FALL MOVEMENTS OF BROWN TROUT IN LAKE ONTARIO AND A TRIBUTARY

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ABSTRACT

Movements of radio-tagged brown trout during pre-spawning, spawning and post-spawning periods were studied in Lake Ontario and Sandy Creek in Monroe County (N.Y.) from September through November in 1980. Most of the tagged trout moved eastward in the lake after leaving Sandy Creek, but most of them eventually returned westward. Several made extensive east-west movements in Lake Ontario, but none ascended Sandy Creek farther than 2 kilometers. Until mid-October, most of the radio-tagged brown trout remained offshore in deep water during the day and moved inshore to shallow water at night. Water temperatures with temperature-sensing transmitters were located generally corresponded to surface temperatures in shallow areas and averaged 11.5°C, well within the 10°C-15°C preference range of the species. However, as surface-water temperatures declined in late autumn, brown trout moved to deeper water where the temperature, although averaging 4°C, was warmer than that at the surface. During storms, the trout generally moved offshore to deeper waters or may have left the study area.

The recent introduction of Pacific salmon and the reintroduction of trouts and charrs (Parsons, 1973) have generated remarkable interest among anglers, recreational businesses and fisheries biologists throughout the Great Lakes region. Beginning in 1968, Lake Ontario has been stocked with chinook salmon (Oncorhynchus tshawytscha), coho salmon (O. kisutch), rainbow trout (Salmo gairdneri), brown trout (S. trutta) and lake trout (Salvelinus namaycush) as reported by the St. Lawrence-Eastern Ontario Commission (1978). Stocked salmonids are providing recreation and economic benefits in upstate New York (Brown, 1976; Panek, 1981), and an understanding of their ecology is important to maintaining a healthy fishery.

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Large numbers of brown trout are stocked annually in Lake Ontario by the State Department of Environmental Conservation (LeTendre, 1980), and it is currently the salmonid species caught in the greatest numbers by anglers (Panek, 1981). While there is some evidence for anadromous spawning populations of brown trout in Canadian tributaries of Lake Ontario (R. Desjardine, Ontario Ministry of Natural Resources, personal communication), such spawning in south-shore (U.S.) tributaries is nil (Abraham, 1980). Establishment of natural salmonid reproduction in at least some of the south-shore tributaries would be a great aid to fishery management. Therefore, the authors examined the movements (and associated environmental factors) of brown trout during the pre-spawning, spawning and post-spawning periods in Lake Ontario and Sandy Creek, a major tributary (Figure 1) in Monroe County (N.Y.), during the fall of 1980. Large numbers of brown trout are stocked annually in the vicinity of Hamlin Beach State Park, 5 kilometers west of Sandy Creek.

The region of Lake Ontario studied is typical of the western basin as described by Jenkins (1980) and is characterized by sharp increases in depth offshore, relatively little substrate structure and considerable private home development, mixed with wetlands, along shore. Although larger than other local tributaries, Sandy Creek is typical with shallow waters, summer temperatures above the optima for salmonids and considerable residential/agricultural development along its banks.

METHODS AND MATERIALS

Eight brown trout weighing from 2.3 to 5.1 kilograms were captured between September 19 and November 8 in the lower reaches of Sandy Creek, using a pontoon boat equipped with electroshocking booms and a DC generator. Using an MS-222/Quinaldine mixture, the fish were anesthetized on board in an aerated tank. Each was measured and weighed and its sex was determined from external characters. A numbered Floyd anchor tag and an externally mounted, side-saddle, temperature-sensing radiotransmitter (Haynes, 1978; Ross et al., 1979) were attached to each trout. The transmitters, encased in epoxy, were cylindrical (1.8 × 8 centimeters) and weighed about 30 grams in water. They were attached by three wires inserted under the dorsal fin and were tied against padded plastic plates (Figure 2). After being tagged the trout were placed in an aerated recovery tank and were released after righting themselves and swimming actively.

The electronic equipment used was designed and built at the Cedar Creek Bioelectronics Laboratory of the University of Minnesota. Receivers operated at 53 MHz and transmitters were separately identifiable. Fish were tracked by boat equipped with a directional Yagi antenna, along shore with a truck on which a Yagi antenna was mounted and on foot along Sandy Creek with a hand-held loop antenna. The methods followed
those described by Winter et al. (1978). Tracking in Lake Ontario was limited to the nearshore area from Point Breeze eastward to the Genesee River, while that in Sandy Creek was done primarily below the Route 19 bridge (Figure 1).

RESULTS AND DISCUSSION

Until mid-October, brown trout moved offshore to deep water during the day and inshore to shallow water at night. This pattern, repeatedly displayed by the radio-tagged fish (and other salmonid species incidentally encountered during electroshocking), was so definite that all capture and most tracking activities were conducted between sunset and sunrise in September and October. The six brown trout that were radio-tagged prior to November left Sandy Creek for Lake Ontario before or during the first
sunrise after tagging. One fish remained motionless in Sandy Creek for 7 hours after being tagged, and then moved quickly out of range into the lake as the sun rose. The two fish that were tagged in November were both gravid and remained in Sandy Creek for 1 and 3 days, respectively. They probably spawned less than 2 kilometers upstream and then moved to Lake Ontario.

Day/night and offshore/inshore movement patterns were also observed for ultrasonically tracked brown trout in Airthrey Loch in Scotland (Young et al., 1972). The same study revealed peak activity periods at dawn and dusk. These peaks were later found to coincide with maximum feeding activity among brown trout (Oswald, 1978).

To depict movements of individual fish, a diagram of the study area was prepared showing key locations and their relative distances apart. The positions recorded for each of the tagged brown trout were plotted on this base map in sequence of occurrence (Figures 3 to 10). The date and time of occurrence for each position are also shown. Vertical distances of the tracking lines from the shoreline, as represented on these maps, are not indicative of the actual distance a fish was from the lake shore. During the study, fish from which radio signals could be detected were generally less than 2 kilometers offshore.

After leaving Sandy Creek, six of the eight radio-tagged brown trout moved eastward. Fish 293 (Figure 3) showed the simplest pattern of eastward movement. Five of these six fish returned west. Fish 325 (Figure 4) and Fish 343 (Figure 5) showed the simplest pattern of westward return, although the transmitter from Fish 343 was ultimately recovered in the fall of 1981 at a stream mouth 65 kilometers east of Sandy Creek. The authors believe that the initial predominance of eastward movement was related to the easterly flowing shore currents in this region of Lake Ontario as described by Jenkins (1980). However, two, Fish 175 (Figure 6) and Fish 214-B (Figure 7), initially moved west after leaving Sandy Creek.

Three brown trout, tagged early in the study, made repeated movements between Hamlin Beach State Park and Braddock Bay, up to 22 kilometers per day. Fish 275 (Figure 8) displayed the simplest pattern. Fish 214-A (Figure 9) returned to the mouth of Sandy Creek before being caught in mid-October by an angler at Hamlin Beach State Park, but the authors do not believe it spawned in Sandy Creek. Fish 113 showed the greatest variety of movements (Figure 10). Not only did this trout provide the greatest number of observations over the longest period of time, but it also moved the farthest west and farthest east, made the greatest number of east-west reversals and spent considerable time off Hamlin Beach State Park. It returned to Sandy Creek in late October where it was snagged and released twice by anglers and then either died or lost its transmitter.

After late October, the trout moved offshore to deeper water and became increasingly difficult to find due to attenuation of radio signals as
293 Female
5.1 kg
67.3 cm

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Legend:
- Captured, tagged, released
- Day to day movement
- 1 to 3 day loss of contact
- > 3 day loss of contact
- 1 Kilometer

Figure 3. Recorded movements of Fish 293.
323 Female
2.5 kg
57.2 cm

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- 1 to 3 day loss of contact
- > 3 day loss of contact
- 1 Kilometer

Figure 4. Recorded movements of Fish 323.
**343 Female**
2.3 kg
52.1 cm

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**Legend**
- ▲ Captured, tagged, released
- --- Day to day movement
- ---- 1 to 3 day loss of contact
- ------ > 3 day loss of contact
- ---- 1 Kilometer

Figure 5. Recorded movements of Fish 343.
175 Male
3.2 kg
61.0 cm

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△ Captured, tagged, released
--- Day to day movement
--- 1 to 3 day loss of contact
--- > 3 day loss of contact

Figure 6. Recorded movements of Fish 175.
214 (B) Female
3.6 kg
61.0 cm

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- Captured, tagged, released
- Day to day movement
- 1 to 3 day loss of contact
- > 3 day loss of contact
- 1 Kilometer

Figure 7. Recorded movements of Fish 214(B).
275 Female
3.0 kg
53.3 cm

Legend

- Captured, tagged, released
- Day to day movement
- 1 to 3 day loss of contact
- > 3 day loss of contact
- 1 Kilometer

Bald Eagle Harbor
Devil's Nose
Area 1 Water Plant
Hamlin Beach State Park
Rt. 19 Bridge
Parkway Bridge
Walker Road
Wautoma Shoals
Bogus Point
W E Braddock Bay Long Pond

Sighting Date Time
(1) 10/8 1800
(2) 10/9 1800
(3) 10/10 1730
(4) 10/10 1930
(5) 10/13 0800
(6) 10/13 1000
(7) 10/24 1700

Figure 8. Recorded movements of Fish 275.
214 (A) Male
3.2 kg
59.2 cm

Figure 9. Recorded movements of Fish 214(A).
Figure 10. Recorded movements of Fish 113.
suggests that brown trout largely failed to use the several miles of stream above this bridge that were suitable for salmonid spawning. Braddock Bay was also important to the tagged fish. Apparently the substrate structure near the bay or the outflow of Salmon Creek was attractive to brown trout.

The total distance travelled (Figure 11) by the tagged fish ranged from 9 to 163 kilometers. However, these distances represent minima, as they are merely the sum of the distances between recorded locations shown in Figures 5 to 10. Except for two fish, the total distance travelled by an individual trout was directly proportional to the length of time it was tracked. The importance of the total distance travelled is that it shows that brown trout move substantial distances along the shore in autumn.

Average distances moved by fish on occasions when they were tracked on successive days ranged from 2 to 17 kilometers (Figure 12). The average distance moved per day is probably more useful in evaluating brown trout behavior and suggests frequent substantial daily movements by individual fish. However, sample sizes for this duration were small.

Several environmental variables may affect brown trout movements. A chi-square analysis showed that fish were located significantly (P < 0.05) more often on days when rainfall was less than 2.5 millimeters, despite a roughly equal tracking effort under rainy vs. non-rainy conditions. A severe wind and rain storm that dropped 2.5 centimeters of rain on Oc-
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October 25 affected our ability to locate fish. Two trout (Fish 175 and 275) that had been located on October 24 were never found again. Several others were not found again until several days after the storm. It seems probable that brown trout either dispersed to deeper waters during and after the storm or moved beyond the study area.

The temperature-sensing transmitters provided water temperatures within ±0.2° C. where fish were located (Ross et al., 1979). In the present study, temperatures at the points where the tagged trout were located were compared with temperatures recorded at the intake pipe (1 kilometer offshore and 8 meters deep) of the Brockport Water Treatment Plant (Figure 1) and with surface temperatures recorded by the tracking crews. Sign tests (Snedecor and Cochran, 1972) revealed that in September and early October brown trout significantly more often inhabited water warmer than that at the treatment plant intake, while in late October and early November the reverse was true ($P < 0.01$). In both cases this meant that brown trout occupied areas near shore, as surface waters there were warmer than those at the intake in September and early October and colder after that. By late November, the tagged fish were inhabiting deeper, 4° C. waters which were warmer than the surface waters.
The findings of this study and others (c.f., Abraham, 1979) indicate that brown trout occupy inshore areas of Lake Ontario during spring and autumn when water temperatures do not exceed the thermal tolerance of the species. In summer, well before water temperatures exceed this level (approximately 26°C.), they retreat to deeper (cooler) water offshore. Abraham (1979) showed that brown trout in Lake Ontario had a close association with the bottom and occupied a temperature range of 10° to 15°C. during the summer. Reynolds and Casterlin (1979) found that brown trout under laboratory conditions preferred a temperature range of 10.5° to 13.7°C. In the present study, brown trout were recorded in waters ranging from 3.6°C (November) to 18.4°C (September), with a daily mean of 11.5 ± 3.9°C. Thus, optimum temperatures for brown trout in Lake Ontario lie in the 10° to 15°C. range, and fish can be expected to occupy such areas if forage, light and other conditions are suitable.

Of importance to fishery management is the presence of all salmonid species near shore at night in the fall. Brown trout, rainbow trout, lake trout and Pacific salmon are within casting distance from shore after dark and should be accessible to anglers, especially in September and October before feeding slows or terminates with the onset of physiological changes associated with spawning. Also, the data indicate that few brown trout ascend south-shore tributaries of Lake Ontario far enough to spawn in suitable areas. It appears that stocking must remain the major source of brown trout for this part of Lake Ontario.

LITERATURE CITED


