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ABSTRACT

Observations on spawning runs of rainbow smelt (*Osmerus mordax*) in Smith Bay Brook and Hague Brook, tributaries of Lake George, during April 1974 are presented. These are thought to have been the first for this lake. The spawning fish belonged predominantly to the 0+ age group. Implications of the presence of smelt in the ecosystem are discussed.

This report constitutes the first recorded account of spawning runs of the rainbow smelt (*Osmerus mordax*) in Lake George, New York. Prior to the runs, single male specimens were taken, on March 22, 1974 and April 1 and 18, 1974, in ½-inch-bar gill netting set at a depth of about 7 meters on the eastern shore of the north basin at Smith Bay. To the best of our knowledge, these were the first specimens of the species ever taken from Lake George. Because of the recognized (Van Oosten, 1937, 1947a, 1947b) ability of the species to expand rapidly and to influence other species when it newly enters a lake, these events are herewith being put on record for future reference.

OBSERVATIONS ON SPAWNING RUNS

The first observations of the spawning run began at 9:00 on the night of April 23-24, 1974 in Smith Bay Brook, the locale of the earlier gill netting. The stream has lower-course widths of 1 to 3 meters, average depths of about 25 centimeters and a bed of boulders, gravel, sand and silt. An underwater sealbeam light was used and appeared to have little influence on the activity of the fish. The sky was overcast, a fine rain was falling and the lake surface was generally calm. Water temperature was 7.5° C. in the brook and 7° C. at the surface of the lake.

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Most fish swam within 10 centimeters of the bottom, shifting from place to place while heading into the current. Typically, a total of 20 to 40 fish of two size groups were evident over about 15 square meters of bottom. Grouping was loose and irregular but with a clear upstream orientation maintained by periodic bursts of caudal sweeping. From time to time, smaller fish approached the flanks of a large individual from the rear, vibrating and touching the larger fish for several seconds. Close observation revealed small ejections of material by the larger fish during these encounters.

It was possible to reach into the water and grasp specimens and to discharge eggs from the larger individuals and milt from the smaller ones. When eggs were expressed under water they attached within a second or less to our hands. Collection of egg-bearing stones and observation under a dissecting microscope revealed the presence of thread-like attachment pedicels which had also entangled a number of sand grains. Study of eggs still present in the ovaries showed no such elaborations, corroborating observations by others that thread formation results from modification of an adhesive coating. When the milt was released it vanished into the water instantly, as if under the influence of a disperant, which explains why the milt was not seen during the spawning. The observed ratio of males to females was roughly four to one.

Observations on the night of April 25, 1974 revealed some 35 individuals spawning. Spawning activity continued on April 27 when 15 smelt were observed, two of which were large and thus probably females. About 30 smelt were again observed on April 29, the ratio of males to females being less than previously noted and about three to one.

In the course of various observations, other species were noted, i.e., several rainbow trout (*Salmo gairdneri*), numerous johnny darters (*Etheostoma nigrum*), several slimy sculpins (*Cottus cognatus*), several banded killfish (*Fundulus diaphanus*), a few yellow perch (*Perca flavescens*), a single cisco (*Coregonus artedii*) and several unidentified minnows.

Gull Bay Brook, about 2 kilometers north of Smith Bay, was also examined on April 25, but no smelt were seen. However, Warren Batchelder, an experienced fisherman, observed a single smelt in this brook on the evening of April 27, 1974.

Ernest Lantiegne and Bruce Shupp, fisheries biologists of the State Department of Environmental Conservation, collected, by means of an electroshocker, 82 specimens from the mouth of Hague Brook in mid-afternoon of April 25, 1974. During the same afternoon they examined other streams of the west shore (i.e., Cape Cod Brook, Northwest Bay Brook, Indian Brook and Alexander Brook) but found only four indi-

viduals in Alexander Brook, a small stream in the Hague area. Subsequently, the authors took four smelt while netting suckers in Hague Brook on the night of May 2, 1974.

The stomachs of specimens collected on April 23-24 were empty, the results being similar to other observations (e.g., Van Oosten, 1947b; Scott and Crossman, 1973). In general, the observations on spawning closely followed those of Langlois (1935) and Hoover (1936).

EXAMINATION OF SAMPLES

Collection by shore seine in the waters at the mouth of Smith Bay Brook produced 87 specimens, 13 of which were preserved without examination for later detailed taxonomic study. Of the 74 examined, 61 (82.4 per cent) were males. Females were larger, averaging 136.8 millimeters in total length and 16.9 grams in weight, while the males averaged 117.9 millimeters and 9.1 grams, respectively (Table 1). Age-group composition showed a preponderance of youthful spawners; of the 74 fish, 60 were age 0+, 12 were age 1+ and only one female was age 2+.

Comparison with the sample taken from Hague Brook (Table 2) further attests to the youthful nature of the spawning group. Although the

TABLE 1. MORPHOMETRY AND AGE COMPOSITION OF RAINBOW SMELT TAKEN AT MOUTH OF SMITH BAY BROOK ON APRIL 23-24, 1974

Sex	Number	Mean total length (millimeters)	Mean weight (grams)	Age (years)*		
				0+	1+	2+
Male	61	117.9	9.1	51	8	..
Female§	13	136.8	16.9	9	4	1
Total	74	121.2†	10.5†	60	12	1

* Total is one less than 74 because one scale set was lost.
§ Average ovary weight (2.95 grams) represented 15.8 per cent of total body weight.
† Weighted average.

TABLE 2. TOTAL LENGTH ACCORDING TO AGE FOR RAINBOW SMELT TAKEN AT MOUTH OF HAGUE BROOK ON APRIL 25, 1974*

Age 0+		Age 1+		Total	
Number	Mean total length (millimeters)	Number	Mean total length (millimeters)	Number	Mean total length (millimeters)
23	147.8	8	187.6	31	160.2
..	..	..	..	82§	146.9

* Sex was not determined.
§ Represents the total sample and includes the 31 shown above for which scale sets were collected.

mean size of the 82 fish measured was significantly greater than that of those from Smith Bay Brook, the divergent weights and times of appearance of the two sexes could easily explain this.

APPEARANCE OF FRY

On June 4, a submersible light was suspended from the dock of the Fresh Water Institute at Smith Bay and fry were collected. Identification was based on Fish (1932). Fry were again collected by night lighting off Burnt Point to the south of Smith Bay on June 19. Midwater trawling at various depths in and above the thermocline in mid-lake between the village of Hague on the west shore and the Fresh Water Institute on the east shore yielded fry on the night of July 5. The only other small fish taken were yellow perch.

ESTABLISHMENT OF THE POPULATION

The events surrounding the establishment of this population remain obscure. The first reported stockings of smelt in Lake George were in 1918 (2,854,000) and 1929 (5,000,000) and consisted of fry taken from a small stream emptying into Cold Spring Harbor on Long Island (Moore, 1930). To the best of our knowledge, these two stocking efforts failed to establish the species in the lake.

A third introduction may have been made in 1941. Evidence for this exists in the form of a letter, dated November 19, 1941, from C. H. Wilson, chairman of the Executive Committee of the Warren County Fish and Game Association, to Harry H. Reoux, the local asssmblyman, in which was discussed the proposed planting of several million smelt eggs in streams near Bolton Landing and about 11 million more in the vicinity of Lake George Village, extending up to and including Indian Brook (file document of State Department of Environmental Conservation). The existence of smaller and larger varieties of smelt is mentioned and, following the advice of Emmeline Moore, the Department's chief aquatic biologist, it was agreed that the smaller was to be stocked in Lake George. The success of this introduction, if indeed it actually took place, also seems unlikely because no collections or verified observations of smelt were made until those reported here.

It thus seems probable that the extant population is the result of quite recent, unauthorized stocking. The run in Smith Bay Brook seemed to be either one or two years old at the most. The stream had been thoroughly checked at night in previous years, exclusive of 1973, for rainbow trout, and it seems highly probable that smelt would have been seen if they were present. Similarly, personnel of the State Department of Environmental Conservation had routinely collected in the mouth of Hague Brook during the latter part of April for many years and had not

taken smelt until 1974. It is possible that, as is the case in nearby Lake Champlain[4], spawning had taken place in the lake proper and not in the streams and that the population was only beginning to develop the stream-spawning habit. In this case, smelt may have been in the lake for quite some time, but the absence of specimens in the stomachs of lake trout, salmon, pike and bass, the absence of the species in the catch of the ice fishery and the lack of the occasional floating dead specimen strongly suggest that the smelt is a newcomer to the lake.

ECOSYSTEMETIC IMPLICATIONS

The implications of the emergent smelt population as related to other species are complex and of potentially great import. Stomach analyses of smelt from Lake Champlain (Greene, 1930) revealed a diet consisting of smelt, other fish, insect larvae, plankton, opossum shrimp (*Mysis relicta*) and other material. Trout were never observed. Other earlier authors (Creaser, 1925, 1927; Van Oosten, 1947a, 1947b; Lackey, 1969; Schneberger 1937) corroborate the observation that trout fry are not a primary food of smelt. In the Great Lakes, the opossum shrimp is a prominent food (Schneberger, 1937). Amphipods, ostracods, aquatic insect larvae and aquatic worms are also taken, reflecting the use of benthic invertebrates. Fish, including sculpins of the genus *Cottus*, small smelt, small burbot, white bass, whitefish and emerald shiners, also enter the diet and constituted 6 to 10 per cent of the food volume in the material examined by Scott and Crossman (1973). But, regardless of the absence of firm evidence of trout predation by smelt, one must be cautious in assuming that the smelt has no role in the mortality of young lake trout because ice and poor weather conditions make sampling awkward during the late winter when lake trout fry leave the spawning areas.

Efforts to procure specimens of smelt from the main body of Lake George for stomach examination were largely unsuccessful. Three specimens taken by gill netting from a depth of about 20 meters at Cotton Point on July 9, 1974 were examined. One was empty. The other two each contained several opossum shrimp. The stomachs of the three smelt taken from the lake in March and April of 1974 also contained opossum shrimp. A competitive relationship with the cisco, smaller lake trout and yellow perch is thus suggested.

In spite of the fact that all evidence points to little significant predation on lake trout fry by smelt, it has been frequently observed by fishery biologists (e.g., Kendall, 1927) that the emergence of a smelt population often results in the serious decline of other species, including the

[4] It may be noted that, although the outlet of Lake George flows into Lake Champlain, it has an impassable falls barrier.

highly esteemed lake trout. A notable study of the phenomenon related the decline of the cisco (lake herring) to the dramatic increase (or decline) of the smelt in western Lake Superior (Anderson and Smith, 1971). The cisco had shown great stability as the primary commercial species in Lake Superior from 1908 until the mid-1950's when the populations in the vicinity of Duluth collapsed. Catch per unit of effort fell from 556 pounds per 1,000 linear feet in 1953 to 14 pounds in 1966. Prior to 1952 the commercial landings of smelt in western Lake Superior were insignificant, but thereafter catches grew to a level of 1,045,000 pounds in 1964 for the extreme western end of the lake (District M-1) and 619,000 pounds in 1963 for the Wisconsin fishery. The correlation of cisco and smelt abundance in 1951 and 1966, adjusted two years earlier for the Duluth area (District M-1), was highly significant, i.e., $r = -0.674$ ($P = 0.01$).

Another form of evidence exists in the recovery of other fish stocks following the decline of smelt populations. The smelt population declined dramatically in Green Bay on Lake Michigan in 1942-43 (Van Oosten, 1947a, 1947b), and during the following spring phenomenal year classes of cisco, lake whitefish and walleye were produced (Hile et al., 1953). Competition and fry predation by smelt when they are at a high level of abundance emerge as possible reasons for the decline of associated fish species.

Application of such studies to Lake George is tenuous at best. The greater average total length of ciscos being taken at the time of this study compared with that of those routinely taken 20 years earlier, along with the nearly total absence of ciscos less than 8 to 9 inches long in the stomachs of lake trout, provide good evidence that cisco reproduction in Lake George was failing at that time. But this seems to be a long-term phenomenon, while the population structure (as indicated by the data in Tables 1 and 2) of the newly found smelt and the absence of earlier observations on its presence suggest the smelt to be a new influence.

That smelt may serve as forage for lake trout is well recognized with respect to Lake Champain and Cayuga Lake. Furthermore, there is some evidence, from Cayuga Lake at least, that cisco and smelt can coexist for prolonged periods of time (A. Eipper, personal communication).

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