The Changing Great Lakes

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This is the first of a two-part article on the fishes of the Great Lakes. Part II, which will appear in the August issue of the Bulletin, will deal with further changes in the lakes, including pollution, and some of the necessary approaches towards reversing the conditions that are leading to their deterioration.

> "Eastward lies the lake as great a contrast with the city as night with day . . . This half of our horizon is as primaeval as the day white men first entered the region . . . Man has done his bit to the lake, but it is trifling. Shores have changed and Chicago River reversed. The lake remains, however, the one unalterable primitive feature of Chicagoland."
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> (Harlan Bretz, 1939, *Geology of the Chicago Region.*)

PART I

WHEN this quote was written in 1939, Lake Michigan was much closer to its original condition than it is today. Geologically speaking, Bretz was essentially correct, but ecologically many changes had already taken place, beginning a hundred years earlier and continuing at an accelerated pace to the present. The most rapid and greatest changes in water quality, flora and fauna have occurred during the past 25 years.

The Great Lakes basin occupies only 300,000 square miles, of which about a third, or 95,000 square miles, is water. More than 30 million people live in the basin, and at least 20 million of these people use the water of the Great Lakes. There are more than 300 towns and cities on the shores. Of the total amount of water used from Lake Michigan, 46% goes to industry, 46% to irrigation and 8% to domestic households. For example, *one* steel plant at the south end of Lake Michigan uses one billion gallons of water daily, as much as the entire city of Chicago.

Certainly, the oldest industry on the Great Lakes is fishing. The Indians had developed many types of fishing equipment and in some places, as at Mackinac and Sault Ste. Marie, fishing was the principal means of subsistence of the Indians. In their descriptions, the French explorers expressed amazement at the abundance of fish and the ease with which the Indians took all the fish they could use and trade.

The French—and later the English—fur traders and settlers did little to affect the lakes, and it was not until after 1812 that people began moving in greater numbers into the basin and establishing towns on the shores, mainly at river mouths, that the changes we will discuss began to take place. The large amount of high quality fish in the streams and along the lake shores provided sustenance for many settlements until they were established. But the activties of the settlers started the deterioration of environment which eventually led to the decline, depletion and even extinction of some of the most desirable kinds of fishes. Even so, despite very intensive fishing, the fisheries have held up for 150 years. But there have been many changes.

The first species to go was the Atlantic salmon, which disappeared from Lake Ontario by 1880. Salmon require clear, cool streams in which to spawn. The early settlers altered the streams by cutting timber along the banks and by building dams and mills for power, leading to warming and silting. Repeated attempts to re-establish Atlantic salmon in Lake Ontario have failed.

In Lake Michigan, the first species to be depleted almost to extinction was the lake sturgeon. This occurred during the period of 1840 to 1870 through a process of "cleaning out." Sturgeon were regarded as a pest by fishermen. There was no market for them. Then, in 1870, a market for smoked sturgeon developed, and sturgeon became the object of a very intensive fishery, taking 10,000 to 20,000 fish per year. In 1885, eight million pounds were taken. After this, they declined rapidly. Within 15 years they were so rare in the lake it was no longer profitable to fish for them.

The total amount of fish produced in the United States waters of the Great Lakes fluctuates between 75 to 100 million pounds per year. This amount has remained relatively constant over the past 80 years. The recent changes that have occurred—the invasion of the sea lamprey and alewife—have greatly affected the quantity of the more valuable species.

Until after 1835, conditions in Lake Michigan were primitive, and there was still a great abundance of fish. In 1850, the population of Chicago was 30,000; by 1870, 300,000. The next year, the first survey of the lake conditions and the fisheries was undertaken. Prior to 1850, fishing was largely by gill nets and large

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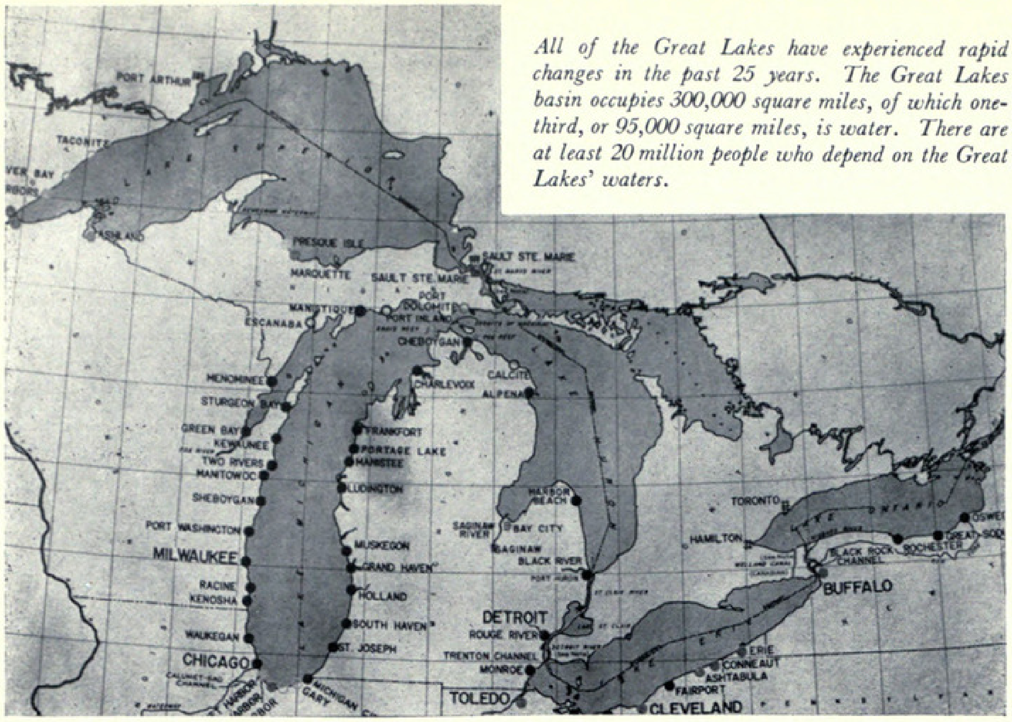


All of the Great Lakes have experienced rapid changes in the past 25 years. The Great Lakes basin occupies 300,000 square miles, of which one-third, or 95,000 square miles, is water. There are at least 20 million people who depend on the Great Lakes' waters.

seines along the shore, principally for whitefish and lake trout. In the 1850's, pound nets came into use, and between 1858 and 1872, fish production was estimated to have decreased by 50%. The decline was blamed on 1) capture of immature fish by pound nets, 2) lost gill nets which continued to fish, 3) the practice of fishermen of cleaning fish in the fishing areas and 4) pollution from sawdust, slabs, sidings, etc. floating widely over the lake, later to sink and cover the spawning grounds.

Until just before World War II, cinders were dumped by lake steamers. Presently, dredgings from the harbors are dumped in the lake. There has also been dumping of garbage and cinders by the barge load by many of the large cities. The only rule restricting this latter practice was that it had to be dumped a number of miles offshore.

But, to return to the 19th Century. Carp were introduced into Illinois in the 1870's and soon spread into Lake Michigan. Their effect was not great, as they lived mostly in shallows and in river mouths. Carp actually became the object of a rather valuable fishery, particularly in Green Bay, where two to five million pounds were taken each year.

During the World's Columbian Exposition in 1893, goldfish and rainbow trout were kept in exposition pools and lagoons as exhibits. Afterwards, these were released or escaped into Lake Michigan. As with the carp, the addition of these had little effect on the lake or its fishes. Large goldfish can still be seen in the weed beds of the various yacht harbors.

Rainbow trout have been reintroduced many times and are well established in clean northern streams of Michigan and Wisconsin, and in many parts of Lake Michigan itself. The descendants of the Exposition stock established themselves in the lake, and for many years a few could be caught offshore around the water intake cribs; but we have heard no reports of rainbow trout in the past 40 years.

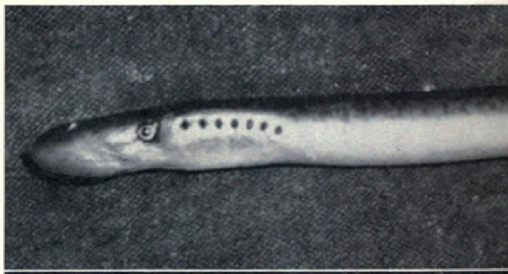
The smelt in the Great Lakes, except in Lake Ontario, are all believed to be descended from a successful planting of eggs in 1912 in Crystal Lake, Benzie County, Michigan. It was not until 1918 that the first smelt were noticed in Crystal Lake, and the first large spawning run occurred in 1922. By 1923, they had escaped into Lake Michigan.

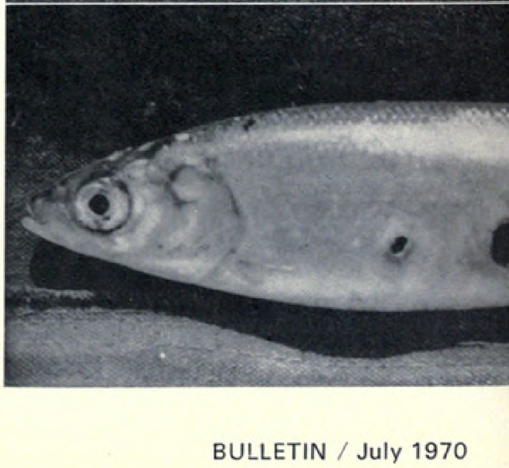
Although the smelt became the dominant commercial species through the spring of 1942 (Lake Michigan catch, 14 million pounds), the other kinds of fishes did not seem to suffer, but instead flourished. Then, in the fall of 1942, dead smelt were noticed in Lake Huron off Saginaw Bay and Mackinac. The die-off spread through Lake Michigan, and by the spring spawning season of 1943 few survivors were left.

They began to recover their numbers by 1945, and by 1951 there was again a very heavy run. The smelt population in the 1960's declined somewhat from its former abundance in the early fifties. The reasons for the decline, however, are not clearly known.

The sea lamprey had always lived in Lake Ontario, presumably since glacial times. In 1825, the Welland Canal, by-passing Niagara Falls, was built. In 1921 the first sea lamprey was taken in Lake Erie. So it took the sea lamprey more than 90 years to pass through this barrier. No easy passage—there are seven locks, a 327-foot lift, and 25 miles of length. When the water is let out of the locks, it flows as a torrent; and a lamprey has to have a firm attachment by means of its sucking mouth to the hull of a vessel or the wall of the locks to keep from being washed backwards.

Once in Lake Erie, the lampreys did not do well because of a lack of suitable spawning streams in the Lake Erie drainage. Because of their long life cycle, it was not until 1937





that sea lampreys were established in Lake Huron. Here they found several excellent streams in which to spawn. Lampreys, instinctively, are pretty particular. They like the same kinds of streams as Atlantic salmon: clear, cool and with good gravel beds, not too far upstream from the lake. Sea lamprey spawning runs begin as soon as the temperature of the streams is between 40 and 50 degrees. This usually occurs in late March or April. The migration is usually at night, the lampreys moving upstream until a suitable spawning area of shallow ripples with clean sand and gravel is reached.

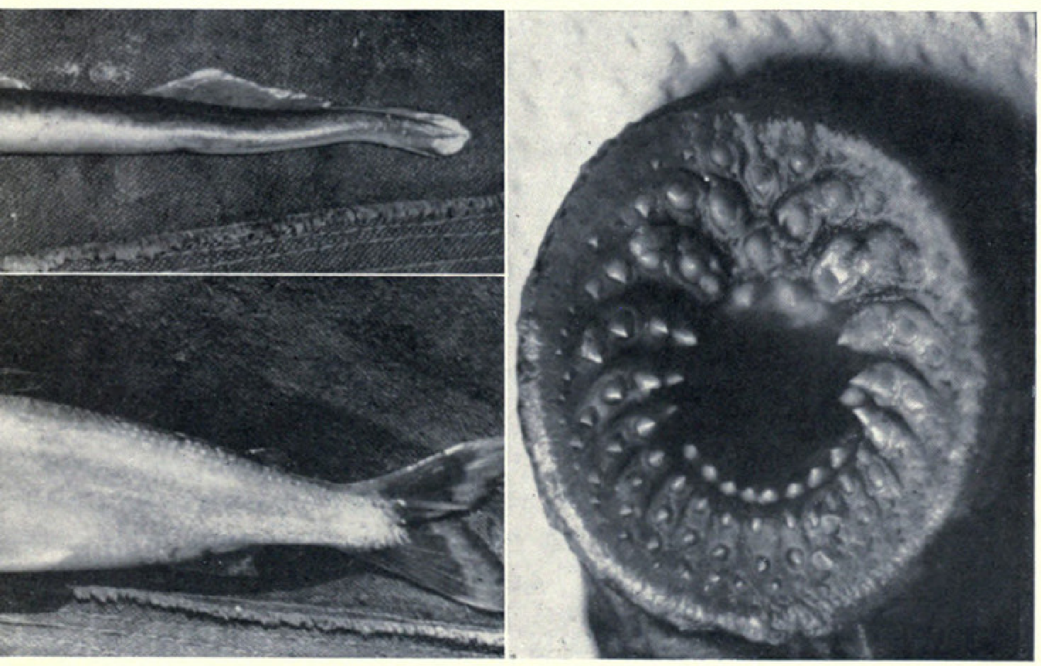
After spawning, the adult lampreys die and are washed downstream, where they rapidly decay and disintegrate. The eggs hatch in 10 to 12 days, and the larval lampreys leave the nest 10 to 12 days later. These larvae are carried off the ripples, where, when the current slackens, they burrow into the soft mud and debris that usually collect in such areas of quieter water. Here they live for the next five years, feeding on microscopic organisms and debris sucked from the water passing the mouths of their burrows. During the fifth year, they develop eyes, a sucking mouth bearing horny teeth and the enlarged fins of adults. In the early spring, they emerge from the mud, drift downstream and enter the deep waters of the lake, where they become parasites and feed on the blood of the larger fishes.

Sea lampreys were first noted in Lake Michigan in 1943 and in Lake Superior in 1954. In each lake, it took eight or more years for the lamprey population to build up to a size that serious depredations were noted on the larger commercial fishes, especially lake trout. Many fishes bearing open wounds or scars were taken and these were unsuitable for marketing. Within a year or two the catch began to decline. In Lake Michigan, it fell from a 75-year average of four to six million pounds to less than a few hundred thousand pounds—and then to nothing. Not even young trout were found. The lampreys turned to other large species, especially whitefish and burbot. They preferred lake trout, however, and preyed on them extensively until the lake trout was virtually wiped out by 1951. A similar decline occurred earlier in Lake Huron. In Lake Superior, the catch was 4.5 million pounds in 1951, but six years later, this had decreased to one million pounds. Clearly, the lake trout could maintain themselves as long as man was the only predator, but the additional predation of the sea lamprey was too much, and their numbers were soon reduced to the point of extinction.

Something had to be done to save the fisheries. Several means were obvious to the United States Fish and Wildlife Service personnel studying the problem. The first was to construct mechanized weirs (a dam with a screen across a stream which allows water to pass while catching all fish) near the entrances of the favored lamprey spawning streams. These were devised to block adult lampreys from ascending the streams and to catch larval lampreys from previous spawnings as they descended. Problems with ice, floods and tending to the weirs soon showed such weirs would never be effective. Next, electrical weirs were installed. Here electrodes were lowered into the water, and the electrical field either killed or stopped the adults on their upstream spring migrations. But other fishes were blocked also. Power failures and kills of rainbow trout and white suckers migrating at the same time indicated electric weirs were not the final answer.

Meanwhile, a screening program to find some chemical that would kill lamprey larvae and not other organisms was under way. Nearly 5,000 different chemicals were tested before a very expensive complex compound was discovered that was effective. This could be used in diluted quantities, the effectiveness dependent upon the length of time the poison surrounded the larvae. Electrical weirs were maintained for monitoring purposes. Teams of trained fishery biologists and woodsmen, concentrating on the most heavily infested streams, treated each stream with carefully determined amounts of larvicide. Thus, several generations of sea lamprey were eliminated by a single treatment. In the quantities used, most other fishes were not affected, but more than 95% of the lamprey larvae were

The sea lamprey (top) is a predator of many commercial fish. Its victim in the lower photo is a chub. Its sucking mouth bears horny teeth which rasp a hole through its victim's skin. Lamprey saliva contains an anti-coagulant, so the wound stays open while the lamprey sucks the blood and flesh.



driven out of the mud and killed. Other harmless, non-parasitic lampreys were killed also, as were mud puppies (*Necturus*) and the burrowing mayfly nymphs—a favorite food of rainbow trout. What other changes may have been effected in the streams, and what the long lasting effects were remains undertermined.

The most recent and probably the most devastating invader to the upper lakes has been the alewife—not only to the inhabitants of the lakes, but to those along shore as well. Alewives have been abundant in Lake Ontario for at least 80 years. Just how they got into Lake Ontario—whether they were left there at the close of the last glacial depression of this area; whether they strayed in through the St. Lawrence River (where they do not live now); or whether they were brought in accidentally by man, has not been determined. In the early 1870's, however, shad were introduced into Lake Ontario, and there is the likelihood that alewives were included in the shipment.

For the past 80 years at least, alewives have been a conspicuous nuisance. Nearly every summer large numbers die and, drifting inshore, clutter the beaches—sometimes in such quantities they form wind rows. On occasion, it has been necessary to haul them away.

Since alewives are migratory, running upstream to spawn, they eventually, after nearly 70 years, made it past Niagara, through the Welland Canal, into the upper lakes. They were first recorded in Lake Erie in September 1931. Eighteen months later, one was captured in northern Lake Huron. Although they were now within a few miles of Lake Michigan, they did not enter until 1949. Perhaps they were kept in check by lake trout and burbot that were abundant in Lake Michigan until about this time.

Four years after being first noticed in Lake Michigan, they had spread to all parts of the lake. The first evidence of their spawning was noticed in Green Bay during the summer of 1953. The first large specimen near Chicago was brought to Field Museum in March 1954. In October 1956 the Museum received young that had hatched the previous summer. The following spring, large numbers appeared floating dead in Burnham Park lagoon and in the harbor north of Shedd Aquarium.

The climax of alewife die-off came in 1967 when the city of Chicago removed 4,500 cubic yards of dead fish from the Chicago shores. This amounted to about six million pounds. Alewives died in all parts of the lake, and it has been estimated that more than 180 million pounds died in this one year. The same year 41 million pounds were harvested by the commercial fishermen. Nearly all of these were three-year old fish. When you consider it takes 10 alewives to make a pound, the numbers assume astronomical proportions, and these are only the three-year olds. The yearlings and two-year olds are yet to be counted. It would appear that alewives are crowding all other fishes out of the lake. The lake herring, emerald shiner, and even perch are much reduced in numbers. Perhaps 90 to 95% of the fishes in Lake Michigan now are alewives.

The question is: Why do they die? The answer is not simple, but it is certainly connected with the fact that alewives are marine fish. Along the Atlantic coast from New England to the Carolinas, they run upstream to spawn, then return to the sea. The young remain in fresh water for a couple of months, then they too move into salt water. In the Great Lakes, alewives are stunted in growth and it would seem that although they can live here, they are not well adapted and so are under constant stress. The cold temperature of the lakes, the changing temperatures, their migration from cold offshore waters into warm, shallow waters, all have been suggested as the cause of death. Another observation has been that when their numbers build up to a peak, die-offs occur. Since the great mortality of 1967, the fish seem to be in better condition, living longer, and though some die, no conspicuous or massive die-offs have occurred.

The best explanation for their death appears to be physiological. In many three-year old fishes examined, the thyroid gland, which functions as a regulatory mechanism of metabolism, excretion, growth and sexual development, appears to have been exhausted. Perhaps this results partly from a lack of iodine in the lake waters and hence in their diet. The stresses of their adopted environment seem to be too much for them.

The managing of a body of water as large as Lake Michigan, along with the many complicating factors discussed here, proves to be difficult. More information is needed on all aspects of the biology and interrelationships of the plants and animals and their environment. We can only hope there is enough time. ■