Cayuga Lake Trout—

Part 2—Their Distribution and Movements

by Dwight A. Webster,
Professor, Fishery Biology,
Cornell University

CAYUGA LAKE has an area of 66 square miles and a maximum depth of 435 feet. Most of the lake is potential trout habitat for much of the year. This provides a lot of territory for a lake trout to swim in and for a fisherman to fish in. Fortunately, conditions are such that the two can get together with reasonable frequency.

The current study of lake trout in Cayuga has been primarily concerned with the role of hatchery-reared trout in maintaining the population and with other pertinent management statistics. Underlying this study are a fair amount of basic data fundamental to drawing up management recommendations, but also of direct interest to anglers. For example, in the preliminary stages of the investigation there was an immediate need to determine the degree to which lake trout utilized the deeper waters. This had a bearing on the sampling program, but has obvious implications to angling. Similar comment applies to movements and distribution of trout as determined by tagging.

Depth Distribution

Cayuga Lake has an ample supply of oxygen at all depths so that this does not limit the use of the deeper water by trout. In 1950, a former graduate student, James Galligan,* undertook a study of the vertical distribution of lake trout in Cayuga.

The procedure consisted of setting gill nets at right angles to the shore, starting them at a depth that was slightly above the habitable range of lake trout and extending outwards into the lake—following the bottom gradient—for the length of the net (usually 500 feet). The bottom in Cayuga Lake drops off quickly in many areas so that the deep end of the net often fished at substantial depths. The position of captured fish was noted along the length of the net as it was lifted. This information was later correlated with the known profile of the lake bottom in the area fished.

The results of this study are summarized in *Figure 1*, showing the depth at which lake trout were caught. In this chart, the width of the pattern band approximates the relative abundance of trout at various depths during the months of June, July, August and September. It will be noted that lake trout move to greater depths as the Summer advances. This is old stuff to lake trout fishermen. Lake trout and warm water don't mix, and it is evident that with higher surface temperatures, trout are forced deeper and deeper. The uppermost limits in these distribution figures correspond with a temperature of about 60° F. Thirty to 40 feet would be reasonable depths to fish in June and July, but it is obvious that late season anglers should be working water of 70 feet or more.

There is a limit to the depth commonly inhabited by Cayuga trout. It is evident that most of the trout live in water less than 150 feet in depth. Contrary to general opinion, lake trout are not particularly fond of "ice cold" bottom waters, even when abundant oxygen permits travel there. Below depths of 200 feet Cayuga Lake temperatures are reasonably constant at about 39° F. in the Summer. This is not a good temperature for growth and there is little suitable food at such depths for large trout. The average preferred temperature of lake trout is about 50 degrees according to laboratory tests by scientists at the University of Toronto. The study was conducted by placing lake trout in a large vertical tank, the water in which exhibited a temperature gradient from top to bottom. Positions taken up by the fish were noted through windows in the side of the tank and related to temperatures at that depth.

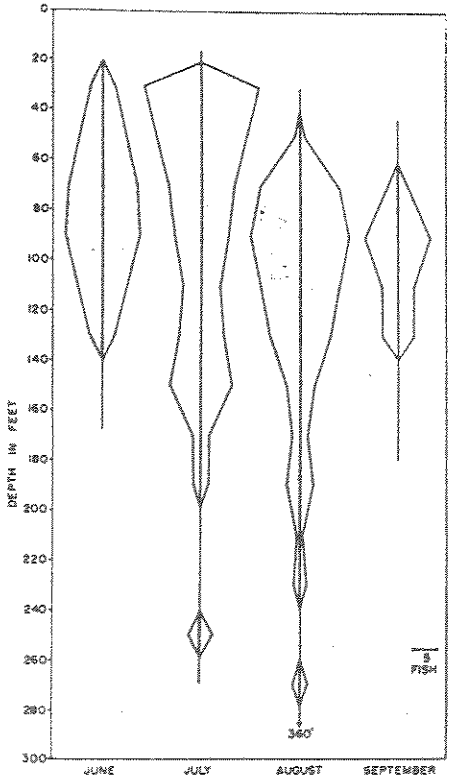


Figure. 1. Depth distribution of lakers during Summer

One must realize that the temperature gradient in a deep lake is not gradual. The temperature cycle in water is too detailed to explain fully in this article, but the essential features for the Summer period are as follows:

A lake has a warm surface layer of water that increases in thickness as the Summer progresses; by late Summer in Cayuga Lake, this layer lies at a depth of 50 to 70 feet. This water follows the air temperatures, rising or falling slightly in warm or cool weather. These temperature changes are dependent upon wind action to a considerable extent. The wind also determines the depth to which the warm water layer penetrates. Below the warm layer is a fairly narrow band where the temperature drops very quickly; then it gradually falls to the minimum bottom temperature in a third layer. Bottom temperatures vary among lakes, depending largely on depth, and exposure to wind. In the deeper lakes, of which the Finger Lakes are prime examples, the minimum temperature is about 39° F. Actual Cayuga Lake Summer temperature in the three layers might be:

Depth	Temperature Drop
Surface to 60′	68-66°
60-80′	66-48°
80-400′	48-39°

Stability of the temperature layers is never complete as it is affected by weather and currents. In the smaller Finger Lakes, the thickness of the warm surface layer is not so great, as wind has correspondingly less effect.

One limitation of the data in *Figure 1* is that it reveals only what happens when the trout are following the bottom where the gill nets are fished. Lake trout are generally considered to be primarily bottom inhabitants. However, angling suggests that at times they move into

*Jim Galligan is well known to many sportsmen in Central New York inasmuch as he served for several years as a biologist in the Central Fisheries District, Norwich. He is now Supervisor of Fisheries Management for the Board of Fisheries and Game of the State of Connecticut.

the open waters, presumably to feed on pelagic (open water) schools of sawbellies. The "Seth Green rigs," a common unit of angling gear in the Finger Lakes area, were developed specifically to ferret out the position of the lake trout by the several spoons strung out over the length of a drop line. In recent years a large flasher type of lure that originated on the West Coast has been successfully used by a number of anglers fishing mid-lake and off bottom. As a general rule, however, the bottom is the most productive area to fish for lake trout. Accordingly, it pays to be familiar with the bottom contours if one is seriously interested in Summer lake trout fishing. The "old timers" know the submarine valleys and ridges of Cayuga Lake and take in or pay out line accordingly.

Seasonal Movement

When surface waters are cold during the Winter and Spring, the lake trout may be inshore, often in water only a couple feet deep. The Winter movement into shallow water is very conspicuous but reasons for this are not clear. There seems to be no food of consequence available and the possible influence of water temperature is not convincing, although little studied. Through late Winter and early Spring the lake is homothermous; that is, the same temperature from top to bottom. Since Cayuga Lake does not normally freeze, cooling continues throughout the Winter and temperatures usually run from 34° to 36° F.

The habit of frequenting shoal water in the Spring makes for more interesting fishing. The advent of spinning has completely revolutionized lake trout fishing in Cayuga Lake as successful angling can be experienced from shore as well as from boat. Lake trout seem easy to catch provided they can be located. The good Spring fishing stems from greater availability . . . trout are concentrated in a relatively narrow shore zone and can see the lures or bait readily. Fishing takes a nosedive if the water becomes roily due to heavy run-off in the tributary streams. Even when trout are inshore it is still a good rule to fish close to bottom, even if it means snagging (and often losing) a few lures now and then. There is enough irregularity to these Spring movements to preserve most of the uncertainty distinctive of angling. Trout may move in—and stay in—over a relatively long period of time or may be more erratic in behavior. It is not uncommon to fish for several hours and have all the activity in a comparatively short space of time.

Fall distribution of the larger trout is conditioned by spawning habits. Trout in some of the Finger Lakes (as well as the Great Lakes and perhaps elsewhere) are characterized by deep spawning populations of trout. This is in contrast with Adirondack lake trout, for example, that travel into shoal water to spawn on gravel bars. Lake trout of Cayuga and Seneca, the sister lake to the west, spawn at depths of 100 feet or more. They seek out areas where the bottom is kept clean by strong sub-surface currents. A former graduate student, Dr. W. F. Royce, took underwater photographs of the trout spawning area off Peach Orchard Point in Seneca Lake. The bottom gravel had a well-scrubbed look as though it had just been brushed. In Cayuga Lake the traditional spawning place for lake trout is at Taughannock. Adult trout concentrate here in late September and October. Other areas attract some spawning fish —Frontenac, Crowbar, King Ferry—but not in such numbers.

Tagging

The concentrated spawning population at Taughannock is a convenient area for obtaining numbers of lake trout for tagging. Subsequent recapture of these marked fish has furnished information on the movements and general distribution of lake trout in Cayuga Lake.

Figure 2 shows the recapture area of tagged lake trout in Cayuga Lake, recoveries made a year or more after release. As only angling recaptures are involved, the number of returns are a fair indication of fishing success in various parts of the lake. There is a widespread scattering of returns throughout the lake, but certain areas are notable for recoveries. A fruitful interpretation, however, requires additional data on the season of the year in which the recoveries were made.

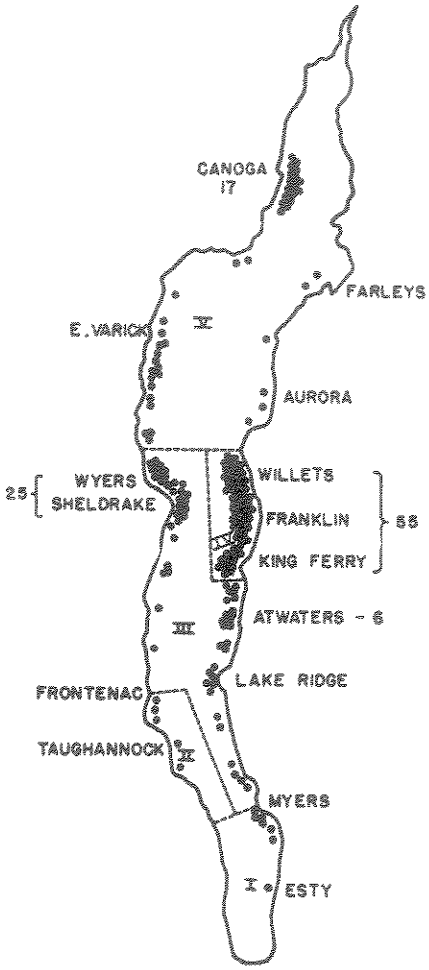


Figure 2. Cayuga Lake areas of recapture. Dots represent tagged fish

To explore this, the data are restricted to trout tagged at Taughannock in the Autumn and recovered during the season

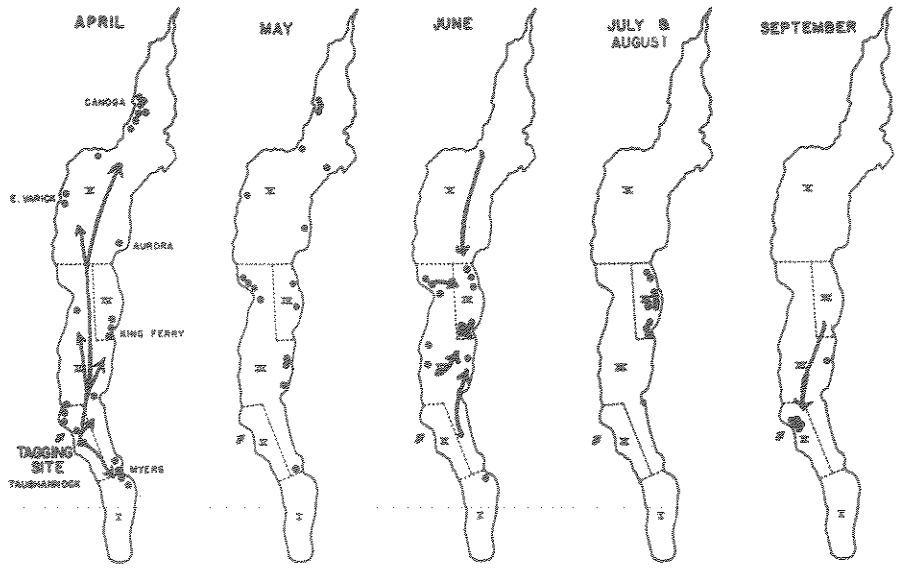


Figure 3. Dots represent tagged lakers; arrows probable direction of travel after tagging at Taughannock previous Autumn

immediately following (i.e., April-September). Consideration of the recoveries by months thus permits the tracing of movements through a calendar year as well as showing seasonal distribution (*Figure 3*).

A widespread dispersion throughout the lake takes place by April. (The arrows indicated in the chart are purely suggestive, as there is no way of telling the exact route a fish travels between release point and recapture area.) Trout invade the western shore of the northern shoals at Canoga, showing a distinct liking for this area in early Spring. Perhaps it is the rubble paved bottom, or perhaps the early warming of the shoal water that attracts them. In any event, the duration of the fishery in this area is at the mercy of water temperature, and in a normal season is likely to end with warm weather in May. There are other areas that provide good early fishing, most of them indicated in *Figure 2*. Even within these favored areas, there are more localized "hot spots." These must be learned from experience.

June recoveries show a closing of ranks to the deeper central basin and through July and August all recoveries are made in a limited area of shoreline roughly five miles long, extending from King Ferry northward to Willets (area IV). If Taughannock is considered traditional breeding grounds, then King Ferry qualifies as the "Summer resort" of large trout. Gill net samples throughout the lake have established the fact that large trout do not occur in substantial numbers in the remainder of the lake during July and August. The following schedule shows the number of trout taken in each of the area or sampling sections netted between 1950-55, using the same amount of netting effort in each section:

Lake Section	*Number of Trout*	
Netted	*Over 20"*	*Under 20"*
I	24	195
II	30	205
III	36	241
IV	196	311
V	12	163

It will be noted that the concentration of trout in Section IV is not comprised wholly of large trout; small trout, too, are more abundant here and in the adjoining portions of Section III. We do not know, as yet, why trout are attracted so strongly to this section of the lake at this season of the year. The bottom here has a gentler slope at depths that may be attractive to trout in Summer. Or perchance the fish may gather to partake of the sulphur waters that are reputed to well upwards into the lake in this area. (Curiously, lake trout in Seneca Lake seem oriented in an almost identical geographical position at Lodi Point during the Summer.)

September netting data must be used to furnish evidence for the return journey to Taughannock. The angling season closes so early in the month that few recaptures are available.

If the Cayuga trout were a natural, self-supporting population one might be tempted to explain their movements as an ancestral hereditary pattern. But as pointed out in an earlier article (CONSERVATIONIST, April-May, 1955), the present stock is virtually all of hatchery origin and from Seneca Lake parents. Perhaps random movements could account for attracting large numbers of trout in areas of favorable habitat, but the possibility of orienting factors cannot be ruled out. The pattern described applies only to adult trout. Recoveries of trout tagged as juveniles are less plentiful, but the indirect evidence from netting suggests they remain well scattered throughout the year (northern and southern shoals excepted). Fin-clipped hatchery fish released in Section II take about two years to disperse completely.

Cayuga Lake Trout

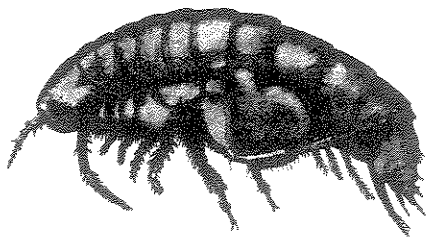
Part 3—Their Food, Growth, Survival and Management

by Dwight A. Webster,
Professor, Fishery Biology, Cornell University

This is the third and concluding article in this series on the lake trout of Cayuga. Twelve years of intensive studies by a great many fishery biologists have been invested in this work. They have produced a milestone in fishery research and management assuring the future of this fine sport fishery.
—Editor

A LAKE TROUT in Cayuga is often gluttonous in feeding habits but can scarcely be characterized as a gourmet, even piscatorially speaking. A single food item appears with regularity: The "sawbelly" or alewife. To this little silvery fish goes the credit for the high lake trout production of certain Finger Lakes where it has taken up residence: Cayuga, Seneca, Keuka and Canandaigua.

Of 738 lake trout stomachs examined during the Summer months (1949-55), 60 per cent had eaten one or more alewives. Alewives first appear conspicuously in the lake trout diet at lengths of 8 to 10 inches. Baby lake trout feed on the deep water crustacea *Mysis* and *Pontoporeia* and occasional bottom insects. The only other recognizable fish eaten by lake trout are sculpins (found in 29 stomachs) and the odd trout-perch, smelt and cisco.



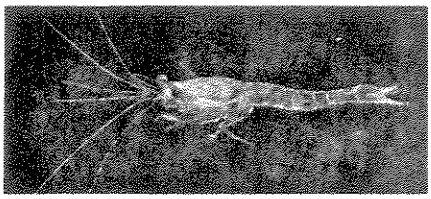
Pontoporeia, another food of baby lakers

The coming of the alewife to the Finger Lakes is somewhat of a mystery. Records indicate it was well established by 1872, so that residents accept the fish as going with the area. Alewives are essentially marine in habitat, living in the coastal waters of the north Atlantic but spawning in fresh-water streams in the Spring. The "landlocked" form in the Finger Lakes differs in the much smaller maximum size (4 to 5 inches compared with 10 to 15 inches in the marine form) and in the loss of desire to return to salt water. Alewives belong to the herring family and they retain the family schooling characteristics in fresh-water. Under Finger Lake conditions they are very successful, occur in tremendous numbers, and are preyed upon by nearly all other species of fish from rock bass on up.

Lake trout probably get in their best feeding on alewives during the late Spring and early Summer. At this time alewives press shoreward to spawn in shallow water and the mature population is crowded around the periphery of the lake. Although warm surface water is sufficient to bar lake trout from following alewives to the along-shore spawning grounds, there is still plenty of easy feeding at depths just below 25 to 30 feet. This is the fattening period for the lakers after a lean Winter. By human standards, alewives would be considered a "fattening diet." They have a high oil content that is reflected in heavy fat deposits in the body of the well-fed trout.

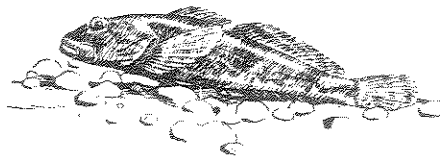
Smelt are often considered as traditional lake trout food, but they are vir-

tually absent from Summer trout stomachs in Cayuga. The reason for this is an almost complete separation of smelt from lake trout at this time. Gill net samples indicate smelt are most abundant over the deep mud flats adjacent to the north and south ends of the lake. Lake trout are relatively scarce here. Smelt are most prominent as food in the Spring when they shoal inshore for spawning.



Young lake trout fare well on mysis —the opossum shrimp

Sculpins present something of a hors d'oeuvre appearance and lake trout find them appetizing. They are best known to lake fishermen by appearance in trout stomachs in the Spring. Trout also eat sculpin eggs. These are laid in clusters under rocks and the fish must have to root about a bit to get them. The pearlescent pink eggs are large (about ⅛ inch in diameter) and the notion is common, though in error, that lake trout are feeding on rainbow trout eggs, and that the latter species is spawning in the lake proper.



Sculpin—another trout delicacy

Growth

Cayuga lake trout diet may not be varied, but alewives have the nutritional punch to provide for flattering growth, particularly in early life. The schedule below shows average mid-season sizes for lake trout in Cayuga Lake:

Lake Trout Growth—Cayuga Lake

Age (years)	*Total Length (inches)*	*Weight (lbs.)*
1	6.7	—
2	10.4	0.3
3	14.4	1.0
4	18.9	2.2
5	22.7	3.7
6	25.0	5.1
7	26.6	6.0
8	27.3	6.6
9	27.7	6.8

Growth through the first six years is much more rapid than usually encountered elsewhere in this species. The pattern is also characterized by a sharp decrease in growth rate after this age and it is evident that on the average Cayuga lake trout grow slowly after attaining a length of about 25 inches and five pounds. In this regard it also differs from lake trout in many lakes where fast growth continues through later life and weights of 20 pounds or more are commonly attained. Some lake trout in Cayuga do reach 10-15 pounds in weight, but these are not numerous. The largest lake trout examined by University biologists weighed 19.6 pounds.

Close-up of two open wounds left by lamprey eel attacking young Cayuga lake trout; body wall has been pierced and part of digestive tract protrudes. Often only a perforation is made as in second wound, (arrow) through which lamprey sucks blood and body juices.

The growth pattern in Cayuga is characteristic of other Finger Lakes with alewives. Attainment of maturity is responsible for the sharp decrease in growth. Male lake trout commonly mature at five years of age, females at six. After maturity, food intake must also go into replacement of the reproductive products as well as general loss of weight that always attends the spawning season. This need has to be taken care of before there is much of a net increase in growth. An alewife diet is adequate to bring the older fish back into condition, but provides little margin for average population growth at current densities of both populations. Waters that typically produce large lake trout do so because of an abundance of larger food fish such as suckers, small whitefish or ciscoes. Apparently it is simply an example of getting more out of a meal consisting of a one pound sucker, for example, than having to worry a school of alewives to consume the nutritional equivalent in 40 or 50 individual small fish.

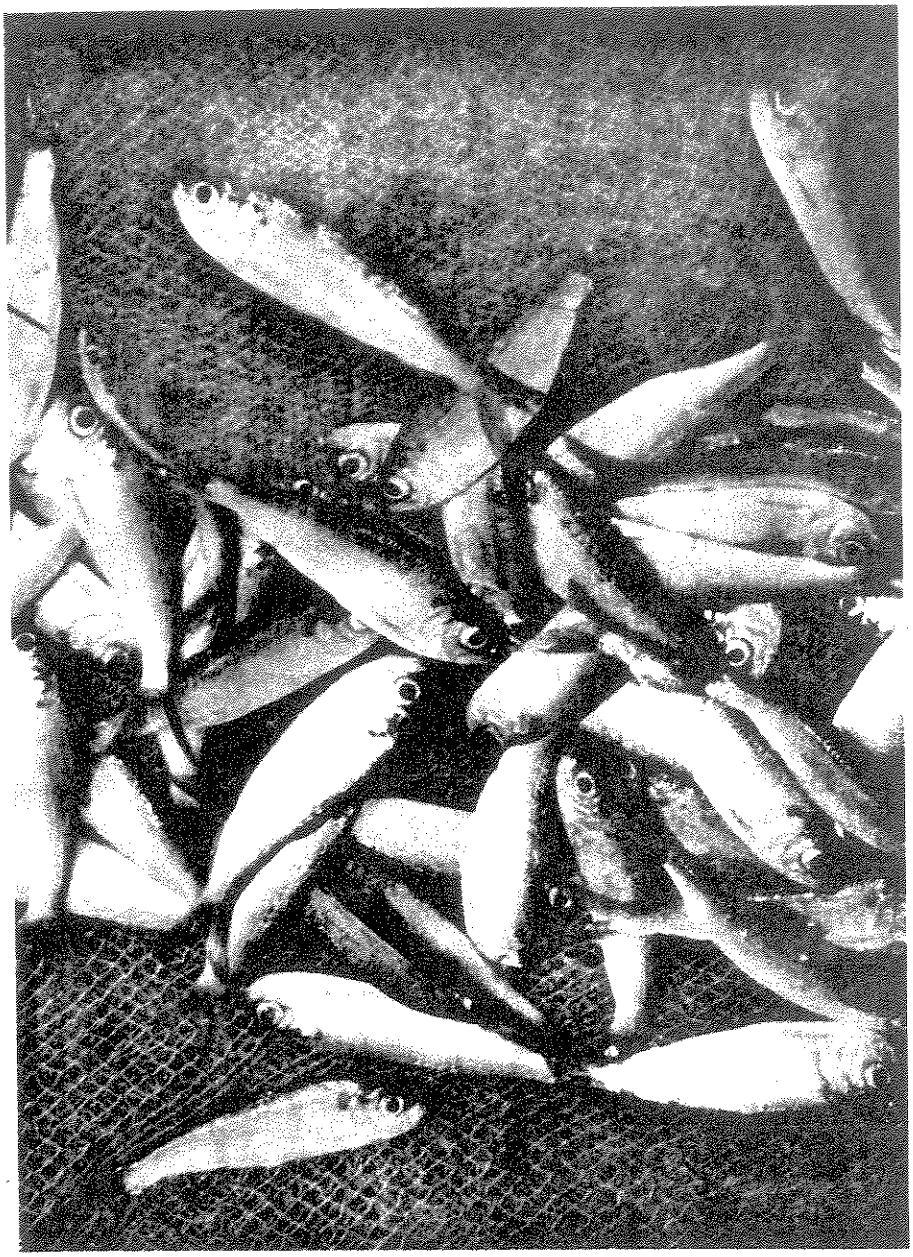
Note from the foregoing growth data that lake trout in Cayuga attain the minimum legal length of 15 inches at three or four years of age. Lake trout are slower growing in waters of the Adirondacks and often take twice this time to reach such a size.

Survival

The age and growth studies in Cayuga Lake are suitable for investigating certain aspects of vital statistics useful in fishery management. One of these is the answer to the question "What proportion of the fish live from one year to the next?" In a large body of water, evidence on this point must obviously be determined by indirect means.

Basically, the method consists of determining the numbers of fish of various ages in a representative sample of the population. On the average, as age increases, the numbers of individuals represented will decrease through the life span of the fish. This is because fishing and natural factors are removing fish from the population. In a simplified example, a sample might show 200 fish of age 3, 150 of age 4. The percentage survival between these two ages is 150 divided by 200, or 75 per cent. This process can be repeated throughout the range of ages in the sample and average survival obtained. In the 1,400 trout sample from Cayuga Lake this works out to 46 per cent for trout over four years of age. It follows that over an estimated 54 per cent (100-46) die off each year. One would hope that most of these deaths were due to fishing, but additional figures do not bear this out.

An estimate of percentage of trout taken by angling can be obtained from tags returned by Cayuga Lake anglers. There is a minimum return of 5 to 6 per cent of trout tagged the preceding season and it is probable that the angling catch does not account for over 10 per cent. This leaves an unaccountable deficit of about 45 per cent loss to natural causes—old age, disease, lamprey eels. Segregation of these various sources of natural



Alewives—No. 1 lake trout food

mortality would be of value but this is not possible from data now available. *The important point is that under present conditions, more fish are lost to these natural factors than are taken by angling.* This implies that more fish could be removed by angling without greatly decreasing the stock of trout or otherwise sacrificing the present quality of fishing by reducing the average size of trout taken. Angling would be removing a share of the fish that would die off each year anyhow.

Summary

The Cayuga Lake studies, extending over a 12-year period (1946-1957) have involved observing the results of planting more than a million hatchery reared lake trout. The results can be summarized as follows:

1. The hatchery fish now planted by the Conservation Department at the rate of 80,000 fingerlings and 8,000 yearlings per year show satisfactory survival and produce angling of high quality. Yearling trout (about 5 inches long) planted in April show four times the survival of fingerlings (3½ inches) planted in September. However, this superiority is not enough to offset the numerical advantage of fingerlings (about four times as many fingerlings can be reared for the same food costs and space requirements) and the related problems of carrying the fish in the hatchery for an additional six months.

2. Natural production of trout in Cayuga Lake is insignificant and presumably due to the poor quality of spawning areas. Taughannock Point, for example, has a heavy silt mantle on the bottom in the area selected by trout for spawning. All available evidence indicates inadequate spawning has been the rule for at least 75 years, perhaps much longer.

3. Growth is rapid up to age six and a size of about 25 inches; thereafter it diminishes rapidly due to the onset of maturity. Alewives are the important food of all but the smallest trout.

4. Owing to the growth rate and the high quality of fishing. Cayuga Lake anglers do not usually keep trout until they have reached a length of about 20 inches. The minimum legal length of 15 inches is thus non-restrictive in regulating the catch. At times of peak availability, many anglers take the 3-fish daily limit, hence this regulation does function to limit the total catch.

5. Under present conditions many more trout in the Cayuga Lake population appear to die of natural causes than are caught by angling.

Management Implications

There is no reason to believe that the present quality of fishing in Cayuga Lake cannot be maintained by hatchery plantings. Improvement of natural spawning areas does not seem practical for a lake of this size as long as there is little assurance that it would be permanent.

Lake trout in Cayuga are not harvested to capacity by angling. A general trend of increased fishing pressure may partly take care of this. However, additional opportunity for taking lake trout appears warranted. It is not reasonable to do this by increasing the daily limit beyond 3 fish (3 fish averaging over 3½ pounds is enough), but it is reasonable to provide increased fishing opportunities by extending the open season.

In Cayuga Lake there is no need for protection of an adequate breeding stock, hence fishing during the breeding season is not an important issue. However, changes in regulations on this body of water may also be applicable on other Finger Lakes even where natural spawning is of importance. Some states and Canadian provinces permit year 'round fishing for lake trout, apparently without unfavorable results. An extended season on the Finger Lakes should be evaluated during a trial period before final recomendations are made. But such a change seems to hold promise for additional fishing opportunity in central New York, particularly when considered with comparable recommendations for rainbow trout in these same waters (see CONSERVATIONIST, Aug.-Sept., 1957).