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American Antiquity, Vol. 47, No. 4. (Oct., 1982), pp. 761-784.

Stable URL:
http://links.jstor.org/sici?sici=0002-7316%28198210%2947%3A4%3C761%3ATISFOT%3E2.0.CO%3B2-1

American Antiquity is currently published by Society for American Archaeology.

THE INLAND SHORE FISHERY OF THE NORTHERN GREAT LAKES: ITS DEVELOPMENT AND IMPORTANCE IN PREHISTORY

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Despite a great many references in the historic and ethnographic records to the importance of fishing by natives of the northern Great Lakes, anthropologists and archaeologists have failed to appreciate the uniqueness and significance of the inland shore fishery. A review of the archaeological evidence for the evolution of the fishery from Late Archaic to historic times indicates that the fishery can provide an organizing concept for understanding the cultural evolution of the region. Further, this record provides a means of examining the process of adaptation as it reflects a long series of technological and social adjustments to a specific set of environmental conditions over time.

THANKS TO THE PIONEERING EFFORTS of Mason (1896), Wissler (1926), and Kroeber (1939), most of the broad environmental and cultural relationships in native North America have long been understood. It is the thesis of this study that in one area—the northern or upper Great Lakes—the relationship between environment and prehistoric cultural adaptation remains poorly known. Further, it is argued that the unique prehistoric fishery, which was extant in this region during European contact and survived through most of the historic era, provides the most important single organizing concept for understanding the cultural development of this region. Here I will review the archaeological and ethnographic data on the development of the fishery and assess the importance of the fishery to our understanding of both the archaeological record and the rate and direction of cultural change in the region. In addition, it is hoped that the long sequence of cultural change described in this paper will provide an important case study for the consideration of theoretical issues involved in hunter and gatherer subsistence.

It is not strictly true that the subsistence modes of the upper Great Lakes region—that is, the northern portions of the Lakes Huron and Michigan basins and Lake Superior—have received no attention from our anthropological forebearers; Kroeber (1939) discussed the northern limits of agriculture, Jenks (1900) wrote extensively on the importance of wild rice to the west of the region, and many scholars have noted the importance of hunting in the boreal forest to the north. Various authors, principally Erhard Rostlund (1952), have indicated the importance of fishing. In his monumental work *Freshwater Fish and Fishing in Native North America*, Rostlund made an exhaustive review of literature pertaining to the upper Great Lakes. Calling this fishery the "inland shore fishery" to distinguish it from the ocean coastal fisheries, he believed that in its technological uniqueness and success it compared favorably with ocean fisheries.

> I submit that as fishermen, these people from the Great Lakes toward the Mackenzie Valley were second to none in aboriginal North America. As a technical achievement, this deep-water gill-net fishery ranks with the Indian halibut fishing of the northwest coast, both very different from the easy catching of shad or salmon that came pouring up the rivers [Rostlund 1952:29–30].

Given the apparent prominence of the inland shore fishery in the lifeways of historic era Indians, including many bands of Ojibwa, Ottawa, Menominee, and some of the Huron groups, it is remarkable that there has been little mention of it in the archaeological and anthropological literature on this region.

Charles E. Cleland, Department of Anthropology, Michigan State University, East Lansing, MI 48824

0002-7316/82/040761-24$2.90/1

HISTORICAL EVIDENCE OF THE INLAND SHORE FISHERY

From the period of earliest European contact with upper Great Lakes people in the early seventeenth and eighteenth centuries, to the reports of travelers in the region during the nineteenth and early twentieth centuries, it is the rare account that does not mention the importance of the fishery. The earliest French contact with the inland shore fishery was among Huron fishermen on Georgian Bay of Lake Huron. Sagard, writing in 1623, was impressed by the dangers of the net fishery.

> When the wind blew strong our savages did not take their nets to the water, because at that time the waves were very high and swollen; and when the wind was moderate they were still so tossed about that it was enough to make me admire and greatly praise God that these poor people did not perish, but got away in their little canoes out of the midst of such raging waves and billows, upon which I looked down from the top of a rock that I ascended for the purpose [Kinietz 1965:28].

Perhaps the best early description of the gill net was made by Henri Joutel at Mackinac in 1687. The exactness of this description indicates that the French were totally unfamiliar with the construction and use of the gill net; as an analogy, Joutel relies on the snaring of birds to explain the basic principle of the gill net to his French audience.

> Their usual food consists of fish and Indian corn. They are very skillful at fishing, and the fishing is very good in these parts. There are fish of various kinds which they catch with nets, made with a very good mesh; and, although they only make them of ordinary sewing thread, they will nevertheless stop fish weighing over ten pounds. They go as far as a league out into the lake to spread their nets, and to enable them to find them again they leave marks, namely, certain pieces of cedar wood which they call *aquantiquants*, which serve the same purpose as buoys or anchors. They have nets as long as two hundred fathoms, and about two feet deep. At the lower part of these nets they fasten stones, to make them go to the bottom; and on the upper part they put pieces of cedar wood which the French people who were then at this place called floats. Such nets are spread in the water, like snares among crops, the fish being caught as they pass, like partridges and quails in snares. The nets are sometimes spread in a depth of more than thirty fathoms, and when bad weather comes, they are in danger of being lost. As these lakes, although they are very large, are frozen over at certain times, they have to make holes in the ice to get the nets in, and they spread them under the ice, which gives them more trouble [Kinietz 1965:29].

Champlain, who observed the practice among the Huron of Georgian Bay in 1615, left a more detailed and very early description of gill net fishing through the ice.

> They make several round holes in the ice and that through which they are to draw the seine is some five feet long and three feet wide. Then they begin to set their net by this opening; they fasten it to a wooden pole six or seven feet long, and place it under the ice, and pass this pole from hole to hole, where one or two men put their hands through and take hold of the pole to which one end of the net is tied, until they came back to the opening five or six feet wide. Then they let the net drop to the bottom by means of certain small stones fastened to the end of it. After it has been to the bottom they draw it up again by main force by its two ends, and thus they bring up the fish that are caught in it. That in brief is the method they use for fishing in winter [Kinietz 1965:24].

Testimony to the effectiveness of gill netting through the ice may be found in Alexander Henry's description of the practice among Ojibwa and Ottawa fishermen in Mackinac almost two centuries later (Henry 1809:55); Henry's description is nearly identical to Champlain's. Modern Indian fishermen still practice this method of gill net fishing.

Randot, writing in 1709, indicates that the cordage from which the nets were manufactured was made by women.

> They are as skillful at fishing as at hunting; they have on this subject a story that a certain Sirakitehak, who they say created heaven and earth and who is one of their divinities, invented the way of making nets after having attentively considered the spider when she worked to make her web to trap flies. They make these nets of nettles or wild hemp, of which there is much in moist places, and the women and girls spin and twist these on their bare thighs. The cords used to draw these nets are made of the bark of basswood or of leather and are very strong and difficult to break [Kinietz 1965:369].

Frances Densmore (1928), who collected ethnobotanical information from the Ojibwa of the Great Lakes between 1907 and 1925, notes that cordage was made from the tough flexible fibers of basswood (*Tilia americana*) and false nettle (*Boehmeria cylindrica*). Nettle, woodnettle, and Indian hemp were also sources of fiber in the region (Yarnell 1964:189). Moreover, both fiber and finished fish nets were items of trade between the Huron and their northern Algonquian neighbors (G. A. Wright 1967). While women produced the fiber and manufactured the cordage, there is good evidence that men made the nets. Thus, Sagard, in describing ice fishing with nets, begins by noting that "from the cordage which the women and girls have prepared, the men, during winter, make nets and seines for catching fish even under the ice, by means of holes cut in different places" (Rau 1884:268–269). As late as the mid-nineteenth century, Reverend Pitezel (1857: 50), visiting the Ojibwa subchief *Iahbedahsing* at Mackinac in 1843, noted that "the chief was employed in making a gill-net, which labor he performed with great ease and dexterity."

Fishing in the upper Great Lakes region was by no means limited to fishing with gill nets. Although this technique was the cornerstone of the inland shore fishery, it was not mentioned quite as prominently as the unique and glamorous dip net fishery at the St. Marys River rapids at Sault Ste. Marie. Dablon, writing in 1669, describes the activity of these Ojibwa fishermen.

> It is at the foot of these rapids, and even amid these boiling waters that extensive fishing is carried on, from Spring until Winter, of a kind of fish found usually only in Lake Superior and Lake Huron. It is called in the native language *Atticameg*, and in ours "whitefish," because in truth it is very white; and it is most excellent, so that it furnishes food, almost by itself, to the greater part of all these peoples.
>
> Dexterity and strength are needed for this kind of fishing; for one must stand upright in a bark Canoe, and there, among the whirlpools, with muscles tense, thrust deep into the water a rod, at the end of which is fastened a net made in the form of a pocket, into which the fish are made to enter. One must look for them as they glide between the Rocks, pursue them when they are seen; and, when they have been made to enter the net, raise them with a sudden strong pull into the canoe. This is repeated over and over again, six or seven large fish being taken each time, until a load of them is obtained [Kinietz 1965:323].

Evidence of the productivity of this fish is found in La Potherie's account of 1716.

> It is only they, the Missisakis, and the Nepiciriniens [Ojibwa bands] who can practice this fishery, although some Frenchmen imitate them. This kind of fish is large, has firm flesh, and is very nourishing. The savages dry it over a fire, on wooden frames placed high above, and keep it for winter. They carry on an extensive traffic in this fish at Michilimakinak, where both the savages and the French buy it at a high price [Blair 1911:276].

In this account, it is important to note that fish were produced in excess for both winter use by the fishermen and for commercial purposes.

The taking of large fish, particularly sturgeon and trout, was often accomplished with spears or harpoons. This practice was common in both open water and through the ice in winter. Writing between 1721 and 1728, Charlevoix tells us that "they take three Sorts of the last [trout] among which some are a monstrous Size, and in such Numbers, that a Savage with his Spear will sometimes strike fifty in three Hours Time" (Rau 1884:272).

Both gaff hooks and harpoons were used to take sturgeon. Schoolcraft, writing in 1820, leaves a detailed report on the taking of sturgeon at an Ontonagon River weir on the south shore of Lake Superior. But perhaps the best description for the harpooning of sturgeon comes from the Beaver Islands in 1885, reported by Smith and Snell.

> The Indians have for some years been engaged in the capture of sturgeon with spears 25 or 30 feet long, having detachable points. They paddle about in the smooth water in the vicinity of the islands watching for sturgeon, which usually lie motionless on the bottom. When one is seen the spear is lowered in the water, its position being clearly marked by a white quill which shows plainly at a depth of 30 feet. When near the sturgeon the spear is quickly plunged into its flesh, the handle becomes detached, and the fisherman seizes the line fastened to the iron and plays the fish until it becomes exhausted, when he draws it to the surface, kills it, and pulls it into the canoe . . . seven fish, averaging 65 pounds, dressed, were brought in by an Indian as the result of one day's labor [1891:203].

Neither can angling be forgotten. As early as 1623, Sagard bemoans the big one that got away.

> We found in the bellies of several large fishes hooks made of a piece of wood and a bone, so placed as to form a hook, and very neatly bound together with hemp; but the line being too weak for drawing on board such large fishes, the result was the loss of the labor of the fishermen, and of the hooks thrown into the sea by them; for, in verity, there are in this fresh-water sea sturgeon, assihendos, trout, and pike of such monstrous size, that large ones cannot be seen anywhere else, not to speak of several other kinds of fish there caught, which are here (in Europe) unknown [Rau 1884:269].

While angling may not have been a very productive mode of fishing, evidence of angling is a consistent feature of the archaeological record. The utility of this fishing method was that hand-held lines could be employed on both open water and through the ice to catch large predaceous species. There is, of course, no reason to believe that angling was any less fun in the past than it is today.

When describing fishing methods, early travelers did not overlook the importance of the fishery itself. Cadillac, writing at Mackinac in 1695, states that

> The abundance of fish and the convenience of the place for fishing have caused the Indians to make a fixed settlement in those parts. It is a daily manna, which never fails; there is no family which does not catch sufficient fish in the course of the year for its subsistence [Kinietz 1965:239–240].

Baron de Lahontan, visiting the same district in 1703, makes a nearly identical observation.

> You can scarce believe, Sir, what vast shoals of whitefish are caught about the middle of the channel, between the continent and the isle of Missilimackinac. The Outaouas and the Hurons could never subsist here without that fishery; for they are obliged to travel about twenty leagues in the woods, before they can kill any harts or elks, and it would be an infinite fatigue to carry their carcasses so far overland [Thwaites 1905:147].

Henry R. Schoolcraft, agent of the Mackinac Agency and student of upper Great Lakes Indian culture, appreciated the importance of fish in the diet of Indian people. In a letter to Secretary of War J. C. Calhoun on June 17, 1820, he stated, "It [fish] constitutes a considerable part of the food of all the Indians upon this extensive frontier. Deprived of this means of support, they must absolutely perish" (Carter 1943:36).

There is no evidence indicating that fishing decreased in importance during the late nineteenth century, Despite the frenzy of the fur trade and the national reverberations that dominated the attention of historians of these periods, Indians continued to fish with traditional methods, and fish continued to be central to the lifeways of these people. Most historic period Indian sites of the region contain ample evidence of this fact in the form of both fishing artifacts and fish remains. In fact, Fitting, in discussing the subsistence of a late seventeenth-century historic site on the north shore of the Straits of Mackinac, concludes that fishing was pursued with even increased intensity after European contact.

> If the introduction of European trade goods had any effect at all on the subsistence base, it was to amplify the trends already present. We must reject the hypothesis that European trade goods drastically altered the subsistence base of the peoples of the Straits of Mackinac [Fitting 1976:327].

Scrutiny of both the archaeological and literary records of the historic period of the upper Great Lakes leads to the conclusion that fishing was vitally important to the survival of indigenous peoples of the region. Further, it may be concluded that this fact has eluded our attention not as the result of any diminution of the importance of fishing over time, but because of our own cultural predisposition to cast these fishermen in the roles of hunters, warriors, and fur traders.

FISHERY RESOURCES OF THE UPPER GREAT LAKES

The drainage of the northern upper Great Lakes is, by and large, an area of ecological transition between the hardwood forest to the south of the lakes and the vast boreal conifer forests to

the north (Figure 1). As it is not an area of rich land resources, important game animals—such as the moose and woodland caribou of the northern forests and the deer and elk typical of the deciduous regions in the south—all occur in marginal habitats and in relatively low density. Similarly, the plant resources, particularly those seed-bearing and nut-bearing species exploited by the prehistoric gatherers to the south of the Great Lakes, are not abundant in the Lake Superior basin and the northern portions of the basins of lakes Michigan and Huron. Although the Late Woodland Indians of the region seem to have experimented with farming, except for some extremely local situations the short growing season precluded reliance on domesticated plant species. Despite the paucity of these plant and animal resources, Indians of the upper Great Lakes not only survived but, at various times in prehistory, attained a high degree of residential stability and population concentration.

The drainage system of the three upper Great Lakes includes 220,480 square miles; 35% of this area, or 77,230 square miles, is open water of the Great Lakes themselves, while there are perhaps 35,000–40,000 smaller lakes in the watershed. This region is probably unmatched on the earth in the high proportion of fresh water to land area. It may, therefore, be surprising to some that it is not a region where fish are readily available! Because the lakes are so cold and deep, they tend to be relatively impoverished in terms of fauna; this is especially true of Lake Superior, a classic oligotrophic lake. Rostlund (1952:65) reports that the estimated fish yield per surface acre for the three upper Great Lakes varies between one and two pounds. These figures might be contrasted to the fertile waters of the central Mississippi River Valley, which can produce 60 pounds of fish per surface acre. Another factor that accounts for low productivity is geography—

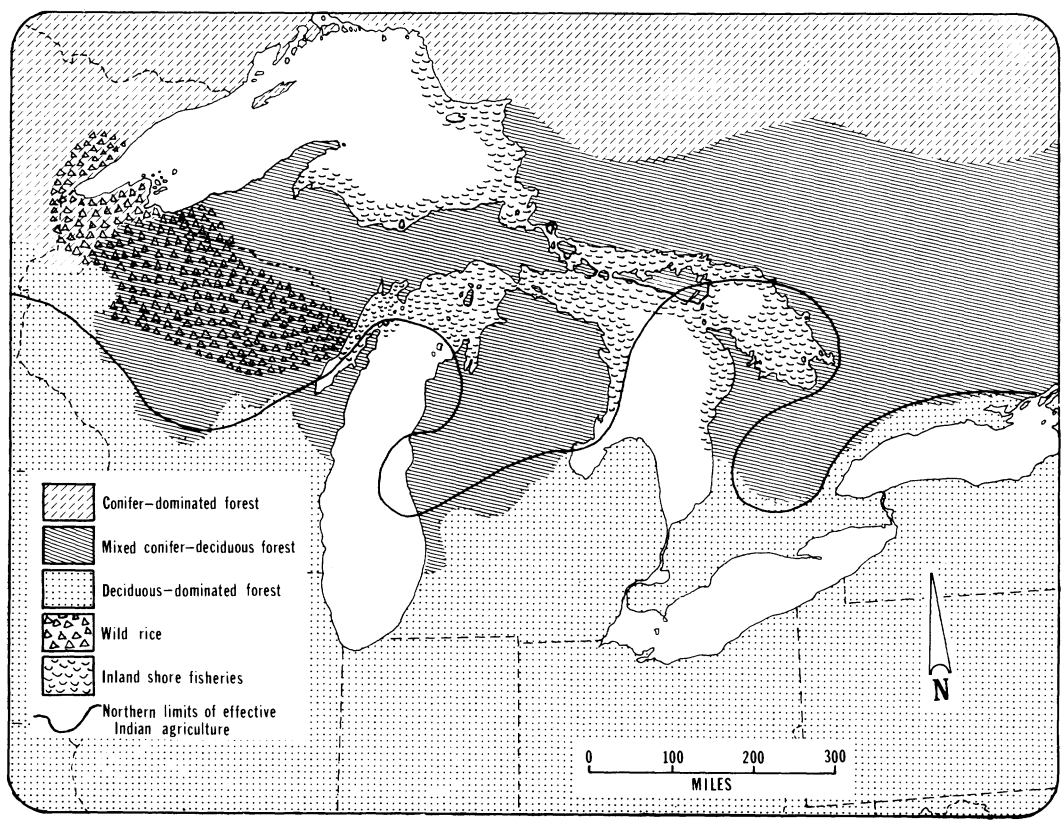

Figure 1. The distribution of the inland shore fishery of the northern Great Lakes.

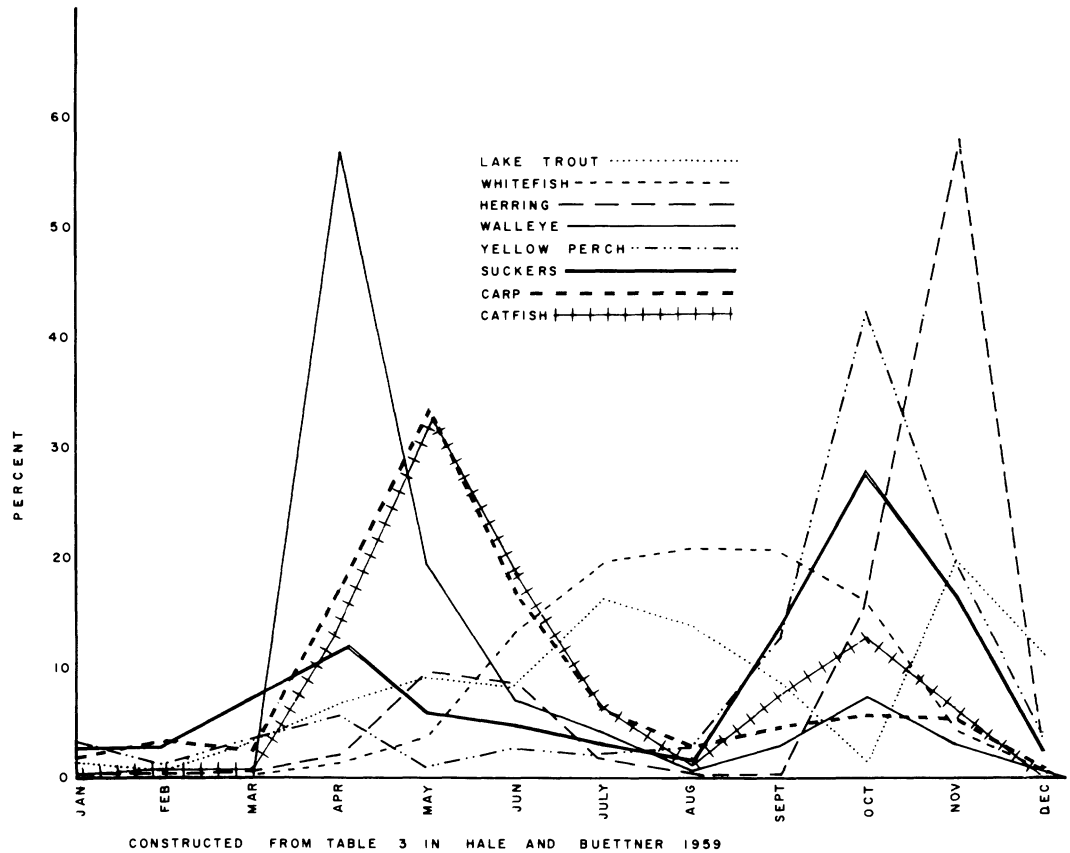

Figure 2. Modern commercial harvest of various fish species in Saginaw Bay.

the lakes are so large that the fish are very dispersed during most seasons of the years. Finally, these lakes are very stormy and difficult to travel in the fall and are to some extent ice-covered for three to four months each year.

Several features of upper Great Lakes fish resources, however, made fisheries a productive subsistence enterprise. While the fish of these lakes may have been relatively inaccessible for much of the year, they were available in almost limitless quantities during certain other periods. Information about the habits of Great Lakes fishes show that the breeding cycles of most species are such that they approach the shallow shore waters to spawn in either the spring or the fall (Hubbs and Lagler 1964). Historic fishing records indicate that modern fish harvesting follows a bimodal curve (Figure 2).

The spring spawning run is triggered primarily by water temperature. Soon after ice leaves the open water in mid-April or early May and the daily water temperature reaches 5° to 10° C, the spring-spawning species either approach the shore to spawn in shallow water or ascend streams and rivers to spawn (Geen et al. 1966). The spring-spawning species of primary economic importance in the prehistoric fishery include the lake sturgeon (*Acipenser fulvescens*), white sucker (*Catostomus commersonnii*), northern redhorse sucker (*Moxostoma macrolepidotum*), northern channel catfish (*Ictalurus punctatus*), black bullhead (*Ictalurus melas*), brown bullhead (*Ictalurus nebulosus*), yellow perch (*Perca flavescens*), walleye perch (*Stizostedion vitreum*), northern pike (*Esox lucius*), and various members of the bass family, Serranidae. Of these, the lake sturgeon and suckers, particularly the white sucker, were the most important of the spring spawners, the

former for its large size (up to 300 pounds) and the latter for its ready abundance in large numbers. The sturgeon spawns on shallow water shoals and ascends large streams for spawning, while the sucker ascends clear, shallow streams or spawns in shallow bays. In addition to these spring-spawning species, some of the fall-spawning whitefish and trout remain in fairly shallow water during the spring and early summer.

The other great peak of fish production centered on the fall spawners. With some exceptions, these species spawn on silt-free, shallow-water gravel shoals and reefs during late November and December and include the lake trout (*Salvelinus namaycush*) and several members of the whitefish family. These are the lake whitefish (*Coregonus clupeaformis*), the lake herring (*Coregonus artedii*), and other varieties of shallow-water ciscoes, the chubs or deep-water ciscoes of various species, and the round whitefish or "menominee" (*Prosopium cylindraceum*). The fall fishery generally commenced in late September or October and became increasingly productive until the weather and ice cover closed the season in mid-December. Whitefish spawn when the water temperature is between .6° and .5° C so that it is near freezing during the period of development and hatching (Lawler 1965).

Although the exact period of spawning and the number of fish involved vary considerably from year to year depending on such conditions as weather, water temperature, changing bottom conditions, and natural fluctuation in fish populations, an attempt has been made to diagram by month the relative abundance of fish in coastal water (Figure 3). Information for this diagram is drawn from the commercial harvest presented in Smith and Snell's exhaustive review of the Great Lakes commercial fishery in 1885. That year was near the peak of commercial fish production in the upper Great Lakes with over 54 million pounds of fish caught in lakes Superior, Michigan, and Huron. In Lake Michigan, 50% of the catch was one variety or another of whitefish and 27% lake trout, the remaining being sturgeon, pike, suckers, and a few other species. The Lake Superior fishery in the same year was composed of 65% whitefish, 30% trout, and a small

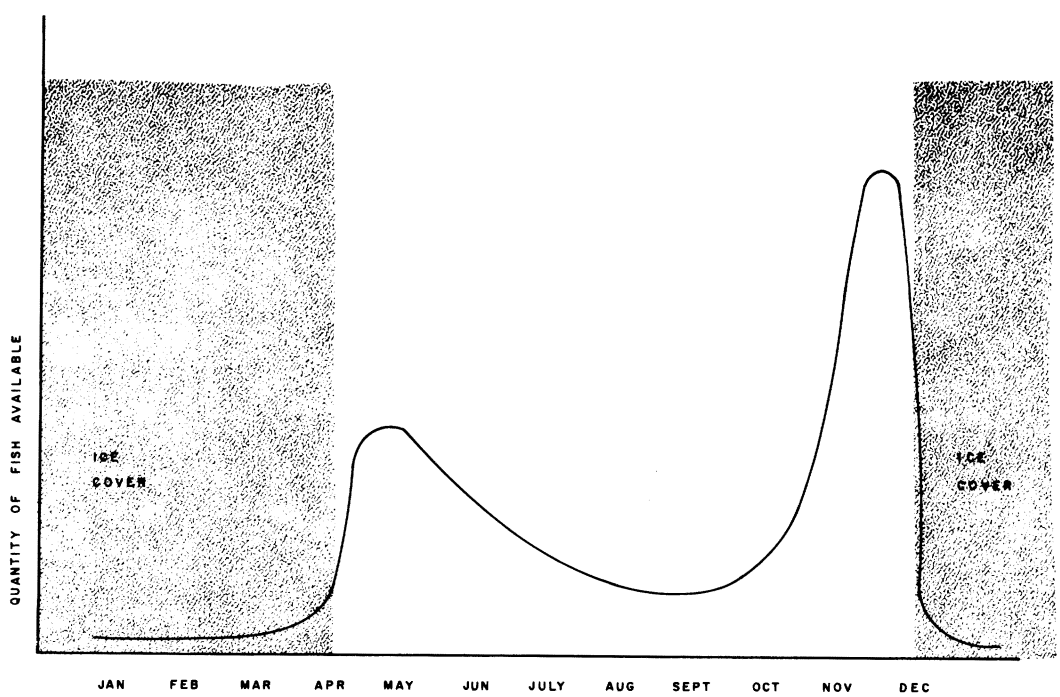

Figure 3. Hypothetical reconstruction of the relative abundance of Great Lakes fish by season.

percentage of sturgeon, pike, and suckers. To some extent, these figures reflect the biomass of the lakes, but they also reflect the commercial desirability of various species. Sturgeon, for example, were taken in small numbers in 1885 and so comprised a much larger percentage of the biomass than these figures suggest. The same is true for suckers.

Fall-spawning species are nutritionally of higher quality than the spring spawners. Atwater (1895:45–52) notes that the majority of spring-spawning fish produce 350 to 450 calories per pound, while the fall-spawning lake trout and whitefish produce 600 to 800 calories per pound. He also notes that fish are an excellent source of protein and are generally rich in minerals and vitamins, some of which are critically important for people living at high latitudes. The shortcoming of fish as a food is the lack of carbohydrates.

To recapitulate, we may conclude that the northern upper Great Lakes area, with the exception of its fish resources, was probably as impoverished as any cultural area of the eastern United States in terms of total available food resources. Although dispersed and unavailable for most of the year, fish were a high quality food available in tremendous quantities at specific times. Availability was regular, predictable, and centered on the spring and fall spawning periods. This cycle becomes the key to understanding the evolution of subsistence and settlement systems of the upper Great Lakes Indians.

ARCHAEOLOGICAL EVIDENCE FOR DEVELOPMENT OF THE FISHERY

The Late Archaic Period

While the Indians who first entered the upper Great Lakes region about 12,000 years ago may have fished occasionally, there is no indication in the archaeological record that they did. In fact, the record is barren of evidence of any fishing activity during the paleo-Indian, Early Archaic, and Middle Archaic periods. By the early part of the Late Archaic, sometime during the third millennium B.C., Great Lakes Indians began to exploit fish as a food source and to display the ability to regularly visit offshore islands in the Great Lakes.

The earliest fishing in the upper Great Lakes took place in the context of the Old Copper Culture during the Late Archaic period (3000–1000 B.C.). Archaeological data from northern Michigan and Wisconsin and from Ontario provide ample evidence of angling in the form of barbless copper fishhooks and gorges. The latter device is a primitive fishing implement consisting of a small copper or bone sliver pointed at both ends and fixed to a line at mid-shank and baited. When a fish swallows the bait, the gorge is pulled crosswise and becomes lodged in the mouth of the fish. There is also evidence of fish-spearing in the form of unilateral multibarbed copper spears, as well as in barbed copper prongs called gaff hooks, which may have been elements of tridents (Steinbring 1967). Some Michigan examples of this fishing gear include a unilateral multibarbed copper spear from the Andrews site, Saginaw County (1220 B.C.), and copper fishhooks from the Riverside Cemetery site in Menominee County (1090 B.C.). Fishbones from Late Archaic period Old Copper sites indicate that fishing was a fairly important activity, at least at some sites during some portions of the year. Hruska (1967) notes that fish remains from Old Copper sites indicate the taking of particularly large numbers of fish, especially sturgeon.

In summary, the few archaeological records for the Late Archaic period indicate that the Indian peoples of the upper Great Lakes began to exploit fish resources sometime during the third millennium B.C. The earliest fishing techniques were spearing, angling, and the use of weirs, where spearing and gaffing could be effectively employed. This last fishing device has been well documented for the Late Archaic at Atherley Narrows, which connects Lake Simcoe and Lake Couchiching in present-day Simcoe County, Ontario (Johnston and Cassavoy 1978:697). It may be concluded that fishing, particularly spring fishing, was seasonally important; how important it may have been in the context of the total annual economy is a moot point. On the basis of evidence available from the northern Great Lakes at this date, we must conclude that fish played a relatively minor role in the subsistence economy of these Archaic peoples, who seem to have been basically hunters.

Although fishing as an important economic enterprise in the upper Great Lakes had not ad-

vanced far during the Late Archaic, significant developments for the future of this fishery were being made in the lakes Erie and Ontario basins and in the area south of the Great Lakes. Here, people had already developed all of those fishing techniques employed in the upper Great Lakes but, in addition, there is ample evidence that they also employed nets. Although the earliest evidence for the use of nets comes from the Atlantic seaboard, where nets were in use by at least 7000 B.C. (Kraft 1975), the Lamoka Lake site in north-central New York, which dates from 2500 B.C., provides the earliest evidence for net fishing in the lower Great Lakes (Ritchie 1965). Over 8,000 notched pebble netsinker weights have been recovered from this site; in one place, 37 sinkers were recovered in a heap distributed in such a way as to suggest the original presence of a net to which the sinkers were attached. Site refuse also produced long bone needles that seem to have been used for making and repairing nets. Ritchie and Funk (1973:41) note that the subsistence remains on Lamoka-type sites "clearly bespeaks of the effectiveness of the Lamoka articulation with the environment." They also note that Lamoka-type sites are located on small lakes, shallower portions of large lakes, sizable rivers and streams, and large marshes. While deer provided the major source of food, fishing was an important economic endeavor.

The continued importance of fishing in this region is noted in subsequent Frontenac and Brewerton phases of the Late Archaic, where netsinkers continued to appear frequently along with such other fishing devices as bone and copper fishhooks, fish spears and bone harpoons, and bone gorges. There is also ample evidence from lower Ontario for the importance of fishing during the Late Archaic; there, net fishing was an important subsistence method for people occupying the north shore of Lake Erie (William Fox, personal communication).

During the second millennium B.C., there is also evidence of fishing among the peoples of the Midwest and mid-South. Barbless bone fishhooks, which appear frequently on Late Archaic sites in these regions, indicate that angling was the principal method of taking fish. The paucity of fish remains on these sites also suggests that fishing was not an important economic pursuit compared with either hunting or collecting plant foods. Netsinkers do, however, appear quite early in this region. Grooved netsinkers appear at the Robison Hills site on the Wabash River near Vincennes, Indiana. This site is radiocarbon dated to 1540 B.C. and 1490 B.C. (Winters 1969). Similar grooved netsinkers have been recovered from roughly contemporaneous sites such as the Carlson Annis site in Butler County, Kentucky (Webb 1950), and the LV° 86 shell mound in Lauderdale County, Alabama (Webb 1939).

The Early and Middle Woodland Period

The use of nets as fishing devices continued into the Early Woodland in the lower Great Lakes. A spectacular find at the Morrow site in Ontario County, New York, laid to rest reservations about the function of notched pebble sinkers. At this site, dated at 563 ± 250 B.C. (M-640) and 630 ± 100 B.C. (Y-1171), sinkers were found attached to a net.

> A thick, ovate-shaped, natural pebble with notched or grooved ends came from the Morrow site, and in one burial a group of such objects, obviously sinkers, was actually still attached by a double cord to a carbonized fish net. Tragically, this unique specimen, rolled into a compact mass along one side of the grave, and reduced to a carbonized state by the crematory fire, was dug out by a collector and only fragments were salvaged. The material was apparently Indian-hemp fiber, twisted into a cord of small diameter, which was woven into a net with about two-inch mesh [Ritchie 1965:185].

Ritchie goes on to say that the faunal remains at Morrow and other Meadowood sites consist chiefly of fishbones; bones of the brown bullhead (*Ictalurus nebulosus*) are most common.

Fishing with nets does not seem to have been practiced in the upper Great Lakes area until the first few centuries before the birth of Christ. End-notched sinkers then appear in the context of the Middle Woodland Laurel tradition, which occurs with variation north of the Great Lakes from western Ontario to the upper St. Lawrence River. Clearly, netsinkers entered the upper Great Lakes from the east; they are, at least, a frequent artifact on the Saugeen focus sites of lower Ontario, where they appear on the Short (Donaldson 1962) and Burley (Jury and Jury 1952) sites and

in the Middle Woodland component of the Donaldson (Wright and Anderson 1963) site. Lee (1952:65), in his survey of southwestern Ontario, mentions a Middle Woodland site in Elgin County where hundreds of netsinkers in all stages of completion have been removed by collectors and by local fishermen for use on modern nets. At the Bear Rump Island site (BhHj-5), located just off the Bruce Peninsula between Georgian Bay and Lake Huron, a structure demarked by a hearth and weight stones was discovered. James V. Wright (personal communication) describes the find of this "ghost net."

> One of the weight stones was what I interpret as the anchor weight for a gill net and consisted of a large (circa 13 lbs.) notched limestone cobble. Outside of the structure occurred a mound of net sinkers which consisted of the following: unmodified—57; notched one side—19; notched both sides—33, for a total of 109. The reason that I was able to recognize the unmodified netsinkers was that they were all made from an iron rich limestone which stood out sharply from the natural white limestone shingle beach. In short, it clearly appears that they brought their net to the site from elsewhere with weights attached. I would place this site somewhere between 1000 B.C. and 500 B.C. although the cultural identification needs firming up. In cultural terms, it falls within the middle portion of the Inverhuron tradition and may even pertain to the ceramic portion of that tradition.

Ultimately, sinkers appear on Laurel sites around northern Lake Michigan, including the Summer Island site (Brose 1970a) and the Mero site (Mason 1966), as well as on the north and south shores of the eastern end of Lake Superior. Sites from this last area include the Heron Bay and the Pays Plat sites (J. V. Wright 1967) and the Middle Woodland component of the Naomikong Point site (Janzen 1968). Interestingly, netsinkers do not seem to appear on the Laurel sites of northern Minnesota (Stoltman 1973) or in the western Lake Superior basin, nor do they appear on Havanna tradition, Middle Woodland sites in the southern ends of the lakes Huron and Michigan basins.

Over the entire geographic and temporal range of Laurel culture, it is clear that the spear and harpoon were also major fishing devices. Spears were manufactured from bone and unilaterally multiple barbed; harpoons include bone varieties resembling the spear but with the addition of a line hole, as well as the socketed togglehead harpoon described by Mason (1965). In addition, bone and copper fishhooks and gorges, bone points assumed to be leister prongs, and what are perhaps composite bone hooks appear with some regularity on Laurel sites.

Unfortunately, faunal materials from Laurel sites are scanty. In the Laurel sites of Minnesota, the bones of large fish such as sturgeon and pike as well as suckers appear, and it is apparent that fish were important in what was essentially a mixed hunting-fishing economy (Lukens 1973). At the Summer Island site in northern Lake Michigan, we find remains of sturgeon, walleye, bass, pike, suckers, gar, and drum, with sturgeon in great abundance (Brose 1970a). Further south, from the Mero site on the Door Peninsula of Wisconsin, Mason (1966) reports sturgeon, catfish, sucker, smallmouth bass, white bass, walleye, and drum. Moreover, Brose (1970a:148), speculating on the relationship between the two sites, says that if the Mero and Summer Island sites were functionally distinct sites occupied by the same group of people, then "the Summer Island site represents the major spring-summer occupation for harvesting sturgeon while Mero may represent a short midsummer occupation by a small group who may have spent the earlier portion of the year at Summer Island." Wright and Anderson, making a similar observation about the Saugeen focus Laurel sites of lower Ontario, conclude that "on the basis of present information all components of this focus appear to represent fishing stations which were occupied during spring and early summer" (1963:1).

During this period of ready acquisition of abundant food in the form of fish, major components of the Saugeen focus were formed. A recent faunal report for the upper level of the late Middle Woodland and early Late Woodland Winter site on the north shore of Lake Michigan gives us the only Middle Woodland record for the exploitation of fall-spawning fish (Martin 1980:94). Here, in addition to the usual walleye, white bass, drum, and catfish, whitefish are found in abundance. Summarizing the Laurel subsistence-settlement system, Mason states that "occurring on rivers and lakes, the excavated sites from Manitoba to Quebec and New York suggest season encampments of hunters and gatherers with locally heavy reliance on fishing and with no direct or even inferential evidence of agriculture" (Mason 1967:339).

The Late Woodland Period

Net weights and fishhooks, both fairly common artifacts on Laurel sites of the Middle Woodland period, become very uncommon on northern upper Great Lakes sites of the subsequent Late Woodland. Spears, and particularly unilateral multibarbed bone harpoons and bone and copper gorges, continue to appear regularly. Despite the fact that Late Woodland sites of the region are larger and more numerous than those of earlier periods, less is actually known about Late Woodland archaeology over this entire region than about the Middle Woodland Laurel cultures. The Juntunen site (McPherron 1967a) on Bois Blanc Island in the Straits of Mackinac is frequently cited as the archetype of Late Woodland occupation in the northern upper Great Lakes area. This site, occupied intermittently from about A.D. 800 until A.D. 1350, exhibits refuse deposits of huge numbers of fishbone, yet the only fishing equipment recovered includes nine unilateral multibarbed harpoons and a few copper and bone gorges. Farther south along the northwestern shore of lower Michigan, smaller but similar sites are located at Wycamp Creek, Nine-Mile Point, the Pine River Channel, and at the O'Neill site at the mouth of Inwood Creek (Cleland 1973). The O'Neill site produced three netsinkers, six gorges, and six ground slate spatulas inferred to be fish scalers (Lovis 1973). The Pine River site, described by Holman (1978), has a very thick early Late Woodland midden that contains some side-notched netsinkers. Near this site, John Moore of Charlevoix, Michigan, recovered two grooved pebble sinkers from the bottom of Round Lake, which is a shallow embayment at the Pine River between Lake Charlevoix and Lake Michigan. Along the north side of Lake Michigan, the Beyer site at St. Ignace (Fitting and Clarke 1974), the Point Scott site, and the Foscoro (Wells 1972) and Mero (Mason 1966) sites in Door County, Wisconsin, are examples of large lakeside Late Woodland village sites. The latter two sites contained notched netsinkers.

To the north, on the south side of Lake Superior, the Late Woodland occupations of the Naomikong Point site (Janzen 1968) and the Sand Point site at the end of Keweenaw Bay are examples of large Late Woodland sites. The Sand Point site, occupied between A.D. 1100 and A.D. 1300, is significant because excavations recovered not only copper hooks and gorges but also sinkers from a discarded net.

> We would like to know more about how the people lived, but we can say that fishing was definitely important in their lives. Not far from the remains of the house was a series of flat pebbles with curious nicks made on opposite sides. Most people would toss such rocks aside without a second thought. The trained eye, however, can recognize them for what they were—sinkers for fishing nets. The plant material from which the fisherman's net had been made probably was rotting and the net was discarded. Net sinkers are so easily made from any beach pebble that there was little reason to salvage them. Hundreds of years later [the site was occupied between A.D. 1100 and A.D. 1300] an odd grouping of nicked and notched pebbles is all that remains of the fisherman's net. Some fish bones, a copper fish hook and other probable fishing implements were also found; this supports the idea that there was an emphasis on fishing. For the most part, however, bones from the fish and game of former meals have been disintegrated by the acidic forest soil [Moore 1973:16].

At the Draper Park site, dated at about 1000 A.D. and located at the foot of Lake Huron, Don Weston of Western Michigan University recovered a large series of netsinkers, some side-notched and others unmodified. In many instances these clearly showed stains resulting from binding material, and in several instances cordage was preserved (Donald E. Weston, personal communication).

Faunal materials are scarce on most of the Late Woodland sites reported in archaeological literature. One exception is the Juntunen site in Mackinac County, Michigan. Here, Cleland (1966) analyzed a sample of 37,000 bones representing subsistence remains from at least seven Late Woodland occupations that have dated between A.D. 800 and A.D. 1350. In the case of six of the seven occupations, fishbones comprised over 91% of the sample; in the other, they constituted 78%. In comparison to mammals and birds, fish supplied 66% of the usable meat obtained by Juntunen peoples. Both spring-spawning and fall-spawning fish were being taken at this site. Sturgeon, which produced 36% of the total bone, predominated the spring spawners; whitefish, which produced 11% of the total, was the major fall-spawning species. Because bones of the

former species are very durable and those of the latter very fragile, this estimate of proportions is conservative.

The faunal evidence at the Juntunen site clearly shows that Late Woodland peoples were both hunters and fishermen. Of these pursuits, fishing was by far the more important subsistence venture from early spring until late fall. In addition, the sites produced undeniable faunal evidence that both spring-spawning and fall-spawning fish were heavily exploited. Unilateral multibacked bone harpoons recovered from the Juntunen site indicate that some of the larger species were taken by this method. The extensive size range of individual whitefish remains recovered from the site leads to the conclusion that this species, which is not easily taken by angling or spearing, must have been taken by a method that did not strongly select for size. Either a seine or a small mesh gill net is thus indicated as a major fishing technique. The same pattern is evident at the Whitefish Island site in the St. Marys River; in many ways it is a companion site to the Juntunen site (Conway 1980). Rick (1978), who analyzed the faunal remains from this site, found both fish and mammal bone in great frequency and noted the strong presence of whitefish. The Scott Point site, located on the north shore of Lake Michigan in Mackinac County, is also similar to the Juntunen site. Martin (1981) analyzed a large excavated collection of bone from this site and found that trout dominated the aquatic assemblage. Further and more significantly, he observed at each of these three Late Woodland occupations a steady increase in the importance of fall-spawning species in contrast to spring spawners.

Late Woodland settlement data from the upper Great Lakes tend to support the conclusion that Late Woodland people developed a shore-oriented settlement system. After studying a sample of 91 archaeological sites in northwestern lower Michigan, Cleland (1974) proposed that there is a substantial shift in settlement type from Archaic until Late Woodland times with regard to the frequency and size of sites relative to their location on types of water courses. In summary, both Archaic and Woodland peoples inhabited the shores of inland lakes. The Archaic sites on these bodies of water are much more numerous than Woodland sites and are probably of a different character in terms of season and lifeway. Similarly, both Archaic and Woodland peoples frequented the banks of inland rivers, but here we see that Archaic period sites so located are very large, while riverine Woodland sites are very small. Finally, it is apparent that the coasts of the Great Lakes were occupied as frequently by Archaic as by Woodland peoples but that the sites of the latter era are very large and the Archaic ones very small.

Several kinds of Late Woodland sites can be identified: small interior camps occupied during either winter or summer, moderate-sized settlements on interior lakes or waterways that were occupied during the summer, and large villages on the shores of the Great Lakes that are thought to be summer sites. It is further hypothesized that these last lakeshore sites may represent small spring fishing sites as well as much larger fall fishing sites. While the Juntunen, Scott Point, and Whitefish Island sites are examples of large, fall-oriented, Late Woodland fishing villages, the O'Neill and Wycamp Creek sites are excellent examples of small, spring-oriented, Late Woodland fishing camps. In his paper "Heartland of the Ojibwa," Conway (1980) recognizes two distinct types of sites in the St. Marys River area and the northeastern coast of Lake Superior. Small, repeatedly occupied sites such as Black Thistle, Maids O'Mull, and Point Louise are believed to be summer fishing stations, while the Metal Toad and Whitefish Island sites are much larger, more intensively occupied villages that Conway equates with Juntunen-type settlement and subsistence enterprises.

The archaeological record of upper Great Lakes subsistence-settlement systems is not as complete as we might like, but the patterns are evident, nonetheless. Late in the Archaic period, small groups of hunters began to visit the lakeshores as part of their seasonal round. Here, they exploited the large and easily available spring-spawning species with spears. By the time of northern Middle Woodland peoples, we see small spring and summer villages appearing on the shores of the Great Lakes. Faunal remains indicate continued exploitation of the spring spawning runs while material culture points to the introduction of nets and harpoons as the means of exploitation.

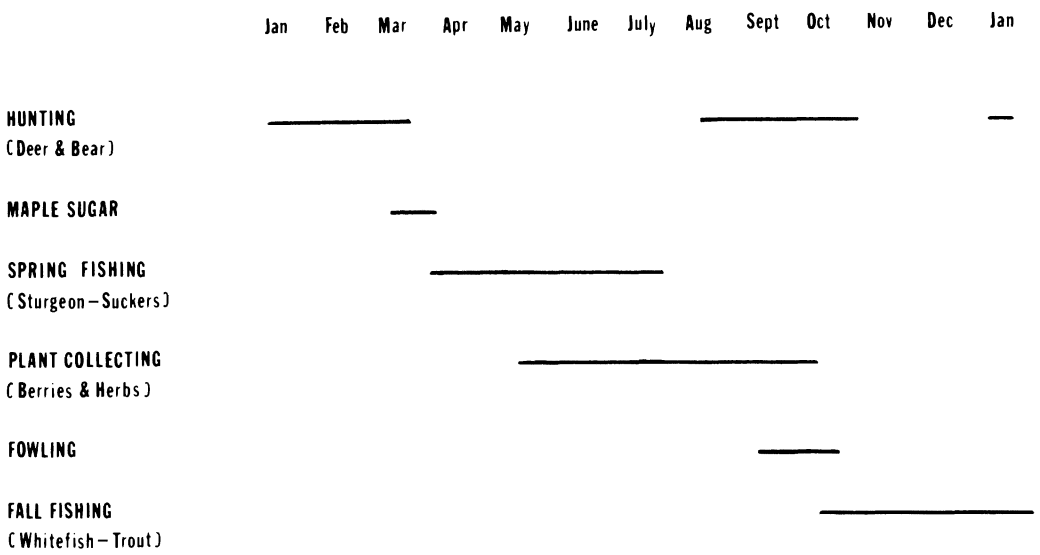

Figure 4. A reconstruction of the subsistence round for the Late Woodland of the northern Great Lakes.

During the subsequent Late Woodland, we see a clear dichotomy between small interior campsites; small, lakeshore villages occupied in the spring; and large, intensely occupied shoreline villages; these last sites, as indicated by faunal and floral remains, were occupied at least during the late fall. Abundant remains of fall-spawning fish indicate that the net technology of earlier times was not being applied during the fall spawning season. A reconstruction of the Late Woodland subsistence round is shown in Figure 4.

THE EVOLUTION OF THE PREHISTORIC FISHERY

The archaeological data bearing on the evolution of subsistence and settlement systems in the prehistoric upper Great Lakes region show the development of increasingly effective means of exploiting fish as a food resource. Given the relative paucity of other plant and animal food resources and the historically documented importance of fisheries at the time of European contact, it is apparent that an understanding of at least the Woodland period subsistence-settlement system of this region must be sought in the development of fisheries.

It seems evident that the development and application of fishery technology was a cumulative process; once fishing devices were developed or introduced, they continued to function as part of the fishery. Thus, we see in the northern Great Lakes region the development of spearing and angling during the Late Archaic, the addition of harpoons and net fishing during the Middle Woodland, and the continued use of all of these techniques during the Late Woodland. The increased complexity and efficiency that is reflected in the archaeological record of the Late Woodland by both increased fish remains and more specialized fishing sites is primarily the result of changes in the application of existing technology rather than the addition of new technological means of taking fish. Information about the size and geographic location of settlements, as well as seasons in which they were in use and the kinds of resources being exploited during each season, is central to understanding how the technology was applied. Although our knowledge of these data is imperfect, a clear pattern in the evolution of the prehistoric fishery can be reconstructed.

Late Archaic peoples, who seem to have been the first to exploit fish as a resource in the upper Great Lakes region, employed simple gear to capture the most abundant species. Thus, spears of several types were used to take the largest species, such as sturgeon and pike, in lake shallows, as

well as the most abundant and easily speared fish, the sucker, which ascended streams in large numbers to spawn. It is logical to suppose that the earliest fishing efforts were simply a transference of the spear technology developed for land mammals to water resources. In addition, primitive angling devices such as copper fishhooks and gorges appear and were probably used from boats and for fishing through the ice. Copper spuds, which appear commonly in Late Archaic context, may well have been used to cut holes for winter ice fishing.

It is clear from the archaeological record that the greatest exploitation of fish took place during the spring spawning season and that small groups of people encamped adjacent to the shores of the Great Lakes for this purpose. The development of a fishing capability is significant because spawning runs come at a time of year when hunting, the mainstay of Archaic economy in the northern climates, is most difficult and least productive because of the absence of cover and the poor condition of game. More than likely, Late Archaic peoples simply added fishing to a hunting-gathering round. In so doing, they established the spearing and angling technology that continued into later periods.

The introduction of net technology to the lower Great Lakes during the first millennium B.C. had a profound effect on the development of the fishery. Here, the archaeological record indicates that nets were employed during the spring fish runs; thus, Middle Woodland peoples exploited the same species as the Archaic peoples but did so much more effectively. The appearance of small, warm-season villages on the shores of the upper Great Lakes during the period of the North Bay, Laurel, and Saugeen Middle Woodland is evidence of the impact of this technology. Since many spring spawners in the shallow waters of lake shores are territorial and therefore dispersed, the most effective means of taking these species is with seines. These are deep, fine-meshed nets that are used to corral fish toward the shore (Figure 5). The effective use of the seine requires that it be kept tight to the lake bottom as it is moved through the water. To accomplish this, the bottom of the seine must be weighted with many closely spaced, tightly attached sinkers. The numerous, small end-notched sinkers of the Middle Woodland period would seem to function very well as weights on seines used to catch species such as pike, drum, bass, and perhaps suckers. Northern Middle Woodland peoples also improved on methods for taking large fish such as the sturgeon by introducing the harpoon. The detachable head of this device permitted playing the fish on a line, thereby vastly improving chances of capture. This method largely, but not totally, replaced spearing as a fishing technique in later periods.

It is suggested here that the now-efficient spring fishery brought concomitant changes in Middle Woodland settlement. The use of nets was a cooperative enterprise: not only could more people be temporarily supported by the increased efficiency of the nets, but more people were needed to apply the nets and to process the catch. This conclusion in part supports the imaginative work of Brose (1970b) in his analysis of the Laurel occupation of the Summer Island site. He concludes, on the basis of structural and ceramic analysis, that the community was composed of 30 individuals representing two extended families. Brose also believes that the archaeological data give "evidence of collective pooling of food resources at a nuclear or extended family level, and some form of reciprocity between several households" (1970b:63). Thus, it is suggested here that the application of a net technology to the spring fish resources both required and made possible larger temporary work groups, which in turn produced the larger and more numerous lakeshore sites of the upper Great Lakes Middle Woodland.

It is apparent from numerous Late Woodland sites with quantities of whitefish and lake trout bones that by A.D. 800, these people were exploiting the fall-spawning species. Unlike the spring spawning runs that occur in shallow water onshore, the fall-spawning species gather in offshore shoals that are often as deep as 30 fathoms. Not only are these incredible concentrations of fish not visible from shore, but their exploitation requires a means of fishing in deeper water. This problem was solved by the redesign of existing net technology, which led to the development of the gill net. This device is a long, coarse, mesh net set to form an underwater "curtain" in which fish become ensnared by their gills. These nets are kept vertical in the water by means of sinkers and floats and can be set at any depth (Figure 6).

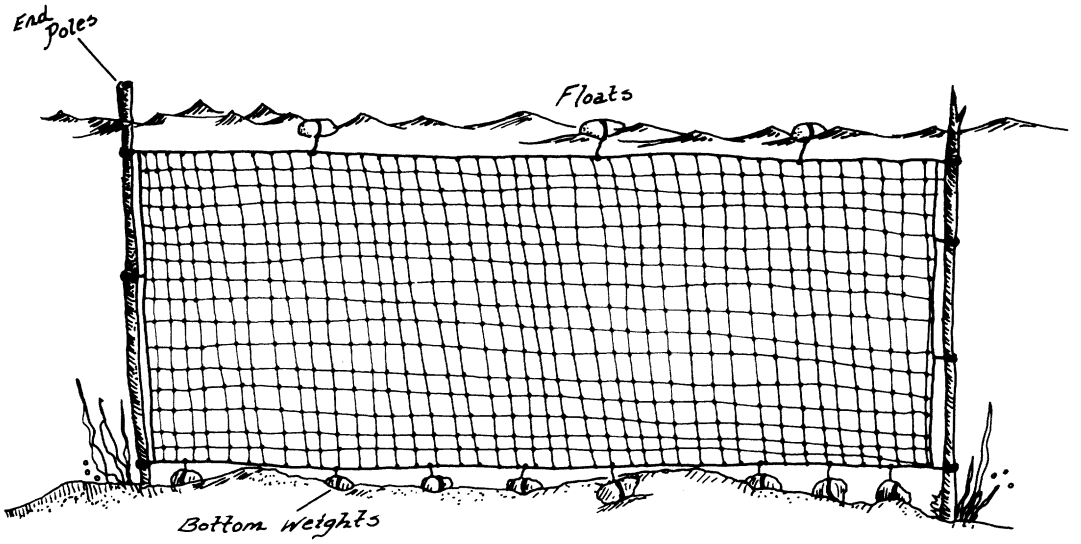

Figure 5. Illustration of seine.

Although the bones of spring-spawning fish continue to appear on Late Woodland sites, on the basis of faunal remains it is clear that the lake trout, and especially the several varieties of whitefish, were being taken in abundance. These species offer several very significant advantages beyond their relatively large size and availability in great numbers: they are also nutritionally of superior quality to spring-spawning species and are most easily taken after the arrival of freezing weather in the fall, thus facilitating preservation for winter use.

The shift in settlement systems from Middle to Late Woodland seems to have accommodated the fall fishery. Lakeside settlements increased in size and duration and, while some specialized Late Woodland sites occupied only in the spring or fall are encountered, most of these villages were occupied throughout the warm season. Additionally, these sites are more numerous than Midle Woodland sites, leading to the conclusion that there was a dramatic increase in Late Woodland population. Again, it is necessary to note that the fall fishery featured the exploitation of fish of nutritionally superior value, which could be taken in great numbers and preserved for future use. Although the spring fishery operated during the optimum season for immediate relief from early spring food problems, the indigenous methods of fish preservation—sun drying and smoking—were not sufficiently effective to keep large quantities of fish through the damp spring and warm summer. In the case of the fall fishery, fish could not only be effectively stored by freezing, but could be set aside in sufficient quantity to last into the late winter. The food supply at this period is the critical limiting factor in determining population level.

Like the spring fishery, the fall fishery was a labor-intensive operation and undoubtedly a community enterprise. This work not only involved the setting and tending of nets, but the manufacture, care, and repair of nets and the processing of the catch; most of these tasks, as we have seen from the historic record, were traditionally performed by women. The major reason to suspect a high degree of cooperation among Late Woodland people during the fall fishery is the fact that this fall spawning period was of short duration. During the spring, the spawning season lasted at least 2 months, and the amount of available fish decreased gradually as summer temperatures warmed the water. But in the case of the fall spawning period, spawning commenced and ended within a period of several weeks; the freezing, stormy weather of the late fall meant that fishing in this season was a highly dangerous and arduous task that had to be completed quickly, before the final onset of winter.

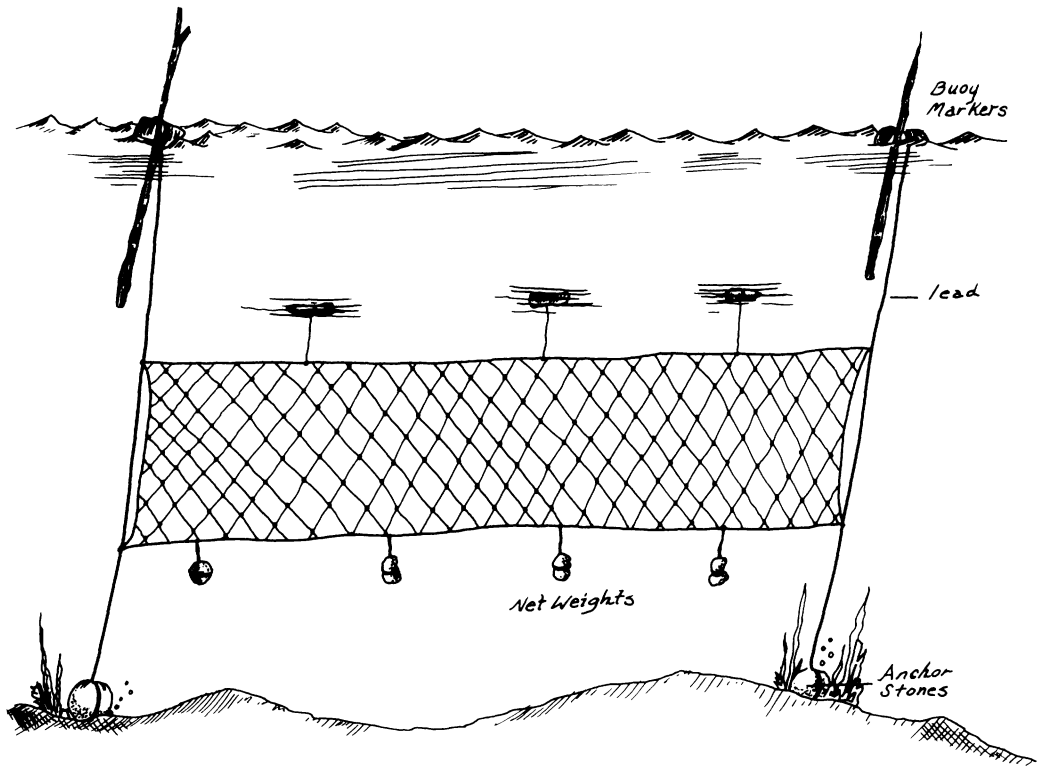

Figure 6. Illustration of gill net.

CONCLUSIONS

It is evident from even a cursory perusal of the historic and ethnographic sources for the upper Great Lakes region that fishing was a prominent aspect of the cultures of the region. Archaeological data provide us with evidence that the fishery evolved in situ over a long period of the prehistoric past. Consideration of data from both written and archaeological sources leads to the conclusion that the northern Great Lakes fishery was a vitally important subsistence regime in the region and unique as a cultural adaptation in native North America. This fact has not been widely recognized by students of Great Lakes Indians, probably because of the great popular and scholary attention both historians and anthropologists have given to the dramatics of the fur trade. Thus, the significance of the fishery has been overshadowed. In fact, the day-in, day-out lifeways of numerous bands of Ojibwa, Ottawa, Menominee, and some of the Huron cannot be adequately understood apart from reference to fish resources and the cultural parameters determined by the exploitation of fish in this particular ecological system.

Apart from tracing the origins of the fishery and explicating its increasing importance over time, the detailed examination of the evolution of the fishery in its cultural and ecological context also provides a means of studying the adaptive process itself. Schalk (1977), in a study of the factors influencing the differential availability of anadromous fish on the coast of western America, was able to document the effect of such availability on the cultural systems of native peoples from Alaska to California. Schalk's study examines ecological variability in space for a limited segment of time. The present study uses a similar approach but is concerned with the development of a cultural adaptation in a specific area, starting with the assumption that there is very little ecological change over time or at least little change that would have any significant effect on the major subsistence resources of the area—particularly aquatic resources.

The addition of the temporal variable also distinguishes this work from those offered by Jochim (1976) and Yellen (1977) in their studies of hunter-gatherer subsistence and settlement systems. The temporal perspective provided here is important because we can view this record as a sequence of experiments in adapting to a specific set of environmental conditions, insofar as the sequence of technological and social change can be established from the archaeological record. Technological innovation, changes in the application of existing technology, change in composition of work groups, settlement size and placement, and many other variables that can be observed by archaeologists can be seen as variables that prehistoric peoples manipulated either singly or in combination. Whether such strategies are satisficing, optimizing, or maximizing matters little at this "microlevel," since the addition, disappearance, or degree of emphasis of particular elements in the system over time indicates a positive selection for these tools or behaviors over others.

A temporal perspective is also important in that an understanding of adaptive process can provide a different understanding of the adaptive strategy in force at any given point in time. Rather than casting about in the ethnographic literature for a model that seems to fit the facts at hand, i.e., "foraging from a central-based camp," it is possible to view the elements of the system as options, each of which effects the other choices available within the system, given a specific set of ecological parameters. It is probably true that the imaginative efforts of most hunter-gatherers and fishermen who spent time thinking about options, such as how, when, and where they should employ their efforts to gain food, far surpassed those of modern archaeologists, who view this process as a static exercise in energetics, or who are constrained by the formal properties of idealized models.

Some years ago, I offered the notion that the evolution of adaptive strategies would, under most conditions, tend to evolve from generalized to specialized or from diffuse adaptation systems to focal adaptations (Cleland 1976). This study provides one test of this thesis, and the current evidence not only supports this hypothesis but permits us to examine the selection process that led to the establishment of the focal configuration in the northern Great Lakes. An examination of the variables should lead to an understanding of why the adaptive sequence unfolded as it seems to have and proceeded at the rates indicated by the archaeological record.

In the context of specific elements of the developmental sequence for the northern Great Lakes fishery, the following variables seem critical.

Knowledge of Environment

The sequence from Late Archaic to Late Woodland shows an apparent increasingly sophisticated understanding of aquatic resource availability. Essentially, it is suggested that these people, moving from hunters to generalized fishermen to specialized fishermen, gradually discovered the scheduling of population aggregation as it related to the bimodal breeding cycles of Great Lakes fish. It is suggested that they discovered the concentration of spring-spawning fish in streams, stream mouths, and coastal shallows before they discovered the late fall, offshore concentration of fish on shoals. A factor that may have contributed to this sequence is that spring spawners would have been visible from on or near shore, while the offshore spawning would have to be observed in deep water and during a season when the weather was generally inclement and the lakes frequently stormy.

Fishing Technology

It is suggested here that the first efforts in fishing developed from an adaptation of techniques used to take larger mammals. Spears were thus the primary implement employed in fishing. Nets, in the form of seines, were introduced and employed first in onshore fishing; later, gill nets were used from boats for offshore fishing. This change follows or coincides with the discovery and use of offshore species in the Late Woodland period. It also implies a redesign of nets toward their specialized use in deep water to take larger species. It should be emphasized that the develop-

ment of the technology employed in the protohistoric fishery represented a combination of all types of fishing gear developed earlier. But it is apparent that over time, various types of gear were employed more effectively; that is, they were used in situations or under conditions for which they had become specialized. Thus, spears or harpoons were initially used to take sturgeon, and they continued to be used in this way in later times because these large fish would tear nets apart. While spears were probably used during the Archaic and Middle Woodland periods to fish through the ice and continued to be used for this purpose for some predator species, the gill net, developed for other purposes, proved more successful for this kind of fishing. Net fishing under the ice did not develop directly from the seine because this device had to be moved through the water and therefore could not be employed through the ice. But seines continued to be used after the advent of gill nets for the spring onshore fishery because they were better suited to the taking of shallow water fish. Although gill nets may also have been used for this purpose, they would have been less effective. It is thus hypothesized that all prior means of taking fish remained options in the technological complex, but the means and timing of their employment changed to accommodate new technology as it was added to the repertoire or as the fishermen gained new knowledge of resources.

The complex interrelationship between knowledge of environment and development or introduction of new fishing technology had implications for the social and political means by which this technology was employed.

Labor Requirements of Extracting and Processing Resources

The first social consideration relates to where and how the technology was applied. The Late Archaic spearing and angling complex was largely a spring activity, probably undertaken by small groups similar in size and composition to those that would normally reside together in the spring for hunting. Conceivably, the abundance of fish at that season could have permitted larger groups to congregate. Groups of increased size would have been the temporary result of seasonal attendance, not an increase in overall population or a response to a need for increased labor, since Late Archaic fishing was an individual endeavor. This situation changed during the Middle Woodland period. Not only would the introduction of the seine have produced more fish, but it was probably the most labor-intensive fishing method used by upper Great Lakes fishermen in any period. While the size of Middle Woodland seines is not known, seines are most effective if they are 4 to 5 feet deep (as deep as a person can wade) and of considerable length, probably several hundred feet. Because the seine is in effect a fence, the finer the mesh, the more fish will be taken. Therefore, the preparation of fiber and weaving of the net represents a considerable expenditure of energy. Further, a large group is needed to move the net through the water; this activity is unspecialized and would probably be performed by people of all sexes and ages. On this basis, we would expect spring fishing sites occupied by Middle Woodland peoples to be in the same locations as Late Archaic sites, but we could predict that they would be larger because of the added labor requirement.

The cooperative nature of a seine fishery might seem to suggest the presence of some political mechanism for the distribution of food obtained through cooperative effort. But because the spring fishing season extends over a period of several months and since preservation of the catch was not a vital aspect of this fishery and because of the increasing abundance of alternative foods, the cooperative effort and distributional aspects of this fishery probably did not create special problems. That is, this manner of fishing probably did not require political coordination for labor mobilization and redistribution of food beyond that normally expected in band or tribal context.

Functionally, the labor requirements of the Late Woodland gill net fishery are very different from the earlier fishery. While Late Woodland spring and even fall fishing sites may be associated with Archaic or Middle Woodland sites used in the exploration of onshore fish, it is the more distant offshore spawning locations that were of primary concern to Late Woodland folk. Consequently, the placements of Late Woodland fall fishing sites are on the coasts and islands ad-

jacent to spawning shoals. The gill net fishery, it should be emphasized, is arduous and dangerous because it takes place in freezing weather, in the season when the lakes are very stormy. The fishery's most productive period is short—from 2 weeks to a month—and bad weather often prohibits setting and tending nets from small craft. Further, the loss of nets due to rough weather was probably substantial.

Perhaps surprisingly, the labor required for making, setting, and tending gill nets is not as great as for that of seines. Fishing with these wide mesh nets is best done by two or three people (presumably men) from a canoe. Despite this fact, Late Woodland sites show evidence of occupation by much larger groups than Middle Woodland sites. This is thought to be the result not only of a larger total population but also of a new labor requirement. Both these factors are the direct result of yet another innovation, which is hypothesized to have appeared in conjunction with gill nets: the preservation of large quantities of fish by freezing or freezing and drying. This possibility not only would have provided the impetus for the specialization of the fishery, but represents an essential change from a low-risk/high-risk return fishery to a high-risk/high-return enterprise.

Although the Middle Woodland seine fishery was undoubtedly productive, we must question the long-term effect of this abundance. Smoking and drying are the traditional means of preserving fish in the region, and these methods, though effective for a short period, leave the catch subject to spoilage, particularly in the warm and humid summer months. Late Archaic and Middle Woodland people using this method could not preserve large amounts of food for any length of time. As a direct consequence, temporary abundances of food were never translated into increased nutritional security or population increments. While the spring fishery may have come at a good time to relieve late winter food deficits, it could not forstall them. Further, the spring fishery was soon followed by a period in which many other food resources were coming into abundance. Any incentive for developing superior preservation techniques would have been relieved. If necessity is the mother of invention, lack of necessity must be the mother of continuity! In the case of the fall fishery, however, smoking of fish was an effective storage method because the smoking was done when temperatures in the region are consistently near or below freezing and remain so until mid-March. Freezing thus greatly retarded spoilage and permitted storage of fish through the winter. The importance of this in the context of regional ecology is that stored fish could be used when other foods were most scarce. The possibility for an increased human carrying capacity was enhanced and the presumed increase in total population would in part account for the larger Late Woodland sites.

Another and perhaps more important consideration than increased size of fall sites is the need for a large labor force to preserve the catch. Obviously, the short fishing season and the huge volume of the catch prescribes a large labor force to clean fish, gather firewood, build smoking racks, sustain fires, turn the smoking fish, and pack the preserved fish. Thus, the increased labor requirements of the gill net fishery are not in the extraction of fish but in the processing. Since most of these jobs are traditionally performed by women, considerable functional advantage would accrue with the development of a kin system or marital residence system that promoted this cooperation. Figure 7 is a diagrammatic comparison of the hypothesized pattern of population aggregation and dispersion for the Middle and Late Woodland periods. It is suggested that the pattern for the Late Archaic is very similar to that of the Middle Woodland. Significant change results from the labor requirements of the fall fishery.

Social Requirements of Residence and Kinship

Unlike adaptations oriented to food production in which a great deal of cooperative toil was necessary in both production and processing, the short, abundant fishery harvest did not require a stable work force or a more formal redistributive system. Thus, it is probable that subtle shifts in several aspects of the kinship system developed along with the need for larger but very temporary groups of cooperating women. Hickerson (1970) suggests that protohistoric Ojibwa of this region were arranged in virilocal bands with localized clan identity. Within a particular band territory, one could expect to find lineages of the band that exploited the food resources of the ter-

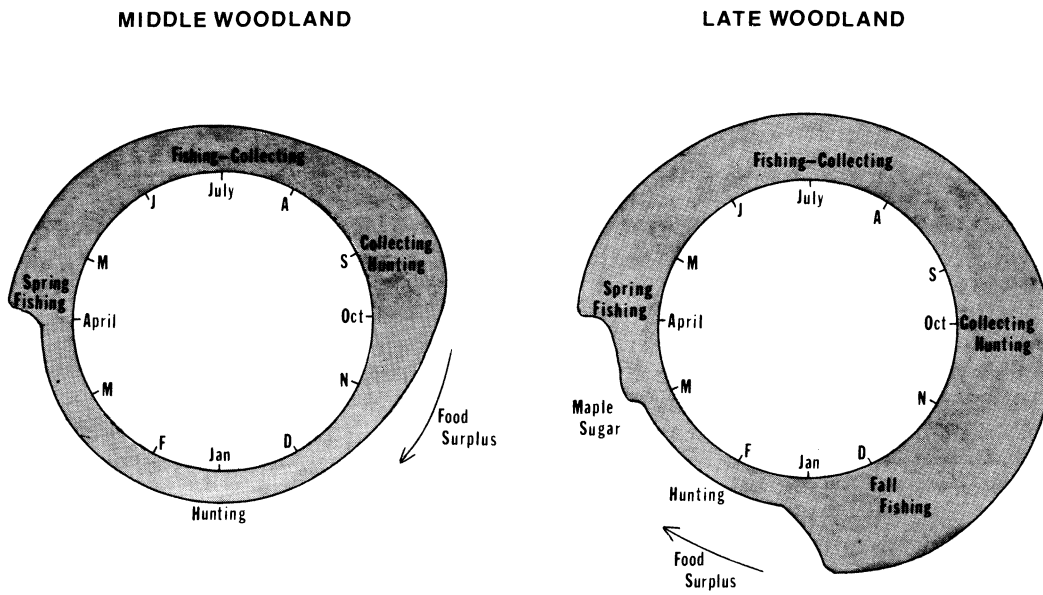

Figure 7. Diagrammatic comparison of the hypothesized pattern of population aggregation and dispersion for the Middle and Late Woodland periods of the northern Great Lakes.

ritory and presumably exchanged women in marriage. Drawing these women together would require greater attention to the affinal linkages than would normally be expected in situations where male food procurement is dominant.

Dunning (1959:89–90), in studying the northern Ojibwa, was struck by the natural close association of sisters, relationships that were equal in strength to those of brothers. These bonds were maintained throughout life as residential contiguity permitted. An increased female-based cooperative work group could thus be attained simply as a matter of propinquity. As populations expanded and lineages were more closely spaced within band territories, the affinal linkages between these groups could also be strengthened by a tendency for spheres of marriage to widen beyond cross-cousins, thus extending the potentially cooperative group of kinsmen. Dunning (1959) noted this same process for modern northern Ojibwa. As they began to participate more intensely in the general Canadian economy population, both population and the number of co-residential groups increased. One ramification of these shifts in kin and residence organization of the northern Ojibwa was a stronger delineation of ones own group from those of others.

Thus, it is hypothesized that the development of the gill net fishery, with its increased labor requirement and the possibility of increased population, resulted in a gradual shift in social organization toward greater group definition and identity and increased intergroup cooperation through the strengthening of affinal relationships.

Interestingly, such a hypothesis seems to tie together some loose ends regarding proto and late prehistoric kinship in the region. First, it supports a tendency toward band endogamy and apparent band stability, which Hickerson (1970) associates with the residential clans of the early historic era. Late prehistoric data indicate increasing homogeneity in ceramic decorative style, which would be expected as a result of both more sustained cooperative contact among females and more effective band boundaries. McPherron (1967b) thought that this coalescence in style tradition resulted from Iroquoian influence on local Algonquian groups. It seems more probable that the phenomenon relates to the impact of internal changes, including an annual convention of sisters who not only cooperated in the processing of fish but exchanged ideas about ceramic production as well.

SUMMARY

The northern Great Lakes fishery was unique in North America and a vitally important subsistence enterprise in the region. The study of the origin and development of the fishery provides at least the following conclusions:

1. Dependency on a reliable food resource neither necessarily decreases mobility nor increases labor required for resource extraction.

2. Increased efficiency of technology over time does not necessarily imply the simple replacement of less efficient implements by more efficient ones. For the case in point, the accommodation of new implements into a preexisting technological complex produces a technology that becomes more efficient as it becomes more diversified. It is probable that replacement is a function of the total energy expenditure, rather than the comparative efficiency of particular implements.

3. Beyond the premise that the goal for the development of all subsistence systems is the production of an energy balance, the direction of the evolution of subsistence systems is toward more secure systems. In the northern and middle latitudes, security is accomplished by the preservation and storage of surplus production. As an illustration, it is likely that the Middle and Late Woodland fisheries of the northern Great Lakes produced an equal amount of energy on an annual per capita basis. The phasing or transfer of this energy in the annual cycle provides the critical variable in understanding the rate and direction of evolutionary change.

REFERENCES CITED

Atwater, W. O.
1895 Methods and results of investigations of the chemistry and economy of food. *U.S. Department of Agriculture, Office of Experiment Station Bulletin* 21. Washington, D.C.

Blair, Emma Helen
1911 *The Indian tribes of the Upper Mississippi Valley and region of the Great Lakes.* 2 vols. Arthur H. Clark, Cleveland.

Brose, Davis S.
1970a The archaeology of Summer Island: changing settlement systems in northern Lake Michigan. *Anthropological Papers, Museum of Anthropology, University of Michigan* 41. Ann Arbor.
1970b The Summer Island site: a study of prehistoric cultural ecology and social organization in the northern Lake Michigan area. *Case Western Reserve University Studies in Anthropology* 1. Cleveland.

Carter, Clarence E. (editor)
1943 *The territorial papers of the United States* (Vol. XI). U.S. Government Printing Office, Washington, D.C.

Cleland, Charles E.
1966 The prehistoric animal ecology and ethnozoology of the upper Great Lakes region. *Anthropological Papers, Museum of Anthropology, University of Michigan* 29. Ann Arbor.
1973 Prehistoric settlement of northwestern lower Michigan. In *Geology and the environment, Annual Field Conference, 1973:* 88–89. Michigan Basin Geological Society, Lansing.
1974 Northern Michigan canoe Indians: a model for prehistoric settlement in the Traverse Corridor of Michigan. Ms. on file, The Museum, Michigan State University, East Lansing.
1976 The focal-diffuse model: an evolutionary perspective of the prehistoric cultural adaptations of the eastern United States. *Midcontinental Journal of Archaeology* 1(1):59–76.

Conway, Thor A.
1980 Heartland of the Ojibway. *Collected Archaeological Papers, Archaeological Research Report* 13, edited by David Skene Melvin, pp. 1–28. Historical Planning and Research Branch, Ontario Ministry of Culture and Recreation, Toronto.

Densmore, Frances
1928 Use of plants by the Chippewa Indians. *U.S. Bureau of American Ethnology, Forty-fourth Annual Report,* pp. 275–397. Washington, D.C.

Donaldson, William S.
1962 The Short site: a preliminary report. *Ontario Archaeological Society, Publication* 6:15–21.

Dunning, R. W.
1959 *Social and economic change among the northern Ojibwa.* University of Toronto Press, Canada.

Fitting, James E.
1976 Patterns of acculturation at the Straits of Mackinac. In *Cultural change and continuity: essays in honor of James B. Griffin,* edited by Charles E. Cleland, pp. 321–334. Academic Press, New York.

Fitting, James E., and Wesley S. Clarke
1974 The Beyer site (SIS-20). In Contributions to the archaeology of the St. Ignace Area, edited by James E. Fitting. The *Michigan Archaeologist* 20:227–277.
Geen, G. H., T. G. Northcote, G. F. Hartman, and C. C. Lindsey
1966 Life histories of two species of catostomid fishes in Sixteen-mile Lake, British Columbia, with particular reference to inlet stream spawning. *Journal of the Fisheries Research Board of Canada* 23(11):1761–1788.
Henry, Alexander
1809 *Travels and adventures in Canada and the Indian territories between the years 1760 and 1776.* I. Riley Publisher and Printer, New York.
Hickerson, Harold
1970 *The Chippewa and their neighbors: a study in ethnohistory.* Holt, Rinehart & Winston, New York.
Holman, Margaret B.
1978 *The settlement system of the Mackinac phase.* Ph.D. dissertation, Michigan State University. University Microfilms, Ann Arbor.
Hruska, Robert
1967 The Riverside site: a Late Archaic manifestation in Michigan. *The Wisconsin Archaeologist* 48: 145–230.
Hubbs, Carl L., and Karl F. Lagler
1964 *Fishes of the Great Lakes region.* University of Michigan Press, Ann Arbor.
Janzen, Donald E.
1968 The Naomikong Point site and the dimensions of Laurel in the Lake Superior region. *Anthropological Papers, Museum of Anthropology, University of Michigan* 36. Ann Arbor.
Jenks, Albert Ernest
1900 The wild rice gatherers of the upper lakes: a study in American primitive economics. *U.S. Bureau of American Ethnology, Nineteenth Annual Report,* Part 2:1013–1137. Washington, D.C.
Jochim, Michael A.
1976 *Hunter-gatherer subsistence and settlement: a predictive model.* Academic Press, New York.
Johnston, Richard B., and Kenneth A. Cassavoy
1978 The fishweirs at Atherley Narrows, Ontario. *American Antiquity* 43:697–709.
Jury, Wilfrid, and Elsie Jury
1952 The Burley site. *University of Western Ontario, Museum of Archaeology and Pioneer Life, Bulletin* 9:57–75. London.
Kinietz, W. Vernon
1965 *The Indians of the western Great Lakes, 1615–1760.* University of Michigan Press, Ann Arbor.
Kraft, Herbert C.
1975 *The archaeology of the Tocks Island area.* Seton Hall University Museum, Archaeological Research Center. South Orange, N.J.
Kroeber, A. L.
1939 Cultural and natural areas of native North America. *University of California Publications in American Archaeology and Ethnology* 38. Berkeley.
Lawler, G. H.
1965 Fluctuations in the success of year-classes of whitefish populations with special reference to Lake Erie. *Journal of the Fisheries Research Board of Canada* 22(5):1197–1227.
Lee, Thomas E.
1952 A preliminary report on an archaeological survey of southwestern Ontario for 1950. *National Museum of Canada, Bulletin* 126:64–75. Ottawa.
Lovis, William A.
1973 *Late Woodland cultural dynamics in the northern Lower Peninsula of Michigan.* Ph.D. dissertation, Michigan State University. University Microfilms, Ann Arbor.
Lukens, Paul W., Jr.
1973 The vertebrate fauna from Pike Bay Mound, Smith Mound 4, and McKinstry Mound. In The Laurel Culture in Minnesota, edited by James B. Stoltman. *Minnesota Prehistoric Archaeological Series* 8:37–45. Minnesota Historical Society, St. Paul.
Martin, Terrance J.
1980 Animal remains from the Winter site, a Middle Woodland occupation in Delta County, Michigan. *The Wisconsin Archeologist* 61:91–99.
1981 *Animal remains from the Scott Point site: a stratified Late Woodland occupation in Mackinac County, Michigan.* Paper presented at the 57th Annual Meeting of the Central States Archaeological Society, Cincinnati.
Mason, O. T.
1896 Influence of environment upon human industries or arts. *Smithsonian Institution, Annual Report* for 1895:639–665. Washington, D.C.

Mason, Ronald J.
1965 Wisconsin Middle Woodland toggle head harpoons. In Papers in honor of Emerson F. Greenman, edited by James E. Fitting. *The Michigan Archaeologist* 11:156–164.
1966 Two stratified sites on the Door Peninsula of Wisconsin. *Anthropological Papers, Museum of Anthropology, University of Michigan* 26. Ann Arbor.
1967 The North Bay component at the Porte des Morts site, Door County, Wisconsin. *The Wisconsin Archeologist* 48:267–345.
McPherron, Alan L.
1967a The Juntunen site and the Late Woodland prehistory of the upper Great Lakes area. *Anthropological Papers, Museum of Anthropology, University of Michigan* 30. Ann Arbor.
1967b On the sociology of ceramics: pottery style clustering, marital residence, and cultural adaptations on an Algonkian-Iroquoian border. In *Iroquois culture, history, and prehistory: proceedings of the 1965 Conference on Iroquois Research*, edited by Elizabeth Tooker, pp. 101–107. Albany.
Moore, Winston D.
1973 In search of Baraga County's ancient past. *Baraga County Historical Book 1972–73*. Baraga County Historical Society, Baraga, Michigan.
Pitezel, John H.
1857 *Lights and shades of missionary life*. Western Book Concern, Cincinnati.
Rau, Charles
1884 Prehistoric fishing in Europe and North America. *Smithsonian Contributions to Knowledge* 25. Washington, D.C.
Rick, Anne M.
1978 *Interim report on faunal remains from Whitefish Island (CdIc-2), Ontario*. Unpublished report from the Zooarchaeological Identification Centre, National Museum of Natural Sciences. Ottawa.
Ritchie, William A.
1965 *The archaeology of New York State*. The Natural History Press, Garden City, N.Y.
Ritchie, William A., and Robert E. Funk
1973 Aboriginal settlement patterns in the Northeast. *New York State Museum and Science Service, Memoir* 20. Albany.
Rostlund, Erhard
1952 Freshwater fish and fishing in native North America. *University of California Publications in Geography*. University of California Press, Berkeley.
Schalk, Randall F.
1977 The structure of an anadromous fish resource. In *For theory building in archaeology*, edited by Lewis R. Binford, pp. 207–249. Academic Press, New York.
Smith, Hugh M., and M. M. Snell
1891 Review of the fisheries of the Great Lakes in 1885. In *Report of the Commission for 1887, United States Commission of Fish and Fisheries, Part XV. U.S. House of Representatives Miscellaneous Document* 133, pp. 1–33. Washington, D.C.
Steinbring, Jack
1967 A copper "gaff hook" from Ontario. *The Wisconsin Archeologist* 48:345–358.
Stoltman, James B.
1973 The Laurel culture in Minnesota. *Minnesota Prehistoric Archaeology Series* 8. Minnesota Historical Society, St. Paul.
Thwaites, Reuben G. (editor)
1905 *New voyages to North-America*, by Baron de Lahontan. 2 vols. Reprint from 1703 English edition. A. D. McClurg, Chicago.
Webb, William S.
1939 An archaeological survey of Wheeler Basin on the Tennessee River in northern Alabama. *Smithsonian Institution, Bureau of American Ethnology, Bulletin* 122. Washington, D.C.
1950 The Carlson Annis Mound. *The University of Kentucky Reports in Anthropology* 7(4). Lexington.
Wells, Edward W.
1972 An artifactual report on the Foscoro site. *The Wisconsin Archeologist* 53:85–109.
Winters, Howard D.
1969 The Riverton culture: a second millennium occupation in the central Wabash Valley. *Illinois State Museum, Report of Investigations* 13. Springfield.
Wissler, Clark
1926 *The relation of nature to man in aboriginal America*. Oxford University Press, New York.
Wright, Gary A.
1967 Some aspects of early and mid-seventeenth century exchange networks in the western Great Lakes. *The Michigan Archaeologist* 13:181–197.
Wright, James V.
1967 The Laurel tradition and the Middle Woodland period. *National Museum of Canada, Bulletin* 217. Ottawa.

Wright, James V., and J. E. Anderson
1963 The Donaldson site. *National Museum of Canada, Bulletin* 184. Ottawa.
Yarnell, Richard A.
1964 Aboriginal relationships between culture and plant life in the upper Great Lakes region. *Anthropological Papers, Museum of Anthropology, University of Michigan* 23. Ann Arbor.
Yellen, John E.
1977 *Archaeological approaches to the present: models for reconstructing the past.* Academic Press, New York.