientists to study the ecology, successional trends, and other aspects of the natural environment.
> 3. To serve as gene pools and preserves for rare and endangered species of plants and animals.[2]

A further function served by such research natural areas is as benchmarks in evaluating landscape and other ecological change (Moir, 1972).

> They are useful for evaluating the improvement or impairment resulting from the intervention of man in an otherwise natural environment. The urgency for setting aside and protecting these areas becomes greater as our expanding population grows; and as far-reaching environmental controls, such as weather modification, become a reality.[3]

When the Federal Committee on Research Natural Areas published its first directory, it was able to list over 300 research natural areas (RNA's) set aside on Federal lands. Since that listing, the total number of such areas on Federal

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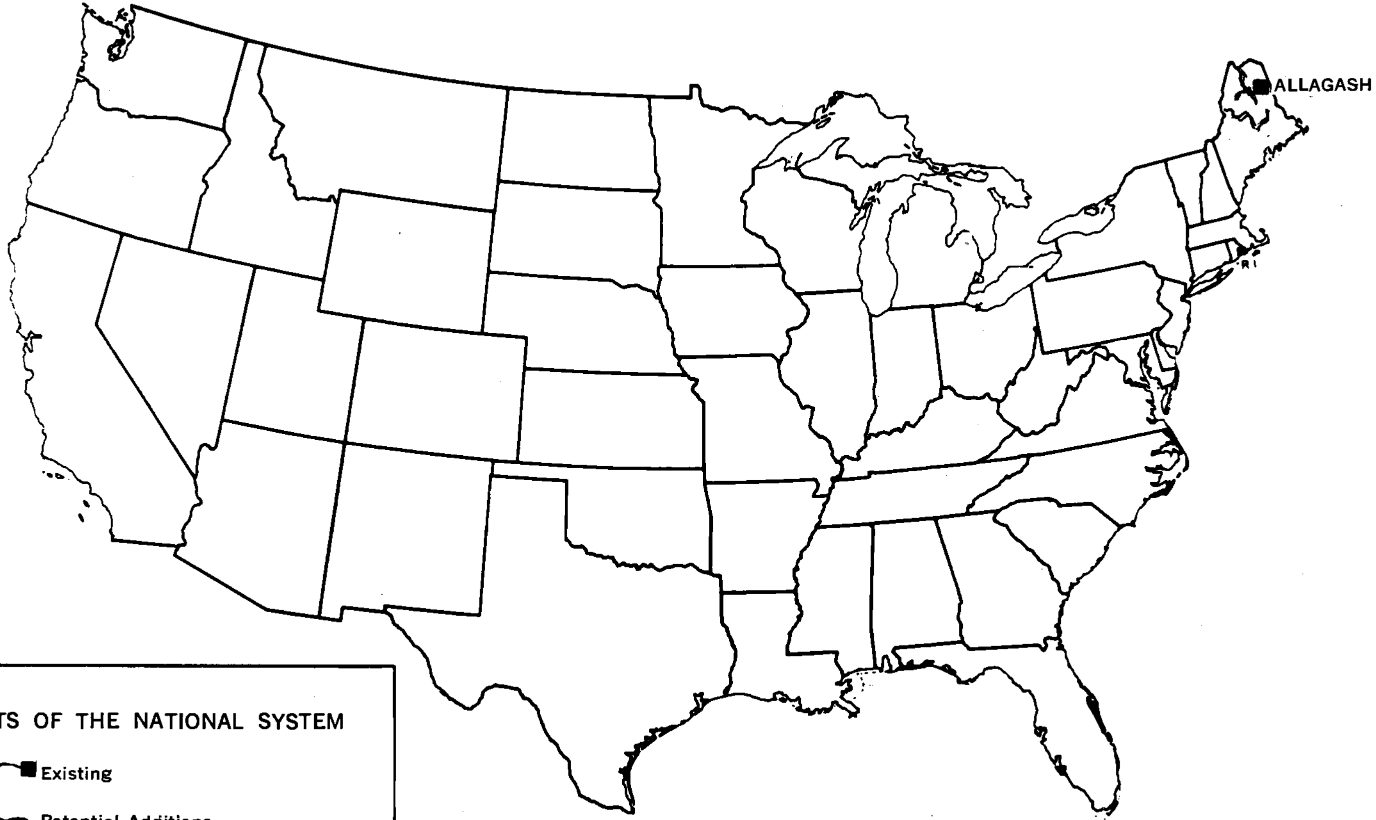
[2] From introduction, "Research Natural Areas," 1968, Federal Committee on Research Natural Areas.

[3] From forward, "Research Natural Areas," 1968, by Secretaries Orville L. Freeman and Stewart L. Udall.

**FIGURE 1.—National Wild and Scenic Rivers System**

AS AUTHORIZED BY P.L. 90–542




UNITS OF THE NATIONAL SYSTEM

Existing

Potential Additions

MANAGEMENT OR STUDY RESPONSIBILITY

★ Dept. of Interior

☆ Dept. of Agriculture

● Non-Federal

[1] State of Maine

U.S. DEPARTMENT OF THE INTERIOR
Bureau of Outdoor Recreation
July 1970

lands has more than doubled. The 1968 directory included 81,884 acres in 74 RNA's under Forest Service management as well as many forest types managed by BLM, NPS, and the USFWS. In 1971 the National Forest System listed 16,116 acres in 25 RNA's on eastern National Forest System lands, and 90,000 acres in 70 RNA's on western National Forest System lands (a total of over 106,000 acres for 95 RNA's in 29 States and Puerto Rico).[4]

Research natural areas seek to include representatives of all vegetational "types." The primary land classification systems used are Küchler's "Potential Natural Vegetation of the Conterminous United States" (American Geographical Society Special Publication 36, 1964) and the Society of American Foresters' "Forest Cover Types of North America (Exclusive of Mexico)" (1954). The SAF system includes 106 separate types for eastern North America and 150 types for western North America. The Federal Committee on Research Natural Areas has calculated [5] that as of 1970, areas were still needed in the System to assure preservation or additional representation of 19 SAF western forest cover types on 29 additional areas as well as of 15 rare and endangered species or varieties on 15 more areas. Also, eastern forest cover types considered as yet ill-represented or unrepresented number 59 on 74 additional areas. Two rare and endangered species of eastern conifer also require further protection, and designation of three areas for this purpose was recommended. It should be noted that nonforest types such as range and desert cover are indicated in the Federal Committee's report but are not summarized here.

By order of the Secretary, the Chief of the Forest Service is required to establish

> * * * a series of research natural areas, sufficient in number and size to illustrate adequately or typify for research or educational purposes, the important forest and range types in each forest region, as well as other plant communities that have special or unique characteristics of scientific interest or importance.

These areas are to be

> * * * retained in a virgin or unmodified condition except where measures are required to maintain a plant community which the area is intended to represent (CFR, 1972).

No timber harvesting in a commercial sense is thus permitted.

These Forest Service approved designations, if fully met, could result in a total addition of over 80,000 acres [6] placed in the Research Natural Areas classification for a potential grand total, so designated, of over 185,000 acres of National Forest System lands.

Before leaving the subject of research natural areas, it should be noted that the work of the Federal Committee on Research Natural Areas may be made a continuing responsibility of the Council on Environmental Quality. The Civil Works Branch of the Army Corps of Engineers is presently considering preparing an inventory of all the Nation's natural, historical, and cultural treasures including natural areas, and the Nature Conservancy, the U.S. International Biological Program Conservation of Ecosystems Section, and the Smithsonian Center for Natural Areas are jointly working to establish a National Registry of all such areas, regardless, of ownerships. These developments portend an increasingly valuable body of information by which to evaluate future land needs for some of the purposes which may affect the commercial timber base.

### Special Interest Areas

Under a separate regulation (CFR, 1972), the Forest Service designates Special Interest Areas which are set apart and reserved for public recreation use. Including historical, archeological, geological, botanical, memorial, and scenic areas, the total as of March 1972 (Forest Service, 1972) was 133 areas netting nearly 900,000 acres of Forest System land.

## IMPACTS ON THE COMMERCIAL TIMBER BASE

The various categories of statutory or administrative restrictions on National Forest System lands are summarized in table 4. It is regrettable that desirable information as to the fraction of affected acreage in these categories which is considered commercial forest is generally wanting. It is also impossible to judge of what relative quality such lands are for purposes of commercial

[4] "Research Natural Areas of the Forest Service," U.S. Department of Agriculture, 1971, U.S. Forest Service.

[5] Memo from the Chief, U.S. Forest Service, to regional foresters and directors, except R–10, FPL, and ITF, Aug. 10, 1970, on subject of research natural areas.

[6] Based on an estimated 693 acres for each of the required 120 new Areas, 693 being the median value (640, mode) for 94 RNA's on FS lands and now in the System.

**TABLE 4.—National Forest System Lands Withdrawn for Nontimber Uses by Statute or Restricted for Use by Administrative Action**

| Land use category | Total National Forest System lands (acres) |
|---|---|
| Forest Service National Wilderness Areas [1] | 10, 258, 036 |
| Forest Service Primitive Areas [1] | 4, 331, 156 |
| National Game Refuges | 1, 357, 760 |
| Special Interest Areas [2] | 900, 000 |
| National Recreation Areas | 495, 499 |
| National Wild and Scenic rivers | 59, 720 |
| National Scenic Trails | (3) |
| National Monuments [4] | 105, 576 |
| Research Natural Areas | 106, 000 |
| Total (less national scenic trails) | 17, 613, 747 |

[1] Of the 14,569,192 acres in National Forest wilderness and primitive area designations, 6,732,000 acres are classified as commercial forest land and are estimated to carry 58,239 million fbm of commercial timber.
[2] Scenic, geological, archeological, historical, botanical, and memorial areas.
[3] Acreage data expected in 1973.
[4] Administered by the National Park Service but remain listed as National Forest System lands.

Source: Materials prepared for the President's Advisory Panel on Timber and the Enviroment by U.S. Forest Service, March 1972.

timber growing, or to learn what volumes of timber of commercial quality are presently on such lands. Data on acreage classified as commercial forest land, and on volume of commercial timber involved was furnished only for national forest wilderness and primitive areas (table 4, footnote 1). In other words, quantitative measurement of the effects of such restricted use designations of National Forest System land on the commercial timber growing base is all but impossible at the present time.

## Allowable Cut Percent Approach to Volume Estimation

Certain estimates or indices for judging commercial timber inventory on such forest lands may sometimes be available. For example, in a letter dated February 21, 1972, and directed to Secretary Butz by Chairman Seaton, the Panel requested the following, among other, information of the U.S. Forest Service:

> For each National Forest and Forest Service Service Region the Panel would like to have your estimate on (1) the effect each withdrawal or limitation of use has had on the allowable cut limit, (2) the impact on the local economy through foregone forest receipts that are shared with the county, through employment that might otherwise be presented, and (3) an estimate of the impact such management decisions have on the regional and national economy, and supply of wood for wood products, compared to benefits derived from the withdrawal.

The Forest Service responded on March 2, 1972, that "* * * rather exhaustive effort would be required at the district, forest, and regional levels to provide the detail requested." It then suggested alternatively, that a "traditional rough estimation method" be employed to approximate effects of certain land use designations on allowable harvest. This method first requires calculation of an allowable cut percent, determined according to the formula:

$$\text{Allowable cut percent} = \frac{\text{Nonmodified annual allowable cut}}{\text{Nonmodified inventory volume}}$$

That is, if one divides the annual allowable cut volume for all stands under usual forest regulation on any given management unit (whether more or less than an entire national forest), by the total inventory volume for those same lands, one gets a base line allowable cut percent. This percent is then multiplied times the modified inventory,[7] unregulated inventory,[8] productive reserved inventory,[9] and productive deferred inventory.[10] This results in an estimate of the *potential limit*—that sawtimber volume that could be cut if there were no constraints in specially designated areas for the lands under these management restrictions. The potential limit can then be compared to the *present limit*—that sawtimber volume presently being harvested—to approximate the harvest opportunity costs or harvests foregone under the management restrictions operating.

[7] *Modified inventory* is that inventory on the part of the regulated forest area where local conditions require an adjustment in the usual rotation. This classification is not used if stand management (usually to provide described landscapes) other than rotation adjustments will meet the objectives.

[8] *Unregulated inventory* is that inventory on all nonused commercial national forest land which is not to be regulated during the plan period. Included in this category are: Material without the prospect of a reasonably steady market such as small, low-grade, or exceptionally remote stock; material on recreation and administrative sites; and material on experimental forests.

[9] *Productive reserved inventory* is that inventory on productive forest lands withdrawn from timber utilization by statute, administrative regulation, or by designation in land use plans approved by the Regional Forester.

[10] *Productive deferred inventory* is that inventory on productive forest land administratively identified for study as possible additions to the wilderness system or for other withdrawal from timber utilization under authority granted in the Federal Code of Regulations.

The Forest Service points out "* * * such a method can be quite wide of the mark for a given small area, but indicative for large aggregations where errors may tend to balance." [11] Such a tabulation showing inventory volume and potential and present harvest limits is presented in the appendix to this paper, as prepared by the Forest Service.

The Forest Service presently administers approximately 29 million acres in the modified, unregulated, productive reserved, and productive deferred categories. Were there no constraints on timber harvesting on these lands, the allowable cut percent approach to estimating timber volumes (as described above and in the appendix) yields an estimated sawtimber volume of 226,400 million fbm (local scale) and an annual potential limit of 3,288.8 million fbm which could be harvested on these 29 million acres.[12]

Thus, for the 14.5 million acres of Forest Service lands in Wilderness and Primitive Area classification and which include 6.7 million acres of potentially commercial forest land, this method estimates a sawtimber inventory of 58,239 million fbm (local scale) equivalent to an annual potential limit of 879.9 million fbm (appendix).

Even this information, if accurate, is inadequate for it does not measure economic impact resulting from the Wilderness and Primitive Area restrictions on timber harvest. In the words of the Forest Service: [13]

Your request for an assessment of the national, regional, and local economic effects of each type of withdrawal and limitation is a most formidable task in view of the time and resources available. Adequate answers to the questions posed would require major comprehensive economic analyses. One major problem is lack of an inventory of timber volume, acres, and productivity, especially in Wilderness and Primitive Areas.

It should be realized that the feasibility and costs of getting such information as was requested of the Forest Service by the Panel have not been fully measured nor assessed. Certainly, there is reason for viewing such a task in the short run as a relatively low priority item when measured against competing demands on the finite resources of personnel and capital. Nevertheless, information on the inventory and site quality of lands presently or potentially affected by use restrictions is generally available in raw form at most ranger districts. It would seem that aggregation of such information at forest, regional, and national levels is desirable. Such compilations can be achieved in the future at minimal extra costs at the time new forest management plans are developed and revised, forest by forest.

### Limited Forest Service Acreage and Volume Estimates

As indicated by table 4 and further noted above, the present Forest Service information system does not carry commercial forest acreage nor commercial timber volume data for many of the restricted use systems. For the areas involved in the Roadless Area Review, however, the Forest Service has estimated the parameters of commercial forest land acreage, potential yield, and annual allowable harvest (table 1). The estimated commercial forest land in this category (18,292,693 acres), carries a Forest Service-estimated potential yield of roughly 5 billion fbm of sawtimber equivalent to an annual allowable harvest of approximately 2.3 billion fbm. It is unclear whether these figures were produced by applying the "allowable cut" percent approach detailed in the appendix, or not.

This arithmetic does provide a partial index of the impact on the commercial timber base should all or part of the roadless area commercial forest land be withdrawn from timber production. But if withdrawal decisions are to be made by the Congress after weighing economic considerations at local, regional, and national levels; then better and more complete data on such lands and their commercial timber value must be developed.

### Generalized Withdrawal Assumptions

Attempts at considering the impact of withdrawals or other land use restrictions on the commercial-timber-producing base by use of percentage estimates of "loss" also exist in the literature.

Stankey (1971), for example, has assumed 100 percent taking of Forest Service primitive areas, 67 percent taking of "de facto" Forest Service wilderness in the 48 contiguous States, and 75 percent taking of such "de facto" lands in Alaska—all to

[11] From materials prepared for the Panel by the Forest Service, Mar. 2, 1972.

[12] Note that this acreage is over 11 million acres greater than the total shown in column 2 of table 4. This is because the latter does not include *all* lands the Forest Service classifies as modified, unregulated, or productive deferred.

[13] From materials prepared for the Panel by the Forest Service, Mar. 2, 1972.

go into the harvest-forbidding wilderness system. While begging the question of the probable validity of such assumptions, one can note that they still deal only with gross acreage and not with either commercial forest acreage or volume.

Marty, in a paper appearing elsewhere in these appendices,[14] has estimated

> * * * the impact on area, inventory, and growth of potential commercial forest land withdrawals and management restrictions. This projection supposes a reduction of commercial softwood forest land acreage of 17 percent, an inventory reduction of 24 percent and a growth reduction of 16 percent. Of course, this is only a guess about what might be the case if withdrawals and restrictions proceed at a rapid pace, and economically inaccessible areas prove to be substantial.

His estimates are for all ownerships—national forests, other public, forest industry, and other private—and are derived from individual estimates for each ownership class. In the case of national forest land, Marty has assumed an area for commercial timber production which is 20 percent less than the 1970 inventory base. He assumes a 30-percent reduction from the 1970 base in inventory and growth on national forest lands. These assumptions of impact are then included in his projections of timber supplies. Marty's assumptions are not refined nor justified by individual withdrawal or restricted use category. They merely serve as aggregated estimates for supply projection purposes and were probably very loosely assumed. They are assuredly very liberal, possibly excessively so.

Ergo, it is quite clear that neither spot estimates of acreage or volume, percentage assumptions, nor formula approximations are sufficient to the task of measuring and weighing real impact of past and possible withdrawals of forest land on commercial timber production. Acreage data is assuredly insufficient as an index to impact, yet this parameter is perhaps most frequently bandied about in controversies over proposed wilderness withdrawals.

Even when the acreage is specified as "commercial", it may be a misleading index since commercial forest land is defined broadly enough to include some land of marginal character—biologically, economically, or both. When commercial forest land in national forests is classified by site class (tables 5A and 5B) one finds that over one-fourth of the national total is capable of producing less than 50 $ft^3$ of wood per acre per year. In the southern Rocky Mountain States, nearly 60 percent of the national forest land falls below this level of productivity potential. By contrast, only 9 percent of the national forest land in the Pacific Northwest falls below this level. Table 5A indicates clearly the disparity among sections and regions of forest land productivity profiles. Quite obviously, much forest land, especially outside the Pacific regions, is not part of the Nation's most productive commercial forest land base. Much present and potential wilderness lands are of relatively lower productivity calibre; such lands when removed from commercial timber production do not have major impact, nationally, on total wood production.

It must be borne in mind that these site classes are based on estimated growing capacity or *potential* yield under conventional management. These classes are not equivalent to *current* productivity (which may be less than the potential) nor to the presently harvestable crop nor to the potential under site modification treatments. Thus, the site class as designator of growth capacity is not to be confused with measures of actual annual growth. Some land presently judged capable of growing but 25 $ft^3$ per acre per year when stocked with hardwoods, may actually be capable of growing nearly twice that volume per acre per year if converted to softwood stands. In this regard, some land presently classified as low in timber productivity may actually be of higher quality under different management.

It has been stated that good estimates of the volume of commercial grade timber on past or proposed withdrawals are rare and that there are almost never actual cruised inventories. Equally rare are analytic data on the economic impact at local, regional, and national levels for past and proposed withdrawals of, or other land use restrictions on, commercial forest land. An example of a case where explicit impacts were estimated was prepared by the Industrial Forestry Association and Western Wood Products Association and presented to the Panel by Mr. Bert Cole of the Department of Natural Resources of the State of Washington. The following figures on three areas[15] in

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[14] Robert Marty. 1972. "Softwood Sawtimber Supply and Demand Projections." App. C.

[15] Alpine Lake No. 6; Conger Lakes No. 12; Goat Rock-Bear Creek Mountain.



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**TABLE 5.**

| Section, region | Total | 165 ft³ or more | 120 to 165 ft³ | 85 to 120 ft³ | 50 to 85 ft³ | Less than 50 ft³ | 50 ft³ or more | Less than 50 ft³ |
|---|---|---|---|---|---|---|---|---|
| A. Area of commercial forest land in national forest, by site class, section, and region, as of Jan. 1, 1970 (thousand acres) | | | | | | | B. Percent of national forest land above and below the 50 ft³ per acre per year productivity level, by section and region | |
| North: | | | | | | | | |
| New England | 832. 4 | 0 | 62. 7 | 142. 9 | 330. 3 | 296. 5 | 64 | 36 |
| Middle Atlantic | 1, 367. 1 | 0 | 100. 7 | 322. 7 | 858. 4 | 85. 3 | 94 | 6 |
| Lake States | 5, 867. 8 | 1. 8 | 17. 5 | 244. 4 | 4, 426. 7 | 1, 197. 4 | 80 | 20 |
| Central | 2, 390. 7 | 0 | 43. 2 | 83. 3 | 1, 275. 1 | 980. 1 | 59 | 41 |
| Total | 10, 458. 0 | 1. 8 | 244. 1 | 773. 3 | 6, 890. 5 | 2, 568. 3 | 75 | 25 |
| South: | | | | | | | | |
| South Atlantic | 2, 789. 3 | 17. 8 | 73. 2 | 306. 8 | 1, 450. 9 | 940. 6 | 66 | 34 |
| East Gulf | 1, 842. 0 | 16. 9 | 42. 2 | 383. 8 | 1, 003. 0 | 306. 1 | 78 | 22 |
| Central Gulf | 2, 344. 3 | 55. 5 | 213. 3 | 808. 2 | 1, 015. 4 | 251. 9 | 89 | 11 |
| West Gulf | 3, 788. 5 | 21. 9 | 127. 5 | 718. 6 | 1, 758. 7 | 1, 161. 7 | 69 | 31 |
| Total | 10, 764. 1 | 112. 1 | 456. 2 | 2, 217. 4 | 5, 228. 0 | 2, 730. 4 | 75 | 25 |
| Pacific: | | | | | | | | |
| Northwest | 22, 571. 0 | 1, 346. 0 | 4, 001. 0 | 6, 487. 0 | 8, 697. 0 | 2, 040. 0 | 91 | 9 |
| Southwest | 8, 344. 0 | 459. 0 | 889. 0 | 2, 214. 0 | 3, 821. 0 | 961. 0 | 90 | 10 |
| Total | 30, 915. 0 | 1, 805. 0 | 4, 890. 0 | 8, 701. 0 | 12, 518. 0 | 3, 001. 0 | 90 | 10 |
| Rocky Mountain: | | | | | | | | |
| Northern | 24, 120. 4 | 978. 9 | 2, 885. 9 | 5, 369. 9 | 5, 194. 8 | 7, 579. 5 | 69 | 31 |
| Southern | 15, 666. 9 | 39. 9 | 44. 7 | 474. 3 | 2, 890. 5 | 9, 282. 1 | 41 | 59 |
| Total | 39, 787. 3 | 1, 018. 8 | 2, 930. 6 | 5, 844. 2 | 8, 085. 3 | 16, 861. 6 | 58 | 42 |
| Total all regions | 91, 924. 4 | 2, 937. 7 | 8, 500. 9 | 17, 535. 9 | 32, 721. 8 | 25, 191. 3 | 73 | 27 |

Source: From material furnished the President's Advisory Panel on Timber and the Environment, special communication, July 18, 1972. Cf "Forest Statistics for the United States by State and Region," 1970, table 5, pp. 16-19. U.S. Forest Service, 1972.

Washington State proposed by the Forest Service for wilderness study were presented:

> The three undeveloped areas proposed for wilderness study by the Forest Service have a total acreage of 170,800 acres, of which 84,900 acres are classed as commercial forest land. These lands contain 2,220 million fbm. If intensively managed for timber production, these areas would sustain an annual allowable cut of 30.9 million fbm. This allowable cut would generate a total of about 1,000 jobs and total income of $22 million, all within Washington.

The Associations' information materials go on to estimates that for other undeveloped areas under Forest Service review and totaling 343,700 acres, the 167,000 acres of commercial forest land contain 5,440 million fbm which, intensively managed for timber production, could sustain an annual allowable cut (AAC) of 77.9 million fbm generating 2,600 jobs worth $55,600,000 to the State of Washington.

These figures average out, for threse two groups of Washington forest tracks, to approximately $260 and $330 per acre of commercial forest land in unmodified income potentially foregone, respectively. Such calculations are not absolute and may be misleading because of the economic assumptions behind their derivation, because they attempt to measure local, not national opportunity costs, and because they do so without comparable calculations of benefits associated with such land uses.

Nevertheless, these examples illustrate the calculations that could be made were better data readily available. Omissions in the Forest Service information capability system can hamper informed and equitable decision making by the Congress and others in deciding the fate, size, and boundaries of proposed statutory withdrawals, as they consider the possible impacts of such actions.

## PRESSURES AND TRENDS TOWARD INCREASED RESTRICTIONS

The various withdrawals or restrictions discussed above are not static. The pressures and statutes under which public land managers and land management agencies operate are increasing in the direction of greater and more explicit restrictions on land uses. There appear to be three broad bases of pressures which tend to restrict full land management options, including timber harvest. One base is existing legislation such as that creating the National Wilderness Preservation and the National Park Systems and which provides for additions to such systems. The second base is the increasing sentiment in the Nation for environmental quality, the environmental ethic in land stewardship, and for a better balance of multiple-use management in favor of greater esthetic, amenity, and fish and wildlife considerations even at the expense of commodity products. Finally, the outdoor recreation movement and its related industry really constitute a valid third base of pressures. A significant and increasing segment of the public seeks a management of public lands which may directly benefit it through recreation opportunities in preference to the sometimes more subtle, indirect benefits it receives from management for wood products uses. Certainly the widespread tendency to view public land recreation as a "free good" is significant here. This is likely to change as recreation users of public lands begin to bear a greater burden of the real costs of providing such recreation opportunities.

Moreover, when the total national supply of productive forest lands is used as a base rather than National Forest System land alone, less than 5 percent of that national total has been reserved for purposes other than timber production. It seems reasonable to conclude that the remaining 95 percent can be so managed to more than compensate for forest lands lost to commercial timber production through withdrawals for other purposes.

Finally, while these pressures or trends toward increased restrictions may well result in some further losses of the commercial-timber-producing base, in most cases timber production will remain compatible, often inevitable, and definitely necessary. Certainly many of the attributes of forested land valued so highly by the public require the best management of which society is capable and commercial production and harvest of timber is inherently part of and contributing to such management. It also must be noted, and firmly so, that many of the increasing demands for the noncommodity uses of America's forest lands are often far less in conflict with timber production than they are with each other. Many forms of outdoor recreation are antithetical to the wilderness experience, for example, and cross-country skiers lose little love on snowmobilers if they compete in time and space.

### Underlying Rationales and Alternatives

The individual forests which collectively constitute the American forest resource vary in size from a dozen to over 16 million acres. Regardless of extent, however, a forest is first and foremost an ecosystem. It is a dynamic complex of many populations of organisms, both plant and animal, which coexist on a given area of land. Its overall properties are a function of biological and geological evolution within a general climatic regime. A forest intrinsically produces many biological, physical, and social products simultaneously. Even if man chooses to manipulate a forest with a view toward maximizing output of one or more products, irrespective of impact on other forest products, he cannot do so to the complete exclusion of the latter. Similarly, no management scheme or action aimed at part of a forest ecosystem will fail to have secondary or even higher order effects elsewhere in the system. These ramifying effects may be supportive of, or competitive with, first order effects in terms of man's stated goals. In other words, it is impossible, for example, to so manage a forest as to produce wood and nothing else; inevitably, water, forage, wildlife and many other products flow from the resource as well. It is also impossible to apply a management action, such as thinning of trees, so as to affect only the primary target in the ecosystem and not affect other parts. There are no single-linkage relationships in any ecosystem.

It is these ecological truisms which lead to conflicts between uses which are not entirely compatible or are entirely incompatible, and hence to conflicts between the various public who identify more strongly with some uses than with others.

With respect to America's public forest lands, the official policy of multiple-use and sustained yield has sought to provide for optimization of forest land products and services in the public interest through integrated resource management. Whenever the operational expressions of this policy led, or seemed susceptible to leading, to inadequate protection for a rare and endangered resource, seemed to result in a "lowest common denominator" version of optimal uses, or seemed to favor one or more uses disproportionately over others, significant political pressure developed to provide alternative mechanisms in support of the threatened product or value.

The fundamental rationale in all cases is that where uses are partially or wholly incompatible and public opinion or policy (as expressed through the Congress) supports explicit favortism to some degree, then a removal of discretionary authority from the agency or land manager is deemed necessary and desirable. Such action makes support and protection of the resource or use in question somewhat easier, stronger, and more stable. Additions and subtractions to systems such as the National Wilderness Preservation System are subject to explicit and systematic procedures and cannot be whimsically affected by short term changes in political climate or in agency personnel.

An inspection of corollary assumptions in the case of wilderness withdrawals may be instructive.

### Wilderness Withdrawals

Through the Wilderness Act, Congress states its belief that increasing population and human developments will occupy or modify all areas of the Nation except those protected through reservation in their natural state. The Act is intended to assure the Nation of an enduring wilderness resource and official wilderness areas are to be administered "* * * in such a manner as will leave them unimpaired for future use and enjoyment as wilderness * * *." The assumptions are that the wilderness resource can be assured an American future only by explicit protection and that such protected Federal lands will ultimately constitute the entire American wilderness resource.

Section 2(c) of the Act officially defines wilderness.

> A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain. An area of wilderness is further defined to mean in this Act an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitations, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; (3) has at least 5 thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, education, scenic, or historical value.

The first part of the definition emphasizes the primitive nature of wilderness land; the second part emphasizes the point that in such areas the imprint of man's works be substantially unnoticeable. The first part of the definition appears to state an ideal concept of wilderness; the second part attempts to realistically define what may qualify as wilderness on the Nation's public lands.

A controversial assumption flowing from the Wilderness Act is tied to semantics as certain key phrases are interepreted by different principals. One school focuses on the phrase "* * * area of undeveloped Federal land retaining its primeval character and influence * * *," emphasizes the word "retaining" and argues that few, if any, eastern areas qualify for wilderness designation because of man's prior cultural activities on the lands. This view assumes wilderness in the Wilderness System must all be of the purest form, without the philosophical taint the mere knowledge of man's past activity evokes in the purist, irrespective of present physical evidence.

A more flexible school has rebutted this case in two ways. First, since the Congress in creating the Wilderness System included some eastern areas (which are subject to the same criticism of impurity as presently proposed eastern lands) as part of the origianl nucleus of the wilderness system, and since Congress has seen fit to add additional eastern areas to the system, "ipso facto" it was and is congressional intent that eastern areas may qualify. In fact, S. 3792, a bill before the Committee on Interior and Insular Affairs in the last session of Congress, was an explicit declaration that eastern wilderness areas do exist and that more of them should be promtply added to the National Wilderness Preservation System. The bill would have also added 11 specific, new wilderness areas on national forest land in the States of Alabama, Arkansas, Florida, Georgia, Missouri, North Carolina, Tennessee, Virginia, and West Virginia. These 11 proposed areas total about 211,000 acres. The second rebuttal returns to the language of the Wilderness Act to focus on additional phrases and key words. For example, the definition also says a wilderness area must be "* * * without permanent improvements or human habitation * * *" and that it "* * * generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable * * *." This school emphasizes the words "permanent," "generally," "primarily," and "substantially." The argument is made that this wording aims at flexible qualifying of lands with respect more to present conditions than to past history *per se*.

Pressures for increasing the supply of wilderness recreation through the designation of additional wilderness areas in the East has been increasing in recent years. The President's message on the environment of February 8, 1972, recognized the need for preserving additional eastern wilderness and directed the Secretaries of Agriculture and Interior to accelerate the identification of eastern areas having wilderness potential. Both Departments are currently reviewing such potential areas. Several special problems exist in the eastern region, however:

(*a*) Almost all eastern wild areas have undergone modification by man at some time over the past four centuries.

(*b*) Federal ownerships are more limited in the East than in the West.

(*c*) Pressures of land price escalation and private second home development are high in the East.

(*d*) Federal ownerships are fragmented; for example, approximately one-half of the land within eastern national forest boundaries is in private ownership.

(*e*) Most waterways and water surface rights, as well as mineral rights, are not controlled by the Federal Government.

A major issue is whether or not many existing "de facto" wilderness lands within Federal ownership fit the criteria defining wilderness in the Wilderness Act.

The Forest Service has interpreted the Wilderness Act such as to conclude that "* * * few areas in the East would meet the criteria for wilderness as set forth in section 2 of that act." [16] It is presently exploring alternatives to the Wilderness Act of providing primitive and wild recreation areas in the Eastern United States.

One alternative receiving serious consideration was the subject of several bills before the Congress in the last session (and which will likely be reintroduced in the present session). S. 3699, H.R. 14392, H.R. 15611, H.R. 15651, and H.R. 15851 were all bills to establish a system of wild areas within the lands of the National Forest System. This proposed system essentially is modeled after the Wilderness System but is aimed at lands deemed unqualified for Wilderness System designation by reason of the past works of man. The mechanisms for designation as an eastern Wild Area are essentially the same as those required by the Wilderness Act. This proposed system of Federal Wild Lands, too, would provide that:

> * * * Primitive, natural, and wild conditions will be restored, maintained, and protected to provide for public use and and enjoyment for recreation, scientific, and educational purposes in a natural setting free from the activities and highly developed works of man, wherein natural attractions prevail in an atmosphere of spacious solitude.

Developments are to be primitive and rustic and "* * * limited to those reasonably necessary for the health, safety, and well-being of the visiting public and protection of natural resources." Among other limitations, commercial timber harvesting would be prohibited. The system could allow, in some cases, for an evolution of land, after continued restoration, into the wilderness system via subsequent congressional action.

Opponents of this proposed second wild land system argue that the duplicate Government machinery would be wasteful and would increase bureaucratic inefficiency, that the Wilderness Act and

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[16] Testimony of John McGuire, Chief, U.S. Forest Service, July 24, 1972, before the Forest Subcommittee of the House Committee on Agriculture.

the Multiple Use-Sustained Yield Act already provide sufficient authority to protect eastern wild lands. Wilderness advocates fear a sapping of the strength of the standards of the Wilderness Act; forest industries fear a further loss to harvest of valuable commercial timber important to national and local economies.

There have been attempts made from time to time to reconcile various distinctions and arguments over what is or is not wilderness or "true" wilderness (i.e., wilderness versus Wilderness). Prof. Earl Stone (whose worthy contribution to this Panel's work appears as app. M) has made some cogent observations[17] which require no further comment.

* * * I believe we exaggerate what pure wilderness means to the great body of men. Europe has survived without it, except above the limits of alpine grazing and—if one ignores the Lapps—in the furthest north. Some Europeans found it by travel, exploration, or colonization, though often not willingly.

Perhaps one could avoid many semantic and biological difficulties, and undefensible distinctions by stating three premises: (*a*) Wilderness is that which is perceived as wild, by whatever expectations, criteria or demands the viewer has. (*b*) There is a vast range in the satisfactions men seek or find through what you are calling "wilderness experience"; there are many non-visitors for whom the experience is only vicarious. For most, the degree of satisfaction is related far more to their perceptions than to any absolute scale of human non-interference. (*c*) Some part of the expressed passion for wilderness is really for scenic grandure and natural beauty on even the smallest scale, free from obtrusive artificiality or meretriciousness. It is against billboards and resort towns, not against ski runs and small access roads.

Each of the three could be elaborated but to me they seem self-evident. Each could be documented many times over in * * * our [New York's] Adirondack Preserve. Distinguishing Pure Wilderness from lesser states of wilderness mostly concerns an elite society of assorted foresters, ecologists, biologists, explorers and a miniscule fraction of Sierra Club types—but certainly not honest philosophers, poets, intellectuals and men on the streets who are untroubled by distinctions they do not perceive. I strongly suspect that this latter group is far less concerned over Wilderness West *vs.* Wilderness East than the former group should be about Indians, sheepherders and miners in Wilderness—or is it wilderness—West.

So instead of wrestling with degrees of virginity, why not explicitly recognize a spectrum of wilderness, in which a vast range of users find varied satisfactions according to their perceptions and needs. For vast numbers, the multiple use forest is more than wild enough, although the manager may have to give more thought to their sensitivities than he has in the past.

[17] Personal communication, Dec. 21, 1972.

## Other Assumptions Behind Land Use Restrictions

A case has been made that some assumptions about wilderness have led to an emphasis on the Wilderness System as the essentially sole provider of the wilderness resource. Also mentioned was the confusion and controversy in the East resulting from differing interpretations of language of the Wilderness Act. Moving beyond the wilderness case alone to land use restrictions generally, the following observations are offered.

Demands that have both economic and political components, such as those in outdoor recreation, are highly subject to being oversimplistically equated with perceived needs. The bases by which opinion-makers and private and public leaders have concluded that Americans *need* more campgrounds or more wilderness area recreation opportunity are woefully unscientific. Beliefs and values held as to what man wants and needs, or at least ought to want and need, are no substitute for scientifically gathered data. The assumption that decision-makers, both private and public, know what the recreationists' driving motives or psychological needs are is a pervasive one with weighty implications for land policy. Unfortunately, in the absence of much more and much better social science research in the fields of environmental perception, cognitive dissidence, and man-nature relationships, one cannot really sift myth from reality.

A second assumption underlying public policy formation and decision making related to land use restrictions is that the public sector, and primarily the Federal public sector, must assume the greatest burden of response to perceived social needs which are to be met by the land resource. If indications are that Americans want, need, or demand greater outdoor recreation opportunities, for example, the conclusion is often reached that their wants, needs, or demands will be satisfied only by adjustments in Federal public land management. If such land is a scarce resource in local areas where pressures to be relieved are high, a corollary assumption is that the Federal Government should acquire the needed land.

Too little attention is paid the opportunities which exist to better utilize the private land resource and the public land resources at local and State levels. Federal dollars may be required if public use of private lands is to be realistic from the landowner's point of view. Yet, social ends may be more economically achieved if these opportunities on private lands are not ignorantly foregone. The public lands cannot be all things to all people at all times.

A third assumption is that a perceived demand for a given land-based opportunity such as recreation is to be met by an increased acreage response—that is, with more land. If it seems more wilderness opportunities for more Americans are needed, one can add more acres to the Wilderness System. If it seems more camping facilities are needed, one builds more (probably Federal) campgrounds. If public visitation pressures threaten to destroy the very treasures which are national parks were created to protect, we too often try to adapt the resources to the people rather than the reverse. We have not adequately explored the opportunities which exist for more sophisticated land and *people management* as a partial alternative to "more of the same" responses. Thus, pressures on wilderness can be lessened by greater regulation of the users. Wilderness is a fragile resource when subjected to use and it cannot be compromised to those who cannot accept the necessarily concommitant regulation of users and user activities. Much greater opportunity exists for dispersal of visitors on our national parks and forests, in our campgrounds, and on our trails. The point is that effective response to pressures and to perceived needs can be made in ways which are ethically, economically, and realistically superior to a response of "more" acres. Dollars expended for greater understanding of the social and psychological needs which we seek to address through our public lands management can buy us more accurate information on which to separate myth from fact and to aid in more sophisticated response to these pressures and to more efficient and less wasteful uses of our lands.

To recapitulate: Land use restrictions often result from assumptions: (1) That perceived needs or wants are being accurately recognized and understood, when in fact scientific knowledge in this area is inadequate; (2) that land based social products and services are the primary responsibility of the Federal public lands; (3) that pressure for more of a land product should be met by increasing the supply of the land rather than through more wisely and efficiently using the existing supply of the land to achieve effective increases in the product of concern; and (4) (as a corollary to the latter) that the problems faced are primarily land management ones when in fact they're often as much, or more, "people management" problems.

## SUMMARY CONCLUSIONS

1. Losses of productive land, whether from agriculture of forestry, for land-destroying purposes such as strip mining, pipelines, highways, and other aspects of "paved America," should be strongly discouraged as a matter of national policy. America's biologically productive land resource is finite and of absolutely fundamental importance to continued national and world welfare. Destructive/consumptive uses of such land, whenever possible, should be shunted onto lands of least potential for biological productivity and least potential for ecological disruption from such consumptive land uses.

The Nation needs and deserves an integrated and articulated national land use policy of which forest land policies would be an integral part. Presently, the din of inequity, one might say, is loud and compelling with respect to national land uses.

2. Responsible consideration and assessment of the total costs and total benefits to society of alternative forest land uses or alternative combination of uses (including the costs of opportunities foregone) is frequently hampered by inadequate information.

Impacts of past and future withdrawals of national forest land on the Nation s commercial timber-producing base cannot be fully judged at present. The Forest Service information system should permit, for each area of past or proposed withdrawals, a determination of the amount of the land involved in each of the various site or productivity classes as well as the volume of timber of commercial value on such areas. Gross acreage figures do not reveal such important information; neither do data on acres of "commercial" forest land for commercial is too insensitive and inclusive a term as presently defined.

3. The National Wilderness Preservation System should be substantially completed by the end of the decade so that that source of diminution of the productive forest land base will cease to be an issue. At the same time, much more attention to the management needs of wilderness and to the need for regulation of wilderness users must be given.

4. The wild lands recreation base can be expanded in time and space through better dispersal of users over the area, through rotation of recreation use consonant with ecological development of the area, and through public-private collaboration for recreation use of private lands. While private forest land holders may require public investment in operating, regulating, and policing recreation use and users in return for opening their forest land to the public, this may well be a sound public investment. The wildlands recreation base can be effectively expanded in ways other than by Federal purchase of land or by other provision of more Federal acreage of land.

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## APPENDIX

FOREST SERVICE RESPONSE OF MARCH 1972 TO PANEL REQUEST FOR INFORMATION (EXCEPTED)

*Timber volume estimates*

For each National Forest and Forest Service Region the Panel would like to have an estimate on the effect each withdrawal or special category has had on the allowable cut limit. Here again rather exhaustive effort would be required at the District, Forest, and Regional levels to provide the detail requested. However, a traditional rough estimation method can be used to approximate allowable harvest effects of the designations. In essence, this system uses an allowable cut percent approach applied to the inventory volume of areas withdrawn or with special modifications in timber production. The allowable cut percent was determined using the following formula:

Nonmodified A.A.C. ÷ Nonmodified inventory volume = Allowable cut percent

This percent is then multiplied times the (1) modified inventory, (2) unregulated inventory, (3) productive reserved inventory, and (4) productive deferred inventory to obtain an estimate of the potential limit. The potential limit is that sawtimber volume that could be cut if there were no constraints in these specially designated areas. The present limit pertains to sawtimber volume that is presently being harvested and has been prorated by Regional estimates to modified areas. Such a method can be quite wide of the mark for a given small area, but indicative for large aggregations where errors may tend to balance. The following is such a tabulation showing inventory volume, (form 2400–26) potential and present harvest limit.

### Sawtimber Nonmodified (million board feet—local scale)

| Region | Inventory | Annual present limit | Annual potential limit |
|---|---|---|---|
| 1 | 98, 773 | 1, 667. 0 | 1, 667. 0 |
| 2 | 33, 321 | 595. 2 | 595. 2 |
| 3 | 24, 541 | 404. 1 | 404. 1 |
| 4 | 54, 956 | 699. 1 | 699. 1 |
| 5 | 133, 020 | 1, 879. 2 | 1, 879. 2 |
| 6 | 267, 184 | 4, 142. 9 | 4, 142. 9 |
| 8 | 33, 898 | 662. 1 | 662. 1 |
| 9 | 12, 161 | 236. 0 | 236. 0 |
| 10 | 89, 898 | 885. 7 | 885. 7 |
| Total | 747, 752 | 11, 171. 3 | 11, 171. 3 |

### Sawtimber Modified (million board feet—local scale)

| Region | Inventory | Annual present limit [1] | Annual potential limit |
|---|---|---|---|
| 1 | 184 | 4. 3 [1] | 3. 1 [1] |
| 2 | 70 | 0 | 1. 2 |
| 3 | 1, 544 | 14. 0 | 25. 5 |
| 4 | 539 | 2. 2 [2] | 6. 8 |
| 5 | 13, 592 | 96. 3 | 191. 6 |
| 6 | 24, 493 | 247. 1 | 379. 6 |
| 8 | 1, 436 | (3) | 28. 0 |
| 9 | 446 | 6. 8 | 8. 7 |
| 10 | 286 | 2. 1 | 2. 8 |
| Total | 42, 590 | 372. 8 | 647. 3 |

[1] Note calculated potential limit is lower than actual. Illustrates error possibilities inherent in the method for estimating potential, especially fo smaller areas.
[2] No data available. Estimate based on region 1 and region 3 average per acre limits.
[3] Separate harvest rates not established for modified areas under the assumption that full yields are possible through special manipulation of silvicultural practices and timing.

### Sawtimber Unregulated (million board feet—local scale)

| Region | Inventory | Annual present limit [1] | Annual potential limit |
|---|---|---|---|
| 1 | 3, 363 | | 56. 8 |
| 2 | 11, 158 | | 199. 7 |
| 3 | 661 | | 10. 9 |
| 4 | 18, 605 | | 236. 3 |
| 5 | 13, 699 | | 193. 2 |
| 6 | 29, 482 | | 457. 0 |
| 8 | 943 | | 18. 4 |
| 9 | 846 | | 16. 4 |
| 10 | 26, 494 | | 262. 3 |
| Total | 105, 251 | | 1, 451. 0 |

[1] Unestimated.

### Sawtimber Productive Reserved (million board feet—local scale)

| Region | Inventory | Annual present limit [1] | Annual potential limit |
|---|---|---|---|
| 1 | 9, 479 | | 160. 2 |
| 2 | 2, 949 | | 52. 8 |
| 3 | 2, 758 | | 45. 5 |
| 4 | 13, 064 | | 165. 9 |
| 5 | 7, 367 | | 103. 9 |
| 6 | 21, 795 | | 337. 8 |
| 8 | 340 | | 6. 6 |
| 9 | 246 | | 4. 8 |
| 10 | 241 | | 2. 4 |
| Total | 58, 239 | | 879. 9 |

[1] No harvest in proclaimed Wilderness and Primitive Areas.

### Sawtimber Productive Deferred [1] (million board feet—local scale)

| Region | Inventory | Annual present limit [2] | Annual potential limit |
|---|---|---|---|
| 1 | 4, 952 | | 83. 7 |
| 2 | 3, 277 | | 58. 7 |
| 3 | 245 | | 4. 0 |
| 4 | 5, 578 | | 70. 8 |
| 5 | 2, 721 | | 38. 4 |
| 6 | 3, 547 | | 55. 0 |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| Total | 20, 320 | | 310. 6 |

[1] The volume of inventory on productive deferred is not available, but it is assumed that such volume is similar to productive reserved. The volume of inventory is an estimate based on the above premise and land area involved. Therefore, the inventory volumes for productive deferred are included in those figures shown as modified, nonmodified, and unregulated.
[2] Not available.

### Sawtimber Volume Summary [1] (million board feet—local scale)

| | Inventory | Annual potential limit |
|---|---|---|
| Unregulated | 105, 251 | 1, 451. 0 |
| Modified | 42, 590 | 647. 3 |
| Nonmodified | 747, 752 | 11, 171. 3 |
| Subtotal | 895, 593 | 13, 269. 6 |
| Less estimate for productive deferred | −20, 320 | −310. 6 |
| Net available commercial | 875, 273 | 12, 959. 0 |
| Productive reserved | 58, 239 | 879. 9 |

[1] The total estimated sawtimber volume that could be harvested annually assuming no constraints on the modified areas or exclusions would be 14,149.5 million board feet (310.6+12,959.0+879.9=14,149.5).

# GLOSSARY

**Accelerated erosion:** Abnormally rapid erosion in an environment disturbed by man and due primarily to such disturbance.

**Ad valorem tax:** The tax that is applied as a percentage of the assessed value of the property.

**Allowable cut:** The amount of forest products that may be harvested annually or periodically from a specified area over a stated period in accordance with the objectives of management.

**Biotic potential:** The inherent ability of an organism to multiply in the absence of intrinsic controlling factors. In the case of a forest the capacity of a site to produce timber volume.

**Board foot (fbm or bf):** The amount of timber equivalent to a piece 12 inches square and 1 inch thick. A board foot of surfaced lumber would be less in size by the amount of material removed in surfacing.

**Broadcast burning:** Allowing a controlled fire to burn over a designated area within well-defined boundaries for reduction of fuel hazard or to consume the logging debris.

**Cable logging setting:** The land within the yarding distance of the spar tree.

**Campground:** A recreation site provided for overnight use usually with picnic tables, water, and sanitation.

**Cant:** A log partially or wholly square cut.

**Capital gains:** An increase in value of an asset such as land, a house, or a share in a corporation.

**Carrying capacity:** The number of organisms of a given species and quality that can survive in a given ecosystem without causing deterioration thereof.

**Chip-and-saw mill:** A sawmill that removes the round surfaces from logs so as to produce square-edged lumber by means of cutterheads that produce chips suitable for pulp production.

**Clearcut:** Removal of an entire standing crop.

**Clearcutting system:** A silviculture system in which the old crop is cleared over a considerable area at one time; regeneration is generally by artificial means.

**Commercial forest land:** Forest lands capable of bearing merchantable timber currently or prospectively accessible and not withdrawn from such use.

**Commercial thinning:** Any type of thinning producing merchantable material at least to the value of the direct cost of harvesting it.

**Construction plywood:** Plywood suitable for use in general construction as opposed to decorative plywood used for interior paneling.

**Controlled burning:** The planned application of fire to natural fuels including logging slash with the intent to confine it to a predetermined area.

**Cubic foot ($ft^3$):** The amount of timber in squared or rounded form necessary to produce the equivalent of 1 cubic foot of wood. One cubic foot equals 0.0283 cubic meters.

**Cubic meter ($m^3$):** The amount of wood necessary to produce a block 1 cubic meter on a side or the equivalent; therefore 1 cubic meter equals 36.0.

**Ecology:** The study of plants and animals in relation to their environment.

**Ecosystem:** Any complex of living organisms with their environment that may be isolated for purposes of study.

**Environment:** All the biotic and abiotic factors of a site or habitat.

**Eutrophication:** Enrichment of soils and water due to fertilization, sewage effluent or other waters that carry a high plant nutrient component.

**Evenflow:** The production from a national forest or other unit of land of the same amount of timber each year for an indefinite period of time.

**Fiber:** Any long narrow cell of wood or bast. Loosely used for wood elements in general.

**Fiberboard:** A building board of felted fibrous material.

**Flake board**: A particle board made of wood flakes giving a characteristic appearance.

**Flitch:** A large piece of timber sawn on two or more sides from a log and intended for further conversion.

**Forest:** An ecosystem characterized by a more or less dense and extensive cover.

**Forest management**: The practical application of scientific economic and social principles to the administration of a forest estate for specified objectives.

**Growing stock**: All the trees growing in a forest or in a specified part of it.

**Hardwoods:** The timber of broadleaf trees.

**Head block**: That portion of the log carriage on which the log rests and is held.

**Head rig:** The principal machine in a sawmill used for the initial breakdown of logs.

**Increment**: Growth accretion generally expressed in volume per acre per year. Also spoken of as annual yield.

**Intensive forestry:** The practice of forestry so as to attain a high level of volume and quality of out-turn per unit of area, through the application of the best techniques of silviculture and management.

**Kerf**: The narrow slot cut by a saw as it advances through wood.

**Landing**: Any place where round timber is assembled for further transportation—commonly with a change in method.

**Leaching**: The removal of soluble substances from soil by perculating water.

**Log rules:** Tables showing the estimated or calculated amount in board feet that can be sawed from logs of given lengths and top diameters inside of the bark.

**Monoculture**: The raising of a crop of a single species, generally even-aged.

**Multiple-use forestry:** Any practice of forestry fulfilling two or more objectives of management.

**Nitrogen-fixation**: The conversion of elemental nitrogen from the atmosphere to organic combinations or to forms readily utilizable in biological processes. Normally carried out by bacteria, living symbiotically in legumes or by free-living soil bacteria.

**Normal forest:** That forest which has reached and maintained a practically attainable degree of perfection in all its parts, for the full and continued satisfaction of the objects of management.

**North**: The North includes New England, the Middle Atlantic States, and the Lake States.

**Pacific Coast States:** Those States that border the west coast of the United States.

**Partial cutting**: Tree removal other than by clearcutting.

**Particle board:** A panel manufactured from woody particles as distinct from fibers and bonded together with resins or other suitable binder under heat and pressure.

**Pesticides**: Any chemical preparation used to control populations of injurious organisms, plants, or animals.

- **Herbicides:** Used to control herbacious plants.
- **Silvicides**: Used to control unwanted trees.
- **Rodenticides:** Used against mice, rats, and other rodents that may consume forestry seed or debark trees.
- **Fungicides**: Used to control fungal pests of trees.
- **Insecticides:** Used to control insects.

**Picnic grounds:** A recreation site providing for daytime use only.

**Pioneer:** A plant capable of invading bare sites such as a newly exposed soil surface, and persisting there until surplanted by successor species.

**Planing mill**: A mill that converts rough lumber into finished products such as doors, flooring, moldings, etc.

**Plantation:** A manmade forest usually established by planting seedlings.

**Plus tree**: An elite tree judged but not proven to be superior in some quality or quantity. Often used for seed collection.

**Plywood:** A composite product made up of crossbanded layers of veneer, bonded with an adhesive.

**Pole:** A young tree usually between 4 and 8 inches in diameter.

**Pulpwood:** Wood cut and prepared for manufacture into woodpulp.

**Range:** All lands including forest land that produces native forage in contrast to land cultivated for agricultural crops or carrying a dense forest. Also applied to the range of individual species of plants and animals.

**Regeneration:** Renewal of a tree crop whether by natural or artificial means. Regeneration period is the period required or allowed in the plan for regenerating following timber harvest.

**Roading:** The provision of roads in an area.

**Rocky Mountain States:** Those States between the Pacific Coast States and the Great Plains.

**Rotation:** The planned number of years between the formation of a forest crop and its final cutting at a specified stage of maturity.

**Sapling:** A young tree normally more than 4½ feet high and less than 4 inches in diameter.

**Sawlog:** A log considered suitable in size and quality for producing sawn timber.

**Sawtimber:** Trees fit to yield sawlogs.

**Section cutting:** The annual or periodic removal of trees individually or in small groups.

**Seedling:** A young tree grown from the seed up to the sapling stage, that is a height of 4½ to 6 feet.

**Severence tax:** A tax on a fixed natural resource such as timber following its removal from its natural site.

**Shelterwood cutting:** Any regeneration cutting in a more or less regular or mature crop designed to establish a new crop under the protection of the old.

**Silviculture:** The science and art of cultivating forest crops based on the knowledge of silvics, the study of the life history and general characteristics of forest trees and stands with particular reference to site factors as a basis for the practice of silviculture.

**Site class:** A measure of the relative productive capacity of an area for timber or other crops.

**Site index:** A measure of site class based on height of the dominant trees in the stand at age 50 or 100 years.

**Skidding:** Moving logs from the stump to a landing usually with the forward end supported off the ground.

**Skyline:** Cable logging in which a heavy cable is suspended between two spar trees on which a load-carrying trolley runs to which logs are attached.

**Slash:** The residue left on the ground after felling timber.

**Snag:** A standing dead tree from which the leaves and most of the branches have fallen.

**Softwoods:** The wood of needleleafed trees or conifers.

**South:** The South includes the States to the south of the Middle Atlantic States and the Lake States, notably along the South Atlantic region, across the South Central States, and across the Mississippi into Texas and Oklahoma.

**Spar tree:** A tall standing tree, trimmed, topped, and braced with guylines near the top of which riggings are fastened in skyline and high-lead-cable logging. Now often replaced by portable steel spars.

**Structural veneer:** Veneer suitable for use in the manufacture of plywood or other utility products as distinct from decorative veneer.

**Stumpage:** Standing timber as viewed by a timber operator. Stumpage value, the value of the timber as it stands uncut in terms of an amount per cubic unit.

**Succession:** The gradual surplanting of one community of plants by another.

**Sustained yield:** The yield that a forest produces continuously at a given intensity of management.

**Timber:** A general term for forest crops and stands containing trees of commercial size and quality suitable for sawing into lumber.

**Tractor logging:** Any system of logging in which a tractor furnished the motive power by direct hauling or by skidding.

**Transpiration:** The process by which water vapor passes from the foliage or outer parts of the living plant to the atmosphere.

**Tree seed orchard:** A plantation of trees assumed or proven genetically to be superior but has been isolated so as to reduce pollination from penetically inferior outside sources.

**Uneven aged:** A forest or stand composed of intermingling trees that differ markedly in age. This contrasts with even-aged stands in which all trees are within 10 to 20 years of the same age.

**Veneer:** A thin sheet of wood of uniform thickness produced by rotary cutting or by slicing or sometimes by sawing.

**Virgin forest:** Primeval forest or original forest. Primarily a forest undisturbed by man.

**Visitor day:** The presence of one or more persons (other than staff) on lands or water generally recognized as providing outdoor recreation for continuous, intermittant, or simultaneous periods aggregating 12 hours. A group of six persons spending 4 hours in a designated picnic ground would therefore count for 2 visitor days.

**Wilderness area**: An area established by the Federal Government to conserve its primeval character and influence for public enjoyment under primitive conditions in perpetuity.

**Wildfire**: Any fire other than a controlled or prescribed burn occurring on wild land.

**Wildlife**: A loose term that includes nondomesticated vertibrates especially mammals, birds, and fish.

**Woodland**: A wooded area in which the trees are often small, short bowled, and open grown; farm woodland, any wooded area that is part of a farm.

**Woodpulp**: Wood fiber separated by mechanical or chemical means used in making paper and other products.

**Working circle or working plan area**: The area covered by a single working plan.

**Yarding**: Transporting timber from a stump to a yard or landing.

**Yield determination**: The calculation of the amount of forest products that may be harvested annually or periodically from a specified area, over a stated period, in accordance with the objectives of management.



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