

# THE LAKE TROUT

## Its Life History, Ecology and Management

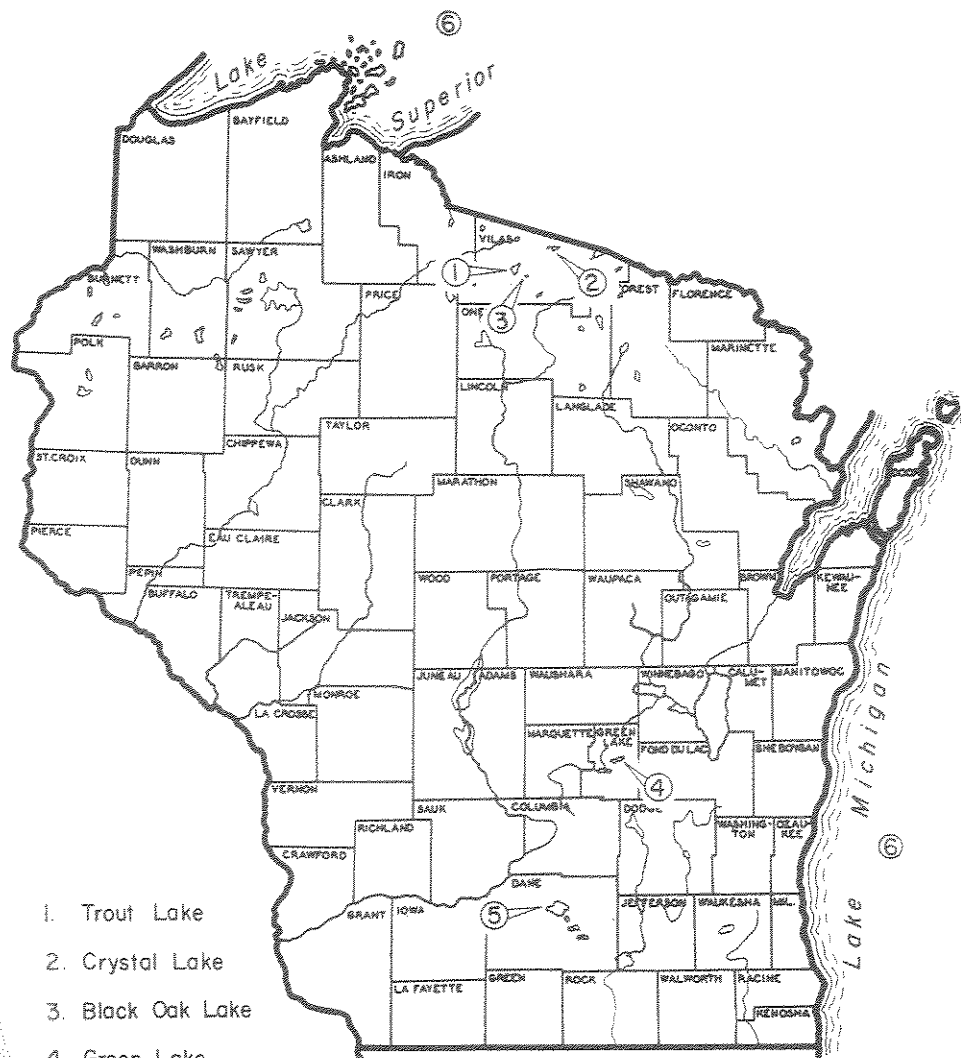


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1. Trout Lake
2. Crystal Lake
3. Black Oak Lake
4. Green Lake
5. Fossil Remains - Lake Mendota
6. Great Lakes

Range of the lake trout in Wisconsin waters.

## THE LAKE TROUT

### Its Life History, Ecology and Management

by

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#### CLASSIFICATION

The name lake trout (*Salvelinus namaycush*) is descriptive of its preferred environment, since other trout are more commonly stream dwellers. The lake trout is also known by such common names as mackinaw trout, togue, grey trout, Great Lakes trout, namaycush and touladi.

Two subspecies appear to exist. The common lake trout (*Salvelinus namaycush namaycush* (Walbaum)) is found at moderate depths in the Great Lakes and in the inland lakes, while the siscowet (*Salvelinus namaycush siscowet* (Agassiz)) frequents the deeper waters of Lake Superior and Lake Michigan.

Lake trout are members of the trout family Salmonidae, and among its relatives are the brook trout, brown trout and rainbow trout. Within recent years, lake trout have been placed in the same genus as brook trout (*Salvelinus fontinalis*) as a result of successful hybridization between the two species. The progeny are called "splake" and result from mixing the eggs of female lake trout and the sperm of male brook trout.

In big waters such as Lake Superior there are a number of different lake trout sub-populations each of which may have slightly different habits. One race on the Canadian side spawns in streams while another sub-population occurs near Isle Royale, and still another in the Apostle Islands area.

#### DISTRIBUTION

Lake trout are cold-water, neo-arctic residents whose range extends from Alaska to Labrador in the north and from Maine to middle Wisconsin in the south. It also occurs naturally in the headwaters of the Columbia and Fraser Rivers and on Vancouver Island. It has been widely and successfully introduced in other lakes and drainages where suitable conditions exist.

In Wisconsin, lake trout are confined to deep, cold lakes. They occur naturally in Trout Lake and Black Oak Lake, Vilas County and in Lakes Michigan and Superior. Introductions have been made in other inland lakes, but these do not support naturally reproducing populations. They have been especially successful in Green Lake. Pre-glacial distribution was widespread with a fossil specimen being recovered in Dane County (Southern Wisconsin).

Once a common fish in Lake Michigan, lake trout have become scarce to non-existent since 1954, because of depredation of the sea lamprey. Their numbers also show a decline in Lake Superior since 1950.

#### DESCRIPTION

Lake trout have typical trout characteristics, with no spines in their fins, a prominent adipose fin and small, embedded, cycloid-type scales numbering

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Profile of the lake trout. It is best distinguished by its forked tail.

more than 185 along the lateral line. This species can be distinguished from other trout by the absence of colored spots on its side and by the prominently forked tail. Brook and rainbow trout have weakly forked tails and brown trout a square tail.

The body form of lake trout is extremely variable but generally more elongate than other species. Young specimens are much more slender and torpedo-shaped than the other three Wisconsin species of trout. As the fish grows older it tends to become heavier, particularly in the belly. Generally on a medium-size fish, the length from the tip of the snout to the base of the tail fin is 4.0 to 4.5 times the depth of the body. The conspicuous dorsal fin has 11 rays. Sexually mature male lake trout do not normally develop the hooked jaw common in other trout species, and male and female trout cannot be readily distinguished externally, except in the water at spawning time when males display a prominent black stripe along the sides. The upper jaw of both sexes extends backward far beyond an imaginary line drawn vertically downward from the eye.

Ground color of the lake trout varies from pale silver gray to dark olive depending upon the water in which they live. Dark-stained waters produce a dark, olive-colored fish. It is darkest dorsally and becomes white to gray on the underside. Dark vermiculate markings which shade out ventrally produce a mottled

effect and in this respect it is like the brook trout. The leading edges of the pectoral fins are whitish, though not so white as those of the brook trout. During the fall spawning season, males tend to have yellow or orange-colored paired fins.

Lake trout have strong, well-developed teeth on their jaws, tongue, and roof of the mouth. The elongate body and forked tail are conducive to speedy swimming.

#### HABITS AND HABITAT

Lake trout are inhabitants of cold water. When the water is cool, generally in fall, winter and spring, they will enter the shallow inshore waters, but when surface waters warm they retreat to the cooler depths. Preferred temperature is about 50° F., and they seldom remain for extended periods of time in water warmer than 65° F. The siscowet probably never gets into water exceeding 40° F. Most of the commercial catches of lake trout are made at depths between 100 and 300 feet.

Baby lake trout are usually found at depths less than 270 feet in Lake Superior. At depths greater than 240 feet the siscowet is usually encountered, and has been taken commercially at depths down to 750 feet; they are normally found at or near the bottom.

Lake trout are not known to school, with both adults and young appearing to

be solitary in habit. When taken in commercial gill nets, they are taken singly, never in a group in one area of the net.

Lake trout observe a migration to and from spawning grounds to a certain extent, and also to and from the shore area in response to water temperatures. Most 16- to 18-inch tagged fish have been caught within 50 miles of their point of release, but there are records of larger fish that have been recovered 300 miles from the tagging site. One tagged fish traveled 190 miles in 19 days. On the other extreme, the lake trout population in South Bay, Lake Huron remains entirely within the Bay.

First foods of newly hatched lake trout consist of zooplankton, as is the case for the young of most species of fish. They begin eating an occasional tiny fish at an age of four months and at lengths of one and one-half inches, but the major food of lake trout less than 14 inches is the invertebrate, opossum shrimp (*Mysis relicta*), in the Great Lakes and Big Green Lake, Wisconsin. In some smaller inland lakes, they often feed extensively upon the larvae of midges and *Chaoborus*. As the young fish continue to grow, fish remains are found in increasingly larger percentages in the stomach samples.

The foods of adults are almost entirely fishes, but the species preyed upon varies from lake to lake. In Green Lake, Wisconsin, northern Lake Michigan, Lake Ontario, and Lake Nipigon, Canada, deep-water and shallow-water ciscoes are the staples. Where introduction and expansion of smelt populations have occurred, these also become an important food according to more recent studies. In some of the Finger Lakes of New York and Lake Ontario, the alewife has become the preferred food of the lake trout. In Lake Opeongo, Ontario, perch and whitefish are the principal foods and in southern Lake Michigan a principal food is the deep-water sculpin. Preferred foods largely consist of species which are common in the cold depths inhabited by lake trout.

At certain times, lake trout become opportunistic and take advantage of

other abundant foods. When large hatches of flies occur in late spring, the trout feed exclusively on the rafts of these insects on the water surface. On inland lakes they have been known to eat migrating shrews as they swam across a lake. Yellow warblers, confused in flight by fog, have been found in the stomachs of surface-feeding lake trout.

#### REPRODUCTION

Most lake trout populations spawn on rocky bars which are kept free from silt by water currents. The Milwaukee and Sheboygan reefs in Lake Michigan and the Apostle Island reefs in Lake Superior were well-known spawning grounds. Spawning occurs in fall, from the middle of October to early December. The depth of the spawning grounds may be a few inches down to 100 feet or deeper.

The lake trout does not build a redd like other species of Wisconsin trout. Instead, the eggs are usually cast indiscriminately among the rocks. Males precede the females to the spawning site and clean the rocks of silt by fanning and rubbing. There is no defense made of spawning territory against the intrusion of other fish as is found in other members of the salmon family. Typically, one or more males approach and nudge the female and press against her side with their vents in close proximity. The spawning act, occurring at night, lasts only a few seconds and is repeated until spawning is completed. The eggs sink into rock crevices and are left unattended. Occasionally, spawning may also take place over smooth bottoms. In Green Lake, lake trout spawn over an unprotected mud bottom; this often results in egg predation by amphibians and other fishes.

Most of the egg development in the female takes place in the five months preceding the spawning season. Mature eggs in the ovaries are large compared with other fresh-water fish. They measure one-sixth to one-fourth inch in diameter. The number of eggs laid by a

lake trout may range from 1,000 for small fish (15 inches) to as many as 18,000 for a large lake trout of 40 inches. Egg production is a function of size and on the average about 700 eggs are produced per pound. The average for Green Lake fish was 5,417 eggs per female.

The eggs, laid and incubated in cold water, take four months or longer to hatch. Under natural conditions, they usually hatch from mid-February to the end of March. A long incubation period in cold water appears to be essential for successful hatching. Newly hatched fry have a large mouth and large yolk sac and measure 0.6 inch. They spend another month among the rocks developing, meanwhile absorbing their yolk sacs. After the yolk sac is absorbed they move into deeper water.

*Saprolegnia* fungus was described as an important cause of egg mortality in Ontario.

When reared artificially, eggs are taken from wild fish captured with gill nets on the spawning grounds, or from adults reared in the hatchery. The eggs are forced into a pen by gentle pressure on the sides and abdomen of a ripe female. Then milt from a male is added and eggs and milt are mixed to assure fertilization. After washing and hardening, the eggs are held in screen trays with water running through them until they hatch. The fry are usually fed finely ground liver and the fingerlings, pellets. Fingerlings stocked in the spring at a

length of 6 to 8 inches have shown the best rate of survival.

## GROWTH AND LONGEVITY

Rate of growth varies greatly from one body of water to another. In Green Lake, Green Lake County, it takes a 6-inch fingerling three years after stocking to reach 16 inches. In Lake Michigan, a trout is almost six years old at this length and in Great Bear Lake, Canada, at a length of 16 inches, they are ten years old. The average growth of tagged trout in Lake Superior and Lake Michigan was 3 inches per year between the sizes of 12 and 26 inches. At the age of one year, a baby trout from Lake Superior or Lake Michigan will be almost 4 inches long.

Green Lake fish weigh 1½ pounds when 17 inches long, about 5 pounds when 24 inches long, and 18 pounds when 36 inches long. Lake trout grow to be very large fish, the record being 88 pounds. The largest lake trout taken by angling was a 63-pound, 47.5-inch specimen from Manitoba. Twenty-pound lake trout are common in many waters, while in other more sterile lakes, they seldom grow larger than a few pounds. The record fish from Green Lake measured 44 inches and weighed 35.8 pounds.

The oldest recorded age for this species was 37 years. The maximum age for lake trout is not known but for this late-maturing fish it can be assumed to be more than that of most common species,

GROWTH RATE OF LAKE TROUT

Lake	Age									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Lake Michigan.....	4.9	8.5	11.9	15.4	18.4	21.1	23.1	24.5	28.0	
Lake Superior.....	3.9	6.7	8.6							
South Bay Mouth* (Ontario).....		10.0	12.7	16.5	18.8	29.6	22.7			
Great Bear* (Canada).....								13.0	13.9	14.7
Fish Lake (Utah)...	5.4	8.4	11.6	14.8	17.5	20.0	23.1	27.2	30.3	32.4

\*Fork lengths

Lake	I	II	III	IV	V	VI	VII	VIII	IX	X
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The lake trout is an inhabitant of deep cold waters. Common associated species are shallow-water and deep-water ciscos, emerald shiners and sculpins. (Drawing by Jens van Sivers).

except the sturgeon. Two lake trout held in a hatchery attained ages of 24 and 28 years.

Lake trout are mature in most waters when either 7 years old or about 24 inches long. The fast-growing Green Lake lake trout population produced 24-inch mature males in six years. Females were still immature at this size. Males mature before females.

## POPULATION SIZE AND MORTALITY RATES

Lake trout, living at the top of the aquatic food chain by feeding on fish, occur in relatively low numbers. Populations of catchable fish number only a few per acre. When gill nets are fished in the Great Lakes and populations are normal, the usual catch is only 100 to 300 pounds per gang of nets.

Little is known about natural mortality rates of subadults and adults but it can be assumed they suffer from little fish predation because of size. Commercial netting and angling take the biggest toll. Commercial harvest on the Great Lakes before the lamprey invasion was only about one-half pound per acre. Data from Great Slave Lake in Canada indicate this lake yields a com-

mercial harvest of less than one pound per acre annually.

When small lakes are subjected to intensive angling, the population quickly declines. At Lake Opeongo in Ontario, a safe harvest to avoid overfishing was placed at one pound per acre per year.

## ECOLOGY

Associates of lake trout are principally other cold-water fishes such as whitefish, cisco, smelt, the various species of chubs, deep-water sculpins, and burbot. Their range overlaps to some extent with the perch, walleye and northern pike.

Parasites encountered with varying frequency in lake trout are the tape worms *Proteocephalus* and *Eubothrium*, the horny-headed worm *Echinorhynchus* and the fluke *Diplostomum*. Diseases in the wild have not been noted. In hatcheries they are subject to the same diseases as other trout, such as red spot and those caused by protozoans. They become blind if kept in bright unshaded raceways or tanks.

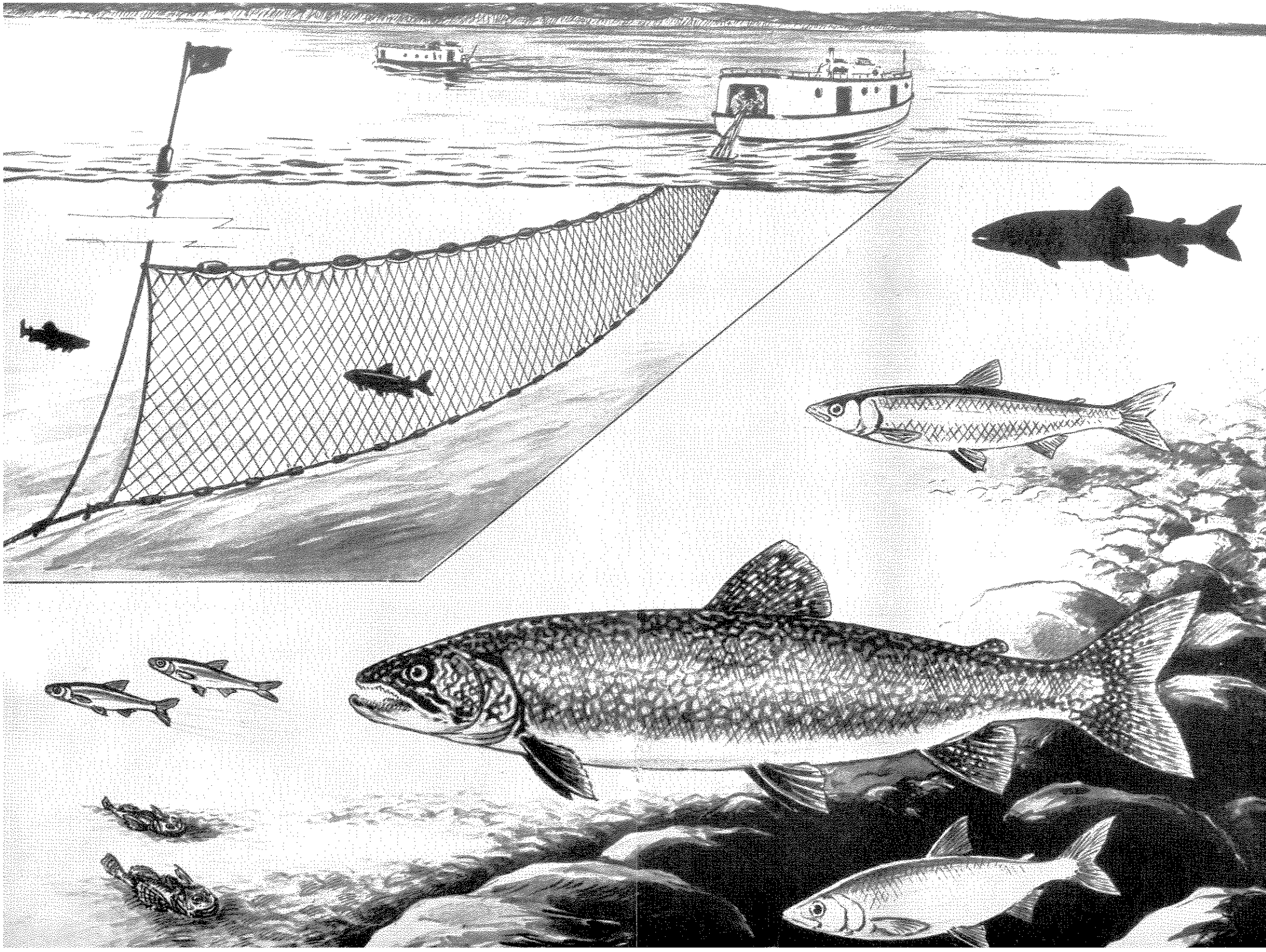
Lake trout will not tolerate low dissolved oxygen. Eggs exposed to low oxygen produce either crippled or incompletely developed fry. It has the lowest known lethal temperature of any North American fish.

Its major predator and cause for demise beside man in the Great Lakes is the sea lamprey (*Petromyzon marinus*). Lampreys attach themselves to the sides of the lightly scaled trout, rasp a hole in the flesh and feed on the body fluids. As lamprey numbers increased during the late 1930's and 1940's, lake trout declined. A single attack is enough to kill a small trout and greatly weakens large ones.

XI	XII	XIII	XIV	XV	XVI
16.2	16.2	16.6	17.7	19.2	20.3

XI	XII	XIII	XIV	XV	XVI
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## ANGLING AND COMMERCIAL FISHING

Trolling with various shaped large metal spoons is the favorite method of catching lake trout. Spoon size and color are usually a matter of local preference, but colors used have been brass, nickel, copper and pearl. An effective set of fishing tackle consists of a series of spinners in tandem called "cowbells" followed by a trailing minnow or wobbling metal spoon. Fishing takes place in shallow water during the spring and in deep water during mid-summer. Because of the heavy line employed and the great depths fished, lake trout are often unable to provide the sport and battle given by other species of similar size. Use of lighter spinning gear enhances the sport.

At Trout Lake in northern Wisconsin, the favorite fishing period is immediately after the ice pulls away from the shore. Hooks baited with live minnows are fished on the edge of the ice floes.

Bobbing is another form of lake trout fishing carried on in the winter, especially in the Apostle Island area of Lake Superior and on Big Green Lake. For this type of fishing a strong line with little stretch, an 8- to 10-pound test leader, a heavy sinker and a large hook are required. A cut bait consisting of pieces of herring, or a large minnow is bobbed up and down within a few inches of the bottom in 60 to 200 feet of water. The larger fish are generally found in the deepest water.

### LAKE TROUT HARVEST

Harvest in pounds by commercial fishing in the Wisconsin portion of Lakes Superior and Michigan, 1940-1958

Year	Lake Superior	Lake Michigan
1940.....	494,000	2,478,300
1942.....	657,800	2,692,700
1944.....	707,200	2,851,600
1946.....	553,400	1,648,800
1948.....	553,100	540,100
1950.....	590,600	16,800
1952.....	520,500	600
1954.....	435,000	100
1956.....	479,300	0
1958.....	258,052	0

Commercial fishing is done mostly with gill nets. Legal meshes for lake trout are 4.5 inches stretch measure, the same size used to catch whitefish. Gill nets are set from enclosed tug boats in "gangs" measuring several thousand feet in length. Lake trout are also taken in trapping nets called "pound" nets which are fished in waters up to about 40 feet deep. When lake trout are relatively abundant, long lines of sethooks are used individually baited with pieces of cut fish.

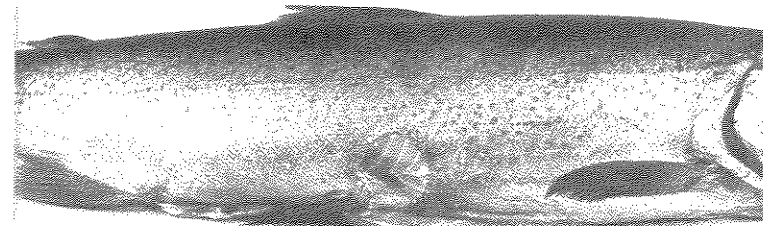
### ECONOMIC VALUE

Lake trout are a highly valued commercial food fish. Recent prices range from 50 to 70 cents per pound in-the-round. At pre-sea-lamprey harvest levels of 2.5 million pounds in Lake Michigan, this resource would now be bringing fishermen \$1,750,000 yearly. The Lake Superior lake trout catches have fallen off sharply. Normal harvest formerly has been about 550,000 pounds per year, and is now down to less than 200,000 pounds per year.

Lake trout flesh is oily and has high energy value. Analysis of the edible portion of the fish shows it is composed of 71 per cent water, 18.4 per cent protein, 9.1 per cent fat, and 1.0 per cent ash. Larger specimens tend to be fatter. A whole lake trout, as purchased, will dress out to 77 per cent of the original weight. The flesh is firm textured, rich in flavor, and tasty, and may have a white to pinkish color.

Prior to the depredations by the sea lamprey, charter boat trolling on both Lakes Michigan and Superior was very popular. During peaks of abundance of lake trout in these waters it was not uncommon for individual boats to land 50 to 100 pounds of trout in a single day of fishing. Discontinuance of this charter boat fleet has created economic losses to many of the small communities bordering the Great Lakes.

Wherever found in fishable concentrations, lake trout provide an excellent fisherman and tourist attraction, with a re-



Lamprey have caused severe lake trout losses. They rasp a hole in the flesh and feed on body fluids.



sultant increase noted in the local economy in the form of lodging, guide service and travel expense.

### MANAGEMENT

Successful management of lake trout must acknowledge many problems such as easy catchability, late maturity and large size at maturity. On the Great Lakes, lamprey predation is the most urgent problem. Sea lamprey have cut production to zero on Lake Michigan and production is rapidly declining on Lake Superior.

Management measures now consist of the operation of electrical and mechanical traps to intercept spawning lampreys. By 1958, a chemical which would specifically kill sea lamprey larvae in the streams was developed, and employed successfully on test streams. Hope is growing for successful and complete control of the lamprey. The next problem is restoration. Fortunately, lake trout can be reared in a hatchery and stocking yearlings in the spring of the year is quite successful. Trout stocked as six-inch yearlings in the Apostle Island area can within three years make significant contributions to the fishery at a size of

17 inches. In some cases half the lake trout caught may be of hatchery derivation. One state fish hatchery is devoted to lake trout production.

Lake trout populations in Wisconsin all seem to display good growth; therefore, no problems exist with populations composed of small-sized individuals. With good growth, maturity occurs at a large size. Females are mature at lengths over 24 inches long and males mature at about 24 inches. With the minimum length set at 17 inches it is possible that many lake trout are being cropped before maturity. From all outward indications, harvest under present regulations is intensive whether as a commercial fishery, or sport fishery with a bag limit of only two fish. Consequently, some biologists think the minimum size should be increased.

Development of a cross between lake trout and brook trout, the splake, has been successful, and it is hoped that this species can become a substitute for lake trout. Faster growth and earlier maturity overcome some of the difficulties associated with lake trout management.

Construction of artificial spawning reefs has been tried in Green Lake with uncertain success.

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