THE BLACK-TAILED DEER : A REVIEW OF ECOLOGY AND MANAGEMENT (*)

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Of the races of the mule deer of North America (*Odocoileus hemionus*), two are called black-tailed deer. These are the Columbian black-tail (*O.h. columbianus* (RICHARDSON) and the sitka deer (O.h. sitkensis Merriam). Their range, shown in figure 1, extends from south-central California to southeastern Alaska. The Columbian black-tail occupies the bulk of the joint range, with the Sitka deer occuring only in its northern extremity. Both races appear to be quite similar in ecology and behavior, so they will be treated under one designation—*black-tailed deer*—in this review.

It is my aim after an introduction of the animal itself, to describe the different ecological situations (range-types) in which these deer occur, the factors limiting deer density, and the principal ways in which the ranges (and deer densities) may be modified. This task has been greatly lightened by the recent review by COWAN (1956) and by personal communications from workers throughout the black-tail range. To this outline of the ecological situation, which follows climatic boundaries, will be appended a treatment of the administrative pattern of regulation and harvest management, which follows jurisdictional boundaries.

Some biological characteristics of the black-tailed deer.

An understanding of the deer itself is of primary importance in an accurate description of ecological situations and a successful planning of management practices. Therefore it is appropriate here to note

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briefly some characteristics of size, behavior and food habits.

The black-tail, over most of its range, tends to be a small deer, with the smallest adult individuals occuring in the coast ranges of California and on certain islands. COWAN (1936) points out that there is a gradual increase in body size from south to north. He also mentions that the resident deer of the northern California coast are smaller than the migratory deer found in the inland mountains at the same latitude.

There is some evidence that the small size of the black-tailed deer is due more to nutrition than to heredity. EINARSEN (1946-b) noted that while a mature buck from the coastal forest of Oregon would weigh 125 pounds (57 kg) dressed, many from the Tillamook burn weighed 210 pounds (95 kg) or more. He attributed this to the superior quantity and quality of the forage on the burned area. More recently, COWAN and WOOD (1955) have raised black-tailed deer in captivity, on diets of high quality. At the age of two years their males were over two hundred pounds (91 kg) in live weight, while wild deer in that neighborhood probably weigh little over half that at the same age. Such information as is available on weights of deer during the hunting season is summarized in Table 1. An important result of the small size of the black-tail is that where areas supporting mule deer (*O.h. hemionus* or *O.h. californicus*) are accessible to hunters, the hunters prefer the mule deer, which is larger and also easier to hunt.

The principal behavioral characteristics of the black-tail which are ecologically important are its need for heavy cover and its small radius of movement. Over most of its range the black-tail shows the habits of a forest-dwelling animal by relying on stealth rather than speed to avoid danger. Typically, hunted black-tails will hide in dense cover rather than escape by flight. This makes hunting difficult, since cover is heavy wherever black-tails are found. Consequently, maintaining a full harvest has become one of the principal management problems for this deer.

The daily and seasonal movements of resident black-tails have been found to be short. In California chaparral, the most annual movement is within an area 1,000 yards (916 meters) in diameter for does and 1,400 yards (1,270 meters) for bucks (DASMANN and TABER, 1956). SIMILARLY, ZWICKEL, JONES and BRENDT (1953) in Washington, found that most returns for deer tagged and released came from within one or two miles of the

Table 1. — Live weights (1) of black-tailed deer from various parts of their range

State or Province	*Type of Population*	*Range Type*	*Fawns*		*Yearlings*		*Two Year*		*Adult*		*Authority*
			♂	♀	♂	♀	♂	♀	♂	♀	♂ ♀
California ..	Resident	Chaparral plus Shrubland	34	33	62	56	85	75	144	77	Taber and Dassmann, 1958
	Migratory	Chaparral (poor summer range)				67				91	Hightower and Hiehle 1953
Oregon	Resident	Coastal Forest							163*		Einarsen 1946-b
	»	Burned Coastal Forest							277*		»
Washington	»	Logged Coastal Forest	57*	62*	137*				193*	121*	Lauckhart 1948
British Columbia .	»	Newly logged coastal forest			95*		126*		167*		Estlin Robinson, 1954
	»	Logged coastal forest closing in			81*	78*	98*	87*	167*	103*	»
	»	On high-quality experimental diet		60			200				Cowan and Wood, 1955
Alaska	Migratory			35*	96*	75*	123*	95*	164*	96*	Olson and Klein, 1959

(1) Dressed weights have been converted to approximate live weight by multiplying by 1.30. Values so obtained are starred (*).

(2) Weights are taken during the October-November period and are given in pounds.

tagging site. This limited radius of movement of resident deer insures that black-tails will inhabit only range where the necessities of life are in close juxtaposition—i.e. where the *interspersion* of habitat elements is high (LEOPOLD, 1936). Migratory deer appear to occupy small home ranges in both the summer and winter,

Figure 1. — Geographical locations mentioned in the text.

although these may be joined by a migration-route many miles in length (LEOPOLD, RINEY, MCCAIN and TEVIS, 1951). It is of ecological significance that black-tailed deer do not leave their accustomed home ranges because of any change in the quality of forage. They often die of under-nutrition on home ranges but little distant from better forage (DASMANN and TABER, 1956).

In food habits the black-tailed deer is essentially a browser, taking herbaceous forage in quantity only when it is young and succulent. Because of the need for food, as well as the need for cover, the black- tail is heavily dependent on shrubs. The ecology of the shrub association is usually of critical significance in the well-being of this deer wherever it is found.

Ecological range types. Black-tailed deer generally occupy that area lying westward of the crests of the Sierra-Nevada-Cascade Mountain chains. The southern extremity of the range extends to about Santa Barbara County, California in the Coast Range and to the neighborhood of the Merced River on the west slope of the Sierra-Nevada (COWAN, 1936; LONGHURST, 1959). The northern part of the range includes the coastal islands and portions of the mainland adjacent to the sea. The range has been extended northward to Kodiak Island and the vicinity by transplantation (COWAN, 1936; KLEIN, 1957).

Within this range, two types of deer population may be defined—that which is *resident* and that which is *migratory.* Resident deer occupy those areas where snow seldom falls; this would include the Sierran foothills, the South and Central Coast Range of California, and the coastal rainforest north to the southern tip of Vancouver Island, British Columbia. The upper elevation of the snow-free zone ranges from about 3,000 ft. (915 meters) in the central North Coast Range, to about 1,500 ft. (460 meters) in Washington and sea-level in southern British Columbia.

The zone of winter snows includes the medium elevations of the Sierra Nevada and North Coast Ranges of California, and the Cascades of Oregon and Washington. From central Vancouver Island northward all of the range is within this zone.

Resident Deer

The area in which resident deer are found may be divided into two ecological types on the basis of climate, the *chaparral* and the *coastal forest.* The Mediterranean climate, with cool, wet winters and hot, dry summers, favors the establishment of *chaparral* vegetation where rainfall is moderate. Chaparral covers large areas in the Coast Ranges and Sierra foothills of California. It consists of an association of fire-tolerant shrubs, many of which send up crown-sprouts following burning.

Typically, chaparral forms a closed canopy, so that understory vegetation is poorly developed. Common chaparral genera are *Adenostema, Quercus, Arctostaphylos* and *Ceanothus.* Often associated with chaparral is the *oak-woodland,* which consists of scattered trees with a well developed herbaceous understory.

The coastal climate, with uniform temperature and heavy rainfall, favors the establishment of the *coastal conifer forest.* This general type extends from northern California through Oregon and Washington to Vancouver Island, British Columbia. The typical dominant is *Pseudotsuga,* but locally other genera are abundant, such as *Sequoia* in the south and *Picea, Tsuga* and *Thuja* in northern areas. This forest is typically closed-canopy, with a poor development of understory vegetation.

The ecology of resident deer in the Mediterranean climatic zone. Dense chaparral, which occupies much of this zone, provides food and cover for black-tailed deer. In fact, except for watershed values, this plant association produces deer (and recreation) as its principal crop. The chaparral is excellent as deer cover, providing shade, shelter from wind, and an almost impenetrable hiding-place from enemies. As a source of deer food, the chaparral has limitations. The deer diet is composed almost entirely of the leaves and twigs of shrubs, with acorns added in occasional years. Most chaparral plants are evergreen, making their principal annual growth during a two-month period in the spring. At this time, the foliage is high in crude protein and phosphorus. During the summer, fall and winter, the shrubs are almost dormant. The percentage of crude protein and phosphorus at these seasons is low. As a result, the deer of the chaparral occur in medium population densities (10-20/square mile; 4-8/square kilometer) and have a low reproductive rate (TABER and DASMANN, 1958 (see Table 2).

The chaparral is often burned, either by accident or design. The crown-sprouts which spring up following a fire attract the deer from immediately adjacent areas, because of the rich food supplies, which also have the effect of increasing production and decreasing mortality. High population densities (occasionally exceeding 100/square mile; 39/square kilometer) are found. These are temporary concentrations which decrease due to dispersal, decreased production and increased mortality about three to five years after the fire when the quality

Table 2. — Reproductive rate and population density with respect to major limiting factors for five deer populations

State or Province	*Type of Population*	*Range Type*	*Reproductive Rate* (1)	*Population Density* (2)	*Major limiting factors*	*Authority*
California	Resident	chaparral	71	27 (10)	low protein level in summer and winter food	TABER and DASMANN, 1958.
	»	shrubland (managed chaparral).	145	64 (21)	medium protein level in summer and low energy level in winter food	»
	»	oak-woodland plus chaparral	107	70 (27)	low protein level in summer and low energy level in winter food	LONGHURST, 1956.
Oregon	»	coastal forest burned 20 years previously		64 (21)		MCKEAN, 1959.
Washington	»	coastal forest with recent opening	125	40-70 (15-27)	low quality of winter food	BROWN, 1959.
	»	coastal forest with openings closing in	95	30-40 (12-15)	»	»
British Columbia.	»	coastal forest with 50-60 % openings	140	40-50 (15-19)	low quality winter food; competition between deer; periodic deep snows	ROBINSON, 1959.
California	Migratory	sub-climax shrubs	154	77 (winter only) (30)	low quality summer food; deep winter snows	HIGHTOWER and HIEHLE, 1953.

(1) Number of fawns born for each 100 does of two years old and older.
(2) Number of deer per square mile after the hunting season; in parentheses is number per square kilometer.

of the forage drops to the pre-fire levels (TABER and DASMANN, 1958).

A system of chaparral management has been developed. *Shrubland* is created by burning small areas and seeding these to grasses and other herbaceous plants. The burns, well dispersed, cover about half of the total area, the remainder being left in dense chaparral for cover. The deer feed in the burned areas, keeping the shrubs within reach and also keeping them from shading the intervening ground. This arrangement is relatively stable. The herbaceous forage (which was largely lacking in full-density chaparral) supplies high-protein food during the winter and early spring. The deer of the shrubland occur in medium population densities (50 or more per square mile; 19 or more per square kilometer) and have a medium reproductive rate (BISWELL *et al*, 1952; TABER and DASMANN, 1958). Management of this range-type requires control of the deer population for success.

The oak-woodland, which may be adjacent to or interspersed with the edges of the chaparral provides types of forage usually lacking in the dense chaparral. These are acorns and herbaceous plants. Deer of the oak-woodland thus usually have shrubs to provide good forage in the spring and early summer, oaks to provide acorns in the fall and herbaceous vegetation to provide food in the winter. Consequently the oak-woodland, when mixed with chaparral, has been found to support 60-75 deer per square mile (22-28 deer per square kilometer) with a medium-high reproductive rate (LINSDALE and TOMICH, 1953; LONGHURST, 1956).

Management problems within the Mediterranean Climatic Zone. The two main ecological management problems in this zone are agricultural damage and deer losses due to poor nutrition, often complicated by disease or parasitism.

The main season of agricultural damage is from May to September, when wild foods tend to be low in succulence and nutritive value (BIEHN, 1951; TABER and DASMANN, 1958). Truck-crops, vineyards, orchards and gardens are damaged in areas where deer-cover is within about one-half mile. The best protection now known is the deer-proof fence.

Deer die-offs occur frequently in the Mediterranean Zone. They are of two general types : a hot-season die-off due to protein deficiency sometimes complicated by bacterial, viral or fungal infection, typical of the

warmer, dryer regions; and a cold-season die-off due to energy-deficiency often complicated by nematode parasitism, typical of the cooler, moister regions, especially toward the sea-coast (LONGHURST, LEOPOLD and DASMANN, 1952; LONGHURST, 1956). These losses may be reduced by building up the physical well-being of the deer and by reducing the possibility of infection. The best way to improve the physical well-being of the deer is to hold the population to the carrying-capacity of the habitat, by means of a heavy hunting harvest. The possibility of infection can be reduced in several ways, depending on the nature of the causative organism. Hoof-rot (caused by *Spherophorus necrophorus*) which is thought to be contracted at muddy waterholes, can be controlled by fencing the waterhole and piping the water to a concrete trough with a float-controlled level (LONGHURST, LEOPOLD and DASMANN, 1952). Nematode parasitism, which is often aggravated by the presence of nematode-infected sheep and cattle can be partially controlled by therapeutic treatment of livestock (LONGHURST and DOUGLAS, 1953). The jackrabbit (*Lepus californicus*) apparently also shares some endoparasites with deer (LONGHURST, 1959), and might be controlled to reduce the possibility of parasitism in deer.

Ecology of resident deer in the coastal forest zone. In the dense, closed-canopy coastal forest the understory provides most of the food for deer. Typical forage genera are *Vaccinium, Alnus, Acer, Gaultheria, Ribes, Sambucus, Salix* and *Rubus.* Because of shading, these plants tend to be low in food value, especially during the winter months. This effect is most marked in years when there are long periods of cloudiness in the fall and winter. During such years there is deer mortality due basically to poor nutrition (EINARSEN, 1946a and b) often aggravated by parasitism (KUHN, 1942) with losses occurring in late winter and early spring.

Because of the low quantity and often low quality of the food available for deer in the mature coastal forest, deer densities in this type tend to be low-about one to five per square mile (LINDZEY, 1943; COWAN, 1945; BROWN, 1959). Reproductive rates in these populations appear to be low (BROWN, 1959; ROBINSON, 1959; see Table 2).

When the coastal forest is burned, or logged, the vegetation of the forest floor responds by increasing dramatically both in quantity and quality (EINARSEN, 1946a and b) resulting in an increase in deer density, size

and reproductive rate (see Tables 1 and 2). Fire has always been an important ecological factor in the snow-free coastal forest, especially its southern portions. Since extensive white settlement, which dates from the middle of the 19th century, fires have been even more common. Logging is also important in opening the forest canopy.

Because of the small size of the home range of black-tailed deer, and its need for heavy cover, the removal of all cover an extensive area will result in use only of the edges by deer. However, heavy cover usually springs up quickly along water-courses and deer ordinarily penetrate large open areas by this means (ZWICKEL, 1959). On favorable areas of opened coastal forest deer densities will rise to 40-50/square mile (15-19/square kilometer) (BROWN, 1959).

Because of the excellent growing conditions for plants in this zone, succession following logging proceeds rapidly. This results in shading (which reduces forage quality) and an increased density of vegetation (which reduces forage availability, since deer are reluctant to feed in heavy cover) (LINDZEY, 1943; COWAN, 1945). Ordinarilly, deer on a logged range tend to increase in population density for about ten years and remain level for another five, after which the population declines. This cycle may be shorter in the coast hemlock belt and longer in Douglas fir if the slash is burned following logging (BROWN, 1959).

Management problems within the coastal forest zone. The principal management problems within this zone are the production of a stable forage supply of high quality, the minimization of deer damage to the reproduction of forest trees and the maintenance of a proper level of deer harvest. These problems are intimately involved with the production and harvesting of timber.

Assuming that accidental fires will be more and more successfully controlled in the future, the principal means of opening the forest canopy and raising the carrying capacity for deer will be associated with logging (cutting areas, roads, fire-breaks etc.). In this zone, the forest is ordinarily clear-cut. The slash is now often burned, but in the future there will probably be almost complete utilization of the tree, with little slash remaining and consequently no burning.

The problem of obtaining adequate reproduction of forest trees after clear-cutting may be met in several

ways. At present, the most common practice is to keep clear-cut areas 600 feet (183 meters) or less wide, to insure adequate seed dispersal (of *Pseudotsuga*) from the edges. This has two principal disadvantages : there is often severe competition between the tree seedlings and the shrubs which spring up in the opened area; and deer from the surrounding forest concentrate their feeding in the openings, thus causing severe browsing damage to the seedlings of important timber trees (MITCHELL, 1950) but still being so close to dense cover that their numbers cannot be controlled by hunting (ZWICKEL, 1959).

The system of *direct-seeding,* in which seed from superior stock is sown from the air, permits the use of larger clear-cut areas in which there it less deer concentration and in which the deer are more accessible to hunters. At present, the cost of seed limits the use of this method, but it is increasing in importance annually.

Some of the most desirable timber species of the coastal forest are also palatable to deer. These include Douglas fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), Port Orford cedar (*Chamaecyparis lawsoniana* and black poplar (*Populus trichocarpa*) (MITCHELL, 1950). On the other hand, western hemlock (*Tsuga heterophylla*) is not eaten (COWAN, 1945) or is low in palatability (ZWICKEL, 1959). While the problem of overcoming damage by deer to forest reproduction might be overcome in some local areas by substituting western hemlock for species more preferred by deer, this is not a widely applicable solution. Possible future remedies appear to involve rendering timber seedlings unpalatable to deer, either by seeding with genetically unpalatable stock, or by using a systemic repellent. A systemic repellent is some substance which is taken up by the seedling, and is then present in the foliage, making it unpalatable. Progress in the development of such a repellent is being made (SPENCER, 1958) but neither this, nor the use of genetically unpalatable strains, is yet ready for widespread application. At present, the cheapest method of minimizing damage to forest seedlings is through control of deer numbers by heavy hunting. This, in turn, is possible only where relatively large openings occur in the coastal forest, and where a heavy network of access roads is maintained. Where sufficient hunting pressure cannot be brought to bear, it may be necessary to fence out the deer until the young trees

grow out of reach. While a vertical fence eight feet (2.42 meters) high is now commonly used to keep deer out of valuable agricultural crops, a new type of overhanging fence only 40 per cent as expensive has recently been developed (JONES and LONGHURST, 1958).

Migratory Deer

Deer migration caused by snow on the summer range is found along the eastern portion of the black-tail range in California, Oregon and Washington, and over most of the range in British Columbia and Alaska. Whether the winter range lies in the foothills of mountains, as it does in the Sierra Nevada and the Cascade Range, or along the sea-coast, as it does in Alaska, the pattern is similar. Ordinarily, the summer range is much more extensive than the winter range, so that the winter period is the critical one.

Ecology of migratory deer in the inland mountains. It is typical of black-tailed deer inhabiting the inland mountains (Sierra Nevada and North Coast Range of California and the Cascades of Oregon and Washington) that they summer spread at low population density over partly forested land. Before the advent of white colonization much of the present range, both summer and winter, was fully stocked with large conifers. At higher elevations lightning fires crept along the ground periodically, not injuring the mature trees, but consuming dead material and killing shrubs (BISWELL, 1959). At that time, « Populations were moderate or only locally abundant in the high Sierra (and)... scarce in the... heavily timbered northwest » [of what is now California] (LONGHURST, LEOPOLD and DASMANN, 1952, pg. 11).

In the inland mountains of California both summer and winter range now have large areas of former timber in a seral shrub cover, because of logging and fire, especially the latter. Further north, in the Cascades, much new winter forage has been provided by logging (ZWICKEL, 1959; BROWN, 1959).

The result in both cases has been an increase in numbers of migratory deer. Some important winter-range forage genera are *Ceanothus, Cercocarpus, Quercus* and (on some dryer ranges east of the Cascades) *Purshia* (MACE, 1959).

In mild winters with little snow there is usually ample forage. Each addition to the depth of snow, howe-

ver, causes the carrying capacity of the winter range to shrink by covering the low food plants and crowding the deer onto areas of shallower snow, where there is increased competition for forage. LONGHURST (1950) has summarized the winter situation for migratory deer as follows : increased population density; low protein content of forage plants; diminishing quality of forage as terminal portions of twigs are consumed; diminishing quality of forage as more highly preferred plants are used.

Winter survival of these deer depends upon their condition upon entering the winter; the condition of the preferred forage plants on the key winter concentration areas and; the severity of the winter. The condition of the deer upon entering the winter depends on the quality of the summer range (which is usually good) and the early-winter diet on the winter range, when snow is light and the deer have a wide selection of choice foods. The high quality of the diet before the breeding season which usually prevails results in a general high level of ovulation and breeding success among these migratory deer. More rarely, when the summer range is deficient, deer may enter the winter in poor condition and suffer a severe die-off even in a normal winter (HIGHTOWER and HIEHLE, 1954).

The condition of the forage plants on the winter range is of course vital to the continued survival of a migratory herd. It is necessary not only that the present individual shrubs should survive in good condition, but also that they should reproduce. Since many winter ranges are merely temporary stages in plant succession, they tend to revert to their original forest condition, and so decline in usefulness for deer. Another factor is the influence of the deer on the plant composition. If deer use is intense, as it usually is on winter concentration (key) areas, the deer will use certain preferred species of plants heavily, not eating others at all. The ones which are taken heavily are weakened; the less preferred plants remain strong and compete with the weakened ones for light, moisture and nutrients. Thus there is a constant pressure working against the survival of the preferred forage plants.

The severity of the winter varies from year to year. In the occasional long, cold, deep-snow winter there are very heavy losses of deer. Then, while the herd is building up again, the winter range is less heavily used. The same effect of lightened browsing pressure is observed in open winters, when the deer are able to spread out over the whole winter range and also to feed on

low-growing vegetation. Again, a reduction of the deer population by heavy hunting will give the same result—a lessening of the pressure on the range.

Management problems on mountain migratory deer range : The principal problem in the management of these migratory deer is to insure that there shall be an adequate amount of preferred forage on the winter concentration areas to carry the deer through until spring. This problem, while simple to state, has many facets : — the ownership of land on which winter range occurs; the use of deer winter range by livestock and by resident deer; the effects of the normal progress of plant succession and; the difficulties connected with anticipating the severity of the coming winter and reducing the deer population, through hunting, to the proper level for successful overwintering.

Many winter ranges lie at least partly on private land, and, especially in the southern portion of the blacktail range, may be subjected to summer use by sheep or cattle. The principal conflict comes about when the livestock are held on the range in late summer and fall. During this period the herbaceous forage drops in nutrient quality and the livestock turn to shrubs, thus coming into direct competition with the deer, although using the range at a different season. Often, livestock lose weight on this shrub diet. In this case, it is the best stock management to take the animals which are to be sold that fall off the range for « finishing » on pasture. This relieves the competition to some extent.

Where the deer eat large amounts of grass and forbs on the winter range, as sometimes happens, especially in the south, competition with livestock may be more intense. Often, it is the livestock which suffer, since the deer take the forage in the early spring, before the stock reach the range. However, dual use by both livestock and deer often accomplishes a more efficient use of forage resources than use by either alone. Deer, in the winter, concentrate on the warmest slopes; livestock, in the summer, often avoid the warmest slopes. Stock may be salted, fenced, or herded in such a way that deer concentration areas are avoided. Thus, if only moderate populations of both deer and livestock are maintained, the landowner may make most efficient use of his forage. If he can obtain some cash return from the deer (as will be discussed in a later section) he will be encouraged to manage for deer and livestock both.

When a resident deer herd occupies the winter range

of a migratory deer herd the resident herd should be reduced by heavy hunting, since the most efficient use of that range will be by the migratory deer, which use it six months each year instead of twelve.

Hunting pressure must also be applied to the populations of migratory deer, to keep them from damaging their own forage. In the southern portion of the blacktail range, especially, many winter ranges are within the *Pinus ponderosa* belt or some similar open, semi-arid forest. On these areas, plant succession is slow and intense shading of the shrub understory is not common. Individual shrubs, under these circumstances, undergo a long period during which they are available as forage for deer. Heavy deer use can weaken or kill them. On such range it is doubly necessary to obtain an adequate hunting harvest. This manipulation of the deer harvest will be discussed in the section on administration.

In the more northern portions of this range type, plant succession is more rapid, and forage availability tends to decline because of growth or shading, rather than overuse by deer. On such ranges only an integration of deer production with timber production will provide for a continuing supply of winter forage.

Because winters vary, the carrying capacity of a winter range varies from year to year. During the ordinary fall hunting season it is impossible to anticipate the severity of the winter-to-come. It appears best to plan for a winter of moderate severity. Then, if the winter is mild the plants are used lightly and gain in vigor. If the winter is extremely severe, an additional kill through controled hunts (to be discussed later) is advisable.

The ecology of migratory deer of the Northern Coast. Black-tailed deer occupy not only much of the coast of British Columbia and southeastern Alaska, but many of the offshore islands as well. Being powerful swimmers, they can move between islands. Typically these deer of the Northern coasts summer above the dense coniferous forest and winter in its lower fringes, adjacent to the beach. Where there are extensive alpine summer range areas the deer develop into larger individuals than those living where there is little or no alpine (KLEIN, 1957).

As in the case of other migratory deer, there is a great deal of difference in survival between different winters, depending on the amount and duration of snow. However KLEIN (1956 and 1959) believes that, on the

islands with mild maritime climate and high deer densities, over-population, and its attendant over-use of the winter forage plants, is the most important factor in winter losses. Important winter forage genera are *Vaccinium, Rubus, Cornus, Alnus, Sambucus* and *Acer* among the shrubs and *Chamaecyparis, Tsuga* and *Thuja* among the trees (PALMER, 1944). Variety of browse species is low in Alaska, with only *Vaccinium, Cornus* and *Tsuga* being abundant and widespread in distribution (KLEIN, 1959).

The heavy coastal forests within the habitat of these deer are only now beginning to be logged. No doubt timber harvest will provide a vastly increased food supply, especially since the terrain usually necessitates cuttings of less than one or two square miles (KLEIN, 1959). One anticipates that then the management problems will be similar to those in the snow-free coastal forest-i.e. involving damage to reproduction of timber species by deer and complicated by the fact that only the early stages of forest succession are optimum for deer production.

Administrative Patterns and Problems. In both the United States and Canada, wild animals are the legal property of the citizens of the State or Province that they inhabit. The owner of the land on which deer are found, therefor, has no more legal ownership of the deer than has any other citizen. Responsibility for administering the resource of resident game animals, including deer, is vested within each State or Province in a government department responsible (through a commission in the U.S.A.) to the governor. The legislature, the law-making body, delegates a variable amount of authority to the department, so that it can make administrative changes in hunting and fishing regulations. Funds for the administration of resident game come from hunting and fishing licenses and a tax on sporting arms and ammunition. The various political units differ somewhat in the framework of legislation and tradition within which they operate. Some aspects of administrative patterns and problems are summarized in Tables 3 and 4.

In all parts of the black-tail range, whether or not an administrative policy has been enunciated, one along these lines is in effect :

To maintain the greatest recreational harvest of deer compatible with other uses of the land.

In realizing this policy, each State or Province encounters problems; among the principal ones are : (1) maintaining flexibility and effectiveness in herd control;

Table 3. — The numbers of hunters and black-tailed deer and the present, and optimum level of harvest

State or Province	(1) *Number of Big Game Hunters*	(2) *Number of Black-Tailed Deer*	(1) *Present Harvest (in per cent of deer population)*	(3) *Desirable level of harvest (compared to present harvest)*
California	410,000	586,000	6	× 4
Oregon (4)	233,885	250,000	18	× 1.3
Washington	237,000	139,000	17	× 1.4
British Columbia (5)	112,000	over 200,000	10-12	× 2.8
Alaska	22,987	123,000 (6)	under 10 (6)	over × 2.4

(1) As of 1954, from LONGHURST, 1957 : they may hunt other big game animals as well as black-tailed deer.
(2) From COWAN, 1956, unless otherwise indicated.
(3) Author's opinion.
(4) From MACE, 1959 : values for 1958.
(5) From ROBINSON, 1959 : values for 1958.
(6) From KLEIN, 1960.

Table 4. — Seasons, bag limits, special hunts and administrative problems and practices

State or Province	*Length of Season*	*Bag Limit per hunter*	*Special hunts*	*Is adequate harvest attained ?*	*Recourse for Agricultural Damage*	*Principal Remaining Problems*
California	5-6 weeks	2 bucks in coastal area; 1 in interior	by permit for antlerless deer by unit	no	permit to shoot deer : special controlled hunts in damage areas	(1) (2) (3) (5)
Oregon	3 weeks (extended in some areas)	1 (either sex)	to control level of kill	in some areas	state assistance in fencing, etc.	(3) (5)
Washington ..	4 weeks (extended in some areas)	1 (either sex)	»	in some areas	payment for game damage claims; state assistance in fencing	(3) (5)
British Columbia	12-13 weeks (of which 2 weeks are for antlerless)	2-3 * (2 either sex)	none	not in remote areas	permit to shoot deer	(3) (4) (5)
Alaska	14 weeks (of which from 3 days to 6 weeks are for antlerless)	1-4 (no fawns)	none	»	none	(4) (5)

* No closed season or bag limit for residents in Queen Charlotte Is. (Game Mgt. Area 5).
(1) Lack of public acceptance of need for regular harvest of antlerless as well as entlered deer.
(2) Problems connected with public access to hunting on private land.
(3) Damage to agriculture and timber reproduction by deer.
(4) Lack of hunting pressure, due to low numbers of hunters and difficulty of reaching all deer habitat.
(5) Difficulty of attaining proper distribution of hunting pressure.

(2) damage to gardens, agriculture and timber reproduction; (3) public hunting on private land; (4) losses due to disease and parasitism; (5) improving deer habitat for increased production.

1. *Maintaining flexibility and effectiveness in herd control.* Each year between one-fifth and one-third of a deer population should be harvested, if optimum health, survival and productivity is to be maintained. The main difficulty in attaining this is the virtual impossibility of ascertaining population numbers. Instead, deer managers must rely on trend counts; observed condition and mortality; doe : fawn counts; range surveys and; calculations of kill per unit area. Ideally, one regulates hunting pressure until a stable high level of kill is obtained, with a minimum of non-hunting mortality and range damage. One attempts to minimize the effects of severe winters by taking an extra-heavy harvest through special hunts. Finally, where a maximum deer population conflicts with other uses of the land, one reduces the stock of deer to a point compatible with overall best land use.

Attainment of this ideal situation is often hampered by lack of public understanding and support. This has been shown to be the most frequent cause of underharvest throughout the United States and Canada (LONGHURST, 1957). Within the memory of men now living, deer were, in many areas, reduced to a low population level by over-shooting. In other areas especially severe winters in the late 1800's drastically reduced deer herds. Populations were restored through the buck law, under which only mature males were legal game. It was maintained by many molders of public opinion that shooting does was actually immoral.

In 1908, for example, the Campfire Club of America published a Code of Ethics, including the statement : « The killing of a female hoofed animal... is to be regarded as incompatible with the highest sportsmanship; and it should everywhere be prohibited by stringent laws ». (HORNADAY, 1913). This view was perhaps necessary during the period when game had been severely reduced by unregulated hunting, but it was so emotionally presented that it took firm hold in the public consciousness and remains there to some extent today. Now that it is almost universally necessary to shoot does, in large numbers, every year, the public often finds it difficult to believe.

Another impediment to efficient herd control, is the fact that populations of deer cannot be counted accura-

tely and easily. The trial-and-error method of balancing herds to their habitats looks to some citizens like incompetent tinkering. Game biologists are often distrusted.

Public opinion, acting through State Legislatures, determines the amount of authority in setting hunting regulations delegated to the Game Commissions (in the U. S. A.) and the Game Departments. Different states and provinces have had different degrees of success in gaining public support for an adequate system of herd control.

Washington and Oregon, within black-tail range, have been most successful. In both of these States during the first part of the deer season only mature bucks are legal game. During the last three or more days of the season antlerless deer are legal game. Hunting pressure is manipulated by adjusting the time and the length of the season (which may be extented to obtain a higher kill) and the proportion of the season during which antlerless deer may be hunted. This system is relatively successful in most areas, although the difficulty of hunting in much black-tail range makes a uniform full harvest unattainable. In localities where the kill must be more closely regulated, controlled hunts are held. These require a permit, obtained by a public drawing, and are conducted under the immediate supervision of the Game Department. Oregon and Washington are thought to harvest about 20 per cent of their deer herds (LONGHURST, 1957).

In British Columbia and Alaska the situation is changing rapidly from a uniform buck-season to a uniform either-sex season as public opinion accepts the need for it. Both areas have relatively low hunting pressure, especially in remote regions. In British Columbia an increased kill is sometimes obtained by extending the season further into the winter, when the deer are more concentrated. There are no controlled hunts there or in Alaska. The intensity of harvest in thought to be about 10 per cent in British Columbia (HATTER, 1959) and less than ten per cent in Alaska (KLEIN, 1959). Hunting regulations are already liberal (see Table 4) so it appears that there are simply not enough hunters in these areas to exert optimum hunting pressure on all the black-tailed deer herds.

California has been the least successful of these political units in attaining adequate herd control. An attempt was made to introduce the Washington-Oregon system, but satisfactory hunter-distribution was not obtained.

At present, a general buck-law prevails. However, the Fish and Game Commission has recently been given authority to order anterless and either-sex seasons on what is essentially a controlled hunt basis, with a quota of permits being set up for each area (DASMANN, HJERSMAN and GILSENAN, 1958). Each such hunt must be approved by the Board of Supervisors of the county involved (LASSEN, 1959). California is thought to harvest about 6 per cent of the deer population annually (LONGHURST, 1957).

2. *Damage to gardens, agriculture and timber reproduction* : It is accepted, on the basis of U. S. Supreme Court decisions that a property-owner can take reasonable precautions to protect his property against damage by wild animals. This includes shooting of offending individuals, under permit. It also includes fencing, repellents, frightening devices *etc.*, but not the use of poison. State and Provincial Game Departments provide advice to landowners suffering damage from deer. Washington and Oregon give aid to the landowner in protecting his property. This usually takes the form of help in constructing deer-proof fences around valuable crop-land (SCHNEIDER, 1957). Washington, in addition, makes cash payments for damage done by wildlife. Controlled hunts, in California, Washington and Oregon, may be held where it is necessary to reduce the level of the breeding herd.

In general, it has been found that repellents and frightening devices are of limited usefulness. The most effective measure at present is fencing, which is expensive, although a new design (JONES and LONGHURST, 1958) may reduce costs. Controlled hunts cannot be held where many people live. There are many areas, therefore, especially where homes and deer-cover lie close together, where crop and garden damage continues to be severe, with fencing as the only remedy.

3. *Public hunting on private land* : Ordinarily, deer hunting on public land is controlled only by the hunting regulations and the occasional need to exclude human use during periods of high fire-hazard. Private land, however, may be posted against trespass, so that hunters are excluded. In practice, private forest lands, especially those owned by the larger timber companies, have been opened to some recreational use, including hunting. Private range (grazing) and agricultural lands, however, are often posted against public trespass and hunted lightly by the owners. Large acreages in California, and smaller ones in Oregon and Washington, are thus growing crops of deer which are not fully harvested. However,

there appears to be a gradual movement toward a solution of the problem involved here—that of compensating the landowner for the crop of deer raised on his property. For many years deer hunters have formed themselves into small « hunting clubs » and leased trespass privileges, often at the same time accepting responsibility for patrolling the property against unauthorized trespass. Income from such hunting leases compares quite favorably with that from livestock, especially on the livestock ranges of lower quality. Where administration of hunting poses problems that the individual owner does not want to undertake, State administered hunting may be an interim solution. Under this system (the Cooperative Public Hunting scheme) the State authorities control the hunting on a large area of private land through registration of hunters and regulation of hunter-density (LONGHURST and HOWARD, 1956). This is an expensive method, but it may be necessary only as an intermediate step, to be followed by control and administration by the landowners themselves, for profit.

4. *Losses due to disease and parasitism* : The steps taken for the improvement of overall deer health and welfare will also result in a decrease in losses due to disease and parasitism. In addition, control of disease and parasitism in livestock will reduce the contamination of ranges used by both deer and livestock.

Beyond this, no steps have been suggested, although the future may hold some serious problems. Two of the most obvious are : the role of deer as carriers of livestock disease; and the possibility of virus-caused epidemics in dense deer populations.

Recently it has been found in California that some wild black-tailed deer carry *anaplasmosis,* which can be transmitted to cattle. Also, the usual complement-fixation tests to demonstrate the presence of *anaplasmosis* were of limited usefulness for deer (OSEBOLD, CHRISTENSEN, LONGHURST and ROSEN, 1959). Previous findings, based on complement-fixation tests, may be suspect; perhaps the level of some livestock diseases in deer is much higher than had been thought. If so, more widespread vaccination of livestock against deer-borne diseases will be indicated (LONGHURST, 1959).

In various parts of the country there have been deer die-offs due to virus infection. Apparently the deer may be in good physical condition and yet succumb. The high population densities attained by black-tailed deer on some ranges appear to be ideal for the spread of such a disease.

Control measures would depend on the mode of transmission. Local reduction of population density might be effective. This was done successfully when foot-and-mouth disease was introduced into wild deer in California in 1924-26 (LEOPOLD *et al*, 1951).

5. *Improving deer habitat for increased production* : At present, the problem of adequately cropping existing deer herds is a pressing one. When this problem has been solved it may be desirable to raise local managed deer populations to a higher level. In the chaparral, management procedures which will increase deer populations several times have been developed (TABER and DASMANN, 1958). In the coastal forests, it is apparent that close coordination of timber management with deer management will result in increased deer densities. The same appears to be true for the north coast forests. Where the migratory deer of the inland mountains winter in subclimax shrub types it may be possible to increase carrying capacity by intensive management of the restricted winter concentration areas. Intensive management procedures may be too expensive to be applied by government personnel at public expense, except on a few demonstration areas. However, Game Departments can also act as management advisors for private landowners. In this capacity, they should be continually developing a body of information on range improvement.

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