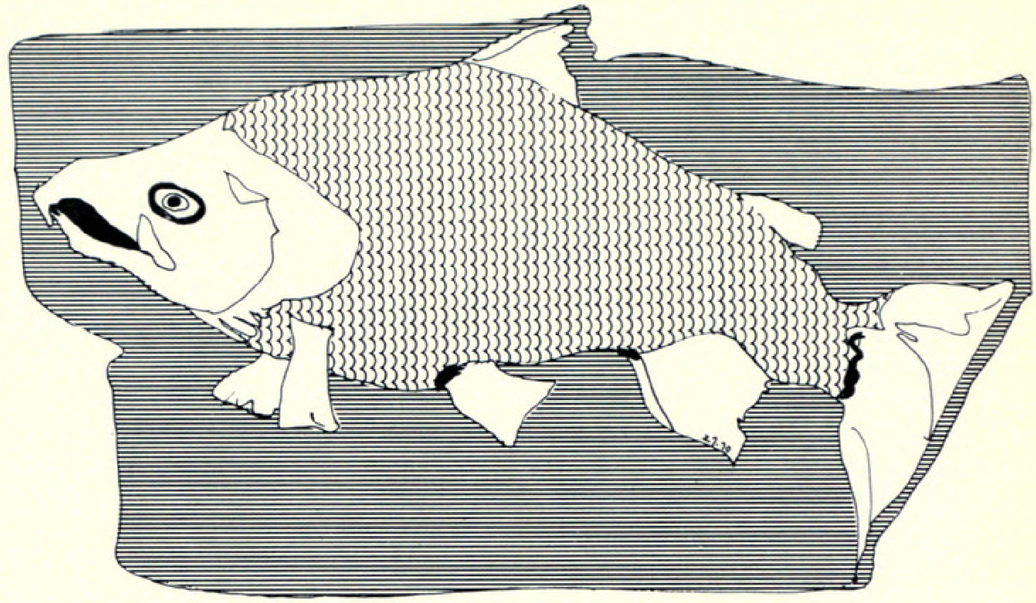
The Changing Great Lakes

PART II



LOREN P. WOODS

This is the second part of a two-part article on the fishes of the Great Lakes. Part I, which appeared in the July issue of the Bulletin, *dealt with changes in the lakes, including the disappearance of the Atlantic salmon, the introduction of goldfish, rainbow trout and smelt, and the invasion of the sea lamprey and the alewife.*

The chain of events in Lake Michigan which began with the invasion of the sea lamprey during the 1950's and the explosion of the alewife population during the 1960's has led to a lack of balance among the various species which inhabit the lake. Both commercial and recreational fishing declined. Biologists, in attempting to reconstruct valuable fish production, have resorted to unprecedented large-scale introductions of three species of Pacific salmon, coho or silver salmon, chinook or king salmon and kokanee, a land-locked form of sockeye salmon. These introductions began in 1965 and have continued, with increasing numbers of salmon being released each year into both inland lakes and into Lake Michigan and Lake Superior streams.

So far, this program of salmon introductions, undertaken by the Michigan Department of Conservation, has achieved some of its primary objectives—the improvement of sports fishing, the promotion of the tourist industry and the restoration of predator-prey relationships. Although there appear to be no published reports that alewives are, in fact, the major salmon food, there have been verbal reports of salmon eating alewives. Hopefully, time will prove these reports to be true.

Chinook salmon were introduced into the Great Lakes in the late 19th century and again just after World War I. These established breeding populations for a few years and then disappeared. In 1967, over 800,000 young chinook were planted in three Michigan streams. When the temperature of the streams rises, the young migrate downstream and enter the lake. As the chinooks increase in size, they feed on lake herring, alewives and other small fish. Most chinooks mature in four years. Like the cohos, chinooks grow rapidly; in 1969 about 43,000 were taken by sports fishermen, weighing an average of fifteen pounds each. The Michigan Department of Conservation took 83,000 more chinooks and cohos at their wiers totaling 950,000 pounds. In 1970, one weighing 24 pounds was taken along the Chicago lakefront. Really large salmon are expected this fall as the first mature fish approach the streams.

If chinooks are principally dependent on alewives for forage, evidently the 1967 alewife die-off, followed by an apparent reduction in alewife abundance, did not influence either survival or growth of chinooks. Most of the alewife die-

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off consists of three-year and older fish and some yearlings. Perhaps chinooks are eating pelagic two-year-olds.

In 1966, nearly one million 4 to 6 inch coho fingerlings were introduced into two Lake Michigan streams and one Lake Superior stream. By September, some of these had grown to 17 to 23 inches and weights of two and one-half to seven pounds. In 1967, more than two million coho were introduced into five streams, and in 1968, 3 million fingerlings were introduced. The recreational fishing that developed as a result of these plantings has been widely publicized and fishing has spread around the lake. The largest fish are caught in the late summer and early fall, when the adults return to their parent streams to spawn.

Unlike the other Pacific salmon, cohos have a three-year rather than a four-year life cycle. After fall spawning, the eggs hatch in mid-winter, the fry remaining in the nest for a few weeks. Once the fry have left the nest, they feed in the streams for one year before entering the lake. They grow rapidly in the lake; some males are ready to spawn after only one summer in the lake. The majority do not return to spawn until after their second summer, when they are three years of age. Once they reach maturity, they have only a few weeks to enter their parent stream and spawn before they die. They die even though they do not enter a stream or spawn.

The few streams in which cohos are planted do not have sufficient spawning grounds for the returning fish, so large numbers are diverted at the stream mouth, where they are led into impoundments. Some are taken to hatcheries, where they are used to produce more fry. The rest are given away or sold. Michigan has sent fry for stocking to the other states bordering Lake Michigan to increase the number of home stream runs and broaden the areas of summer-fall angling.

During the first year of coho salmon fishing, 1967, anglers caught about 35,000 fish. In 1968, about 100,000 were taken. There was a further increase in 1969 when anglers harvested 132,000 cohos, weighing 1.25 million pounds, an average of 9.5 pounds per fish.

THE ECOLOGICAL BALANCE. How is the introduction of these various exotic salmon likely to affect the native fishes, whose adaptations to oligotrophic (deep, cold, clear lake water with low nutrient supply) conditions and whose ecological balance has been established over thousand of years?

From mere collecting of vital statistics on the stocks of commercial species, the various state and federal fishery departments have moved into management. But the management of a body of water the size of Lake Michigan is management of a system, the complexity of which is beyond anything ever attempted. If the principal abundant species is reduced to one forage fish—the alewife—whose numbers fluctuate widely because of periodic die-offs, and a couple of predator species—coho and chinook—this results in a highly unstable situation. Consider too, that this new management system is being superimposed upon the whitefish, chub and lake trout population and *their* foods. Lake trout are being introduced on a scale equal to that of salmon introduction in the hopes of restoring the predator-prey relationships between lake trout and chubs, both of which live in deep water.

Another matter that directly concerns everyone is whether this management can be carried out under the relatively free enterprise system we have now. Will even greater restrictions be placed upon commercial fishermen and the managing be done only for recreational fishing and associated enterprises? The use of large mesh gill nets was abolished in 1968 in parts of Lakes Michigan and Superior to prevent commercial fishermen from taking salmon, and presum-

Chicago Tribune photo

ably, to allow a building of breeding stocks of lake trout. Further restrictions are being considered. Will it be necessary to phase out commercial fishing?

The answers to such economic questions lie in the biological results of the present fish introductions. If these salmon can only be maintained by continued artificial means, requiring large brood stock, it may be necessary to find other solutions, such as controlling alewives by fishing beyond their reproductive capacity and reducing their numbers.

RISING DDT LEVELS. The most serious problem associated with the coho program has been with the residual pesticide, DDT. At one of the Michigan hatcheries, a large number of eggs and fry died and studies indicated DDT to be the cause. Eggs of Lake Michigan coho had DDT residues 2 to 5 times higher than eggs from Lake Superior coho. Losses from Lake Michigan fry ranged from 15 percent to more than 50 percent, while mortality of Lake Superior fry was negligible. Formerly, the state of Michigan sold excess coho to a commercial packing company for processing. Shipments of these frozen coho were found to contain significant DDT levels, but at the time, no standards had been set regarding a "safe" level for human consumption. In April, 1969, the Food and Drug Administration set a limit of 5 parts per million for DDT and its derivatives.

A three-year study (from 1965 to 1968) reported that levels of DDT and its breakdown derivatives, DDD and DDE, ranged from 3.5 to 5.5 parts per million in the eggs and from 5.0 to 8.5 parts per million in the flesh. This same study analyzed nine other species of fish from each of the Great Lakes, including two species which were common to all five lakes. The report, given by fish and wildlife physiologists Carr and Reinhart in 1968, concluded that, "Fish from Lake Michigan contained the highest concentration of DDT—two to four times as much as similar species from the other lakes . . . During the three years of this study (1965-1968), DDT levels in the Great Lakes fishes showed no detectable trend."

Chicago Tribune photo

DDT has since been banned in Ontario, Wisconsin and Michigan. Although strong bills to curb its use in Illinois have received much attention and support, action is still pending. However, this very concern has led to voluntary curbing of the use of DDT and other chlorinated hydrocarbons in the lake watershed.

It is very difficult to determine the amount of DDT and its derivatives in the environmental system. DDT has a great affinity for fat. It is taken up by organisms so quickly that it is useless to monitor the water. Some residues are found in bottom silt of lake tributary streams, but most of the DDT that gets into the water seems to pass through the food web and much is eventually concentrated in the predators—not only fishes, but also fish-eating and scavenger birds.

In areas where known amounts of DDT or other chlorinated hydrocarbons have been used and subsequent attempts have been made to trace it through the ecosystem, most was found to have disappeared, presumably taken up by organisms.

Apart from pesticides, there is another chlorinated hydrocarbon, the polychlorinated-biphenyls (PCB), which eventually can be expected to build up to levels exceeding those of DDT. PCB is virtually indestructible. It is concentrated in fish and birds in the Great Lakes and other regions in physiologically significant amounts. PCB is used in many industrial products—in the manufacture of plastics, paints, resins, hydraulic fluids and other products—which are eventually released into the environment. As yet, no studies have been made on tolerance levels of PCB or on its effects on animals of the food web, diatoms and planktonic algae.

Photo by John Hendry

THE CLADOPHORA MENACE. A recently developed nuisance, as a result of nutrient buildup in Lake Michigan, is an excess of the blanket weed, *Cladophora.* This dark green, filamentous, branching algae grows attached to rocks, pilings, seawalls and boats. When attached, it is a sheltering place for several kinds of small crustaceans and also a feeding and sheltering place for small fishes.

The nitrogenous wastes from domestic sewage and phosphates, especially from detergents and field runoff, are both essential nutrients for the growth of this algae. Field experiments have shown that if either nutrient is absent, *Cladophora* growth is minimal. Usually, phosphates and nitrates are not abundant in an oligotrophic lake such as Lake Michigan.

In spring, the rocks and pilings are bare of growth; *Cladophora* needs a water temperature of at least 50°. Other requirements are good light, clear, active water and sufficient nutrient materials.

In former years, *Cladophora* grew to only a few inches length during the summer and most of it remained attached to rocks. However, given sufficient nutrients, the filaments grow much longer and when pounded by waves during storms, are broken off. The mats of algae continue to grow, even though unattached, and drift along shore. If carried into turbid waters, some die and decompose, liberating their nutrients for recycling.

The problems with *Cladophora* that have arisen in many parts of Lake Michigan become acute when the floating mats plug water intake systems or are washed ashore onto beaches and begin to decompose. The shiny and amorphous mats look and smell like sewage. The beaches may be covered with windrows of algae and the edges and shallows of beaches offshore may

be anywhere from ankle to knee deep in algae. Since most *Cladophora* growth is in the areas of enrichment (i.e., excess nutrients mentioned above) in the vicinities of cities and because most of the algae that is broken loose is tossed onto nearby beaches, it is primarily the cities that are forced to deal with the problem. Removal is difficult because of the very nature of the algae. Chemicals and practical methods of destroying the mats offshore have not been developed. Having a crew of men rake the algae from the edge of the beach, then bulldoze it into piles or load it onto trucks, is not only highly inefficient, but very costly.

The only solution to the problem appears to be reduction of nutrient materials that the *Cladophora* depends on, and this is also costly. Sewage treatment can be and is quite effective in the removal of nitrogenous materials, but utilizing this method for the removal of phosphates is very expensive. One method of removal is to send the effluent onto land covered by plant growth, but few urban regions have such areas available for this type of disposal. Recycling of nutrients as well as other pollutants as such would seem to be at the heart of nearly all of our waste disposal problems.

Courtesy of Federal Water Pollution Control Administration

INDUSTRIAL POLLUTION. Overall, Lake Michigan is still in good condition. Its great mass of deep, cold water has maintained its oligotrophic condition and abundant life. However, industrial pollution continues to affect certain areas of the lake. The southern part of Green Bay is so badly polluted that the city of Green Bay draws its water across the peninsula from open Lake Michigan rather than from Green Bay. Other locally polluted areas are mostly in tributary rivers and in the vicinity of the larger cities.

The Calumet industrial area just south of Chicago, among the heaviest industrial complexes in the world, has significant pollution. Here are located ten major steel mills, five great petroleum refineries, five other large industries (mostly chemical) and a large number of smaller concerns. The kinds and number of aquatic plants and animals living here reflect the water quality in that area. According to government surveys by Federal Water Quality Administration, pollution become more severe between 1965 and 1967. The amounts of iron, sulphates, cyanide and phenols were all significantly higher. The water quality at a southern Chicago and a Gary water intake were below standard. Generally, conditions on Chicago beaches and Indiana beaches were satisfactory, except when winds locked in contamination. The worst form of contamination so far has been periodic oil spills or bilge oil. This has extended along shore, causing beaches to be closed and bird kills. Not only a local problem, oil spills occur in many industrial harbor areas throughout the Great Lakes.

The same water of the Great Lakes is used over and over again. In 1954 there were 2000 industries using nearly 3000 billion gallons of Great Lakes water. 96 percent of this was returned to the source after using. The greatest industrial water use in the Great Lakes is for electrical power. Steam generators take water through their turbines and return it to the source relatively unchanged. The next greatest use appears to be in the primary metal industries, which utilize nearly half of all water withdrawn. All other industries utilize the other half.

POLLUTION AND PUBLIC CONCERN. Until quite recently, water pollution has been primarily a concern of the public health departments. If there were no known pathogens and if the water smelled and tasted all right, its quality was considered good.

During the past three years, other forms of pollution have been mentioned in the scientific literature, and more and more often in the news. There were reports of mercury poisoning from Japan in 1953, 1960 and 1965 (more than 100 people were killed or disabled in one community). In Sweden, bird populations decreased and subsequently fresh water fish were found to contain large amounts of mercury. Various mercury compounds are used in pulp and paper production, as fungicides—especially in treatment of seeds, in herbicides (crab grass control) and in antifouling paints for ships as well as in the manufacture of other products. In April, 1970, because of their mercury level, fishes from Lake Erie were withdrawn from the Canadian market and embargoed; a month later, all commercial fishing in Lake Erie was ordered halted by the state of Ohio. About the same time, sport fishing in Lake St. Clair and in the St. Clair River were banned by Michigan. Within the past few weeks, mercury has been found in Lake Michigan waters. There are reports from many other regions that fishes and drinking water have been found to contain dangerously high levels. Mercury, like DDT, moves through the food web of aquatic animals and regardless of the chemical form in which it is introduced, it is eventually converted to its most toxic form, methyl-mercury. There have been Senate Commerce Committee meetings and international meetings between the United States and Canada on the problem. Where sources of pollution have been located, the mercury levels have been reduced or eliminated.

Airports and dikes sealing off the southwest corner of Lake Michigan may become the most important problems in the future. But there are numerous immediate problems and insufficient information to lead us to a quick solution. At least we now recognize that to maintain water quality, there must be a thriving aquatic life.

The problems won't wait while the laborious data collecting and analysis are completed. Despite the upswing of investigation by government and private agencies and institutions, despite the large numbers of people working on lake problems, both biological and physical, much more has to be learned if we are to stop the deterioration of water quality. Changes in the lake waters and biota cannot be stopped, but the process of increasing nutrients can be slowed, temperature levels can be held to normal and input of toxic materials can be stopped.

Pollution problems are increasing. Great expenditures of effort and money are going to be required to prevent further deterioration and preserve the lake, our most valuable resource, so it can be used in the future as it has been in the past. □

Sun-Times photo by Bob Kotalik