SEASONAL CHANGES AND ACTIVITIES OF LAKE FISHES

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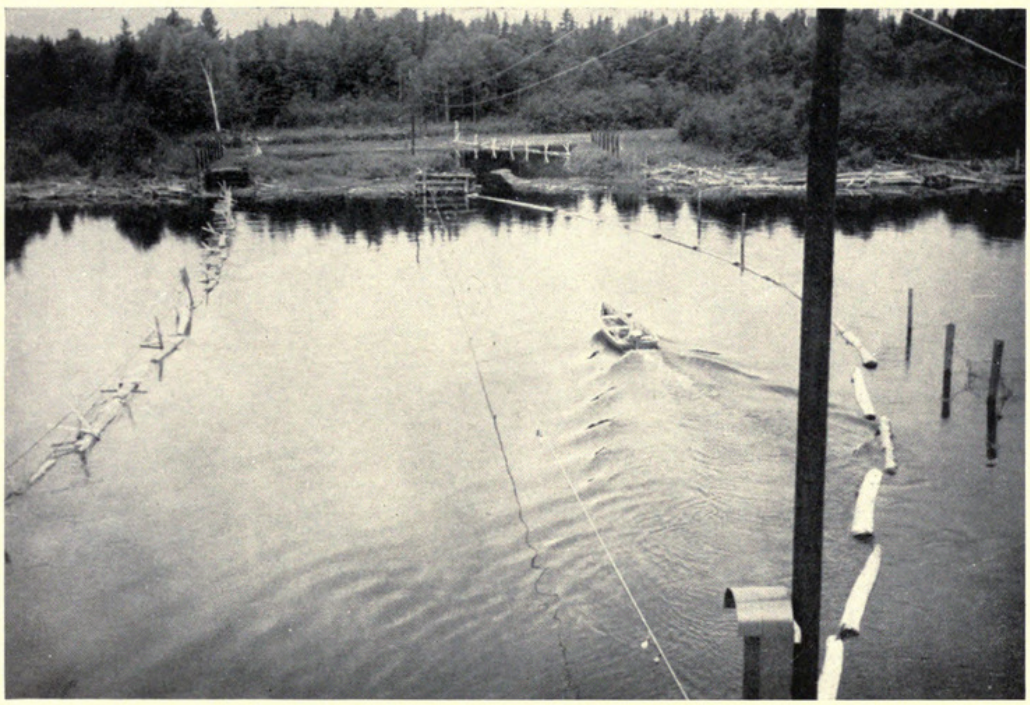
CURATOR OF FISHES

TWICE EACH YEAR, in the spring and early December, a phenomenon occurs on a grand scale in Lake Michigan. This is the semiannual circulation or *turnover*. This occurrence, of far greater importance than the first spring robin or the first autumn snowfall, passes unheralded but not unnoticed by the great majority of Chicagoans. We notice it because of more heavily chlorinated water and we notice it especially in the spring when our lake water from the tap is more turbid than usual or even tastes slightly fishy. The new filtration plants, however, have greatly alleviated the effects on our drinking water resulting from the unusual turbidity produced by the tremendous change that takes place in the lake when its waters give up heat in the autumn months or absorb it during the rare warm still days of early spring.



ELECTRIC WEIR FOR LAMPREYS

Above is an electrically-charged weir blocking river mouth to prevent migration of lampreys upstream. At right center is a trap made of netting for suckers, rainbow trout, and northern pike.

This seasonal period of circulation is of such profound importance to the plants and animals, large and small, living in the lake that their periods of greatest and least activity follow the same rhythm.

It is common knowledge that water is different from most other liquids in that it reaches its point of greatest density at 39.2° F. and then becomes lighter, no longer sinking as it is further cooled until it solidifies at around 32° F. This property accounts for water freezing at the surface first (and only at the surface) when in a large mass, as in a lake, rather than becoming a solid chunk of ice from top to bottom.

In the very early spring the temperature at the surface of the water or just under the ice is close to 32° F. As we measure the temperatures downward they become slightly warmer until near the bottom the temperature is about 39 degrees. The colder but lighter water is on top of the heavier but warmer water.

When the ice melts and the surface water begins to warm toward 39 degrees it becomes heavier and sinks through the colder but lighter water just beneath it, which in turn rises to the surface where it is warmed to 39 degrees before sinking. This process continues until the whole lake becomes the same temperature and therefore the same density. Once the lake water reaches the same temperature throughout, currents caused by the winds stir the waters until they are mixed from surface to bottom. This complete circulation is called *spring turnover*.

The effect of the spring turnover on plant and animal life is significant. During the previous year as plants and animals died and sank into the colder and relatively stagnant parts of the lake, there was a gradual removal of organic materials from the warmer parts of the water. A great deal of this nutriment is returned into circulation by the fall turnover, but it is not used to any great extent until the following spring when warming temperatures bring increased activity. The development of several kinds of small planktonic algae (diatoms, desmids) followed by an increase in minute crustaceans (daphnia, copepods) that feed upon the various algae insures a good food-supply for the hatchling fishes of most species whose first food consists of tiny crustaceans. The spring turnover and subsequent warming also touches off the migrations of many species toward the areas where they subsequently spawn.

EARLY SPAWNERS

There are approximately 100 species of fishes living in Lake Michigan and each month finds one or several of these spawning. The earliest is a fresh-water codfish, the burbot (*Lota*). This species is known to spawn in February and March. Sometimes burbots enter streams to spawn. Because of the low temperature of the water the eggs have a long incubation period and the young may not appear for five or more weeks.

The sculpins (Cottidae), of which there are four species in the lake, are believed also to spawn in the very early spring (March) but nothing more definite is known of them in Lake Michigan. More completely known are the spawning runs of the sea lamprey and the smelt.

SEA LAMPREY

Sea lamprey spawning-runs begin as soon as the temperature of the stream waters is above 40° F., but very few migrate before temperatures reach 50°, usually in late March and early April. As the temperature rises the number of migrating lampreys also increases. The migration occurs almost entirely at night, the lampreys moving upstream until a suitable spawning area of shallow riffles with a bottom of gravel and sand is reached. The distance traveled upstream may be as much as 50 miles but is usually much less (fewer than 20 miles). Spawning activity begins when temperatures are 52–53° F., but the maximum spawning activity occurs at temperatures of 58–60°. 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 8 to 10 days later. These larvae are carried downstream off their riffle 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 sucked from the water passing the mouths of their burrows. During the fifth year they develop eyes, horny teeth, and the enlarged fins of adults, and in the early spring they emerge from the mud, drift downstream, and enter the lake where they become parasitic and feed on the blood of fishes.

Spawning-migrations of smelt occur at about the same temperature and therefore at the same time of year as those of the sea

lamprey. Smelt also migrate at night, and so large numbers of smelt and lampreys enter the streams together, but the lampreys proceed farther upstream, the smelt usually going only a few hundred yards. A sand and gravel bottom is preferred for spawning by both smelt and lamprey but, because the smelt do not require a riffle or downstream mud-bottom pool, the two forms utilize different geographical parts of the stream. Another difference is that smelt leave the streams the morning following their spawning (see BULLETIN, March 1954)

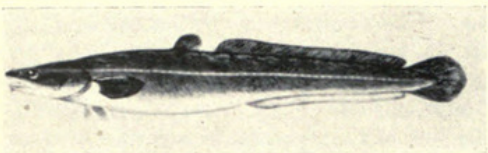


Photo courtesy Iowa State Conservation Commission

EARLY SPAWNER

Burbot, a fresh-water codfish, spawns in February and March.

but the migrating lampreys die there. Moving inshore along with the smelt, which they resemble, are the trout perch (*Percopsis*). They enter streams either in the day or night and gather in quiet water behind obstructions such as boulders. They spawn in turbid water over a rocky bottom. The alewife, a recent invader in Lake Michigan, has spawning habits similar to the smelt, but its spawning run begins a week or two after that of the smelt has ended.

Entering the streams with the migrating smelt and lampreys are large numbers of white suckers that migrate to distant headwaters beyond even the lamprey grounds, as do the rainbow trout from the lake. Still another lake fish entering streams in the early spring for the purpose of spawning is the northern pike (*Esox*) that may begin its migration as early as March 1, even before the ice leaves the streams. These fish move to very shallow waters near the stream source and, at the time of floods, leave the stream channels and spawn over the flooded swamps and bottom lands.

Many of the lake species do not normally leave the lake to spawn, as do the half-dozen species just discussed.

PERCH

The abundant yellow perch (*Perca flavescens*) is the fish most anglers are seeking when fishing along the lake shore during the summer. Normally living in shallow waters and open bays, the perch make their spawning runs close to shore in late April or early May when the water temperature is 44–54° F.

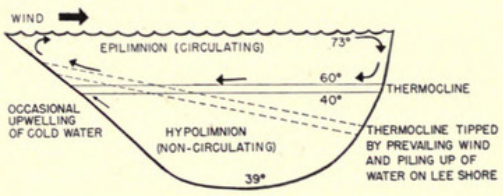
The perch eggs are embedded in long flattened gelatinous ribbons. The spawning female seeks aquatic vegetation, submerged brush, logs, or pilings where the sticky egg-ribbon is attached. Very often the eggs are plastered all over the commercial fishermen's submerged nets. The eggs are fertilized by the 15 to 20 males that follow the female as she deposits her eggs.

The nursery grounds of the young perch are shallow bays and weedy areas among pilings or close to piers. Schools of tiny perch numbering in the millions can be seen in late July or August just before dusk along the seawalls of Grant Park.

Probably the most numerous of all fishes in Lake Michigan is the emerald shiner (*Notropis atherinoides*), the fish most commonly used as a bait minnow by the lake-front fishermen. Its swarms outnumber the combined population of all other species in the lake. During December and January of each year the emerald shiners congregate in protected bays and in the mouths of rivers. In the spring huge unbroken schools can be seen along the promontories and breakwaters, moving just beneath the surface. The school may stream by for several hours or all day. The green bodies, with purple iridescent stripes down the middle of the back, flash past and are replaced by more bodies in an unending stream several feet wide and as deep as it is possible to see (2 feet). The schools later break up into spawning groups of 50 to 300 individuals and these small groups move around the open lake. Pairing and spawning occurs in mid-water during June or July.

THERMAL STRATIFICATION

As the temperature of the surface water rises above 39 degrees during hot late-spring days, these surface waters are no longer the same density as the colder deeper waters and therefore do not mix readily. Gradually a stratification is brought about with warmer lighter waters in the upper layers. Below this is a narrow vertical distance where the temperature of the water falls sharply and below this a mass of water that is still 39 degrees (*see diagram*). By the end



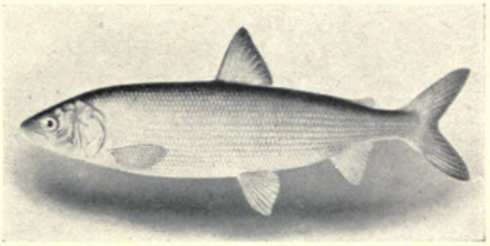
of May the demarcation between the upper warm layer (epilimnion) and the lower cold layer (hypolimnion) has become very narrow, only a few feet in thickness. This line of demarcation, the region where the temperature gradient is greatest, is called the *thermocline*.

Once the thermocline has narrowed, the difference in density is of such magnitude that little mixing occurs between the upper and lower layers. The lower cold layers are shut off from any source of heat so that they remain cold. The upper layer circulates freely, growing warmer, and the thermocline sinks lower and lower (80 to 120 feet below the surface) as the summer advances. Captain Jacques Cousteau, the undersea explorer, has said that the difference in density is sufficiently great that a skindiver in an aqualung can float upon the upper face of the thermocline as ordinary swimmers float at the lake surface. If a strong west wind should blow for several days, much of the warm water would be drifted from the Illinois shore toward Michigan. There it would pile up, depressing the thermocline on the lee and causing the cold waters to come nearer the surface on the windward. Conversely, during periods when cold northeast winds make conditions for visiting beaches most unpleasant, Lake Michigan water is found to be unusually warm.

In Lake Michigan the bottom waters do not become completely stagnate or depleted in oxygen, and so some kinds of fishes such as lake trout, the chubs (*Leucichthys*), smelt, burbot, and deep-water sculpin can live there most of the time. Others like the emerald shiner, perch, and alewife do not normally enter the hypolimnion.

FALL SPAWNING

The definite thermal stratification lasts in Lake Michigan until December, although as the surface waters gradually cool and days grow shorter in autumn a number of deep-water species of fishes move from the cold hypolimnion to spawn in shallow water.



LATE SPAWNER

Deep-water chubs, such as the one above, spawn in the fall. They include the longjaw, shortjaw, kiyi, and blackfin.

Lake trout spawn in late September through October on rocky shoals at depths of less than 20 fathoms. These are followed by whitefish, the several kinds of chubs such as kiyi, longjaw, shortjaw, blackfin, and the lake herring. The eggs of all these fishes spawned in the fall develop slowly in the cold waters of the lake and hatch at various times during the winter or the following spring (April or May).

The lengthening cold clear nights of autumn cause the warmth of the lake to be slowly lost by radiation. The epilimnion cools to about 39 degrees and the gales of winter are able to mix the now scarcely different upper and lower layers. This is the period of *fall turnover*. The water of the lake once more circulates from top to bottom and continues in this mixed condition, being constantly stirred by the fierce winds of winter storms. During this period the strong currents are felt in all but the deepest holes.