Evaluation of Offshore Stocking to Mitigate Piscivore Predation on Newly Stocked Lake Trout in Lake Ontario

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In Lake Ontario, returns of stocked lake trout at ages 2 and 3 to annual NYSDEC and USGS assessment surveys declined sharply in the 1990's relative to levels measured in the 1980's (Lantry et al. 2006). These declines are believed due, in part, to increased predation on newly stocked fish by large salmonids (Elrod et al. 1995). Large trout and salmon congregate near shore in springtime as the relatively shallow water there warms at a much quicker rate than the deeper water in the open lake. Prior to the 1990's, vast schools of alewives moved shoreward in spring (O'Gorman et al. 1987) when hatchery fish were being stocked along the shoreline. Suitable nearshore temperatures for lake trout stocking coincided with shoreward migrations of alewives, effectively buffering newly stocked fish from large salmonid predators.

Since the early 1990's, sharp declines in alewife abundance have been observed (O'Gorman et al. 2006). These declines in abundance followed 20 years of declines in nutrient loading, establishment of vigorous populations of stocked salmon and trout, and colonization of Lake Ontario by dreissenid mussels. As lake productivity declined water clarity increased. The increase in water clarity was exacerbated by the dreissenid mussels and was linked to a shift in springtime distribution of alewives into deeper water (O'Gorman et al. 2000; O'Gorman et al. 2006). The coupled effect of decreased numbers of alewives and their deeper distribution in spring is believed to have resulted in increased predation on newly stocked lake trout.

The objective of this study was to evaluate the relationship between location (offshore vs. onshore) and timing (May vs. June) of stocking to the recruitment of stocked lake trout to the adult population in Lake Ontario. Relatively simple changes in stocking practices such as those examined in this study may provide cost-effective alternatives to enhance survival of stocked fish. At the very least, this study may indicate that the suspected predation-induced mortality of newly stocked lake trout in Lake Ontario is not the cause of recruitment declines and direct management attention to other factors.

Methods

In the fall of 1999 to 2001, young-of-the-year Seneca strain lake trout raised at the Allegheny National Fish Hatchery, Warren, Pennsylvania, were marked by implanting coded wire

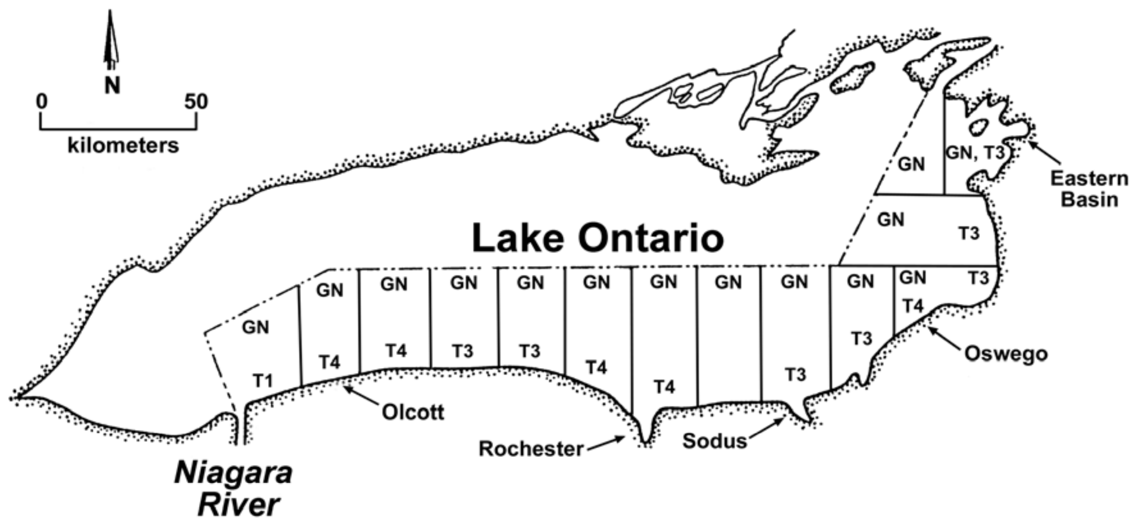

Figure 1. Map of Lake Ontario showing annual USGS and NYSDEC survey grids. All fish used in the stocking study were stocked near Olcott and Sodus. GN indicates that the grid is sampled in September with gill nets (Lantry et al. 2006). T# indicates this grid is sampled with bottom trawls with the numbers representing the number of times this location is surveyed between April and October (O'Gorman et al. 2006).

tags (Northwest Marine Technology, Inc.) in their snouts. Each lot of 40,000 tags decodes to a specific 6 digit number facilitating identification of raceway origin of the lot in the hatchery, strain, age, and stocking time and location. Each year from 2000 through 2002, six separate groups of 40,000 lake trout received tags with codes unique to that lot (total = 240,000 tagged trout per year). Each tagged lake trout also received an adipose fin clip to facilitate identification. Stockings took place at 2 sites, one in western Lake Ontario at Olcott and the other in eastern Lake Ontario near Sodus (Figure 1). At each site one lot each was stocked along shore in May and again in June. Because water temperatures at the hatchery approach the upper limit for lake trout (13C or 55.4F) in early June, stocking could not be delayed past the first week of the month. In May only, using a military style landing craft, one lot at each site was transported offshore about 1.6 km (1 mile) and stocked over water at least 55 m (180.4 ft) deep. Treatment tests were onshore vs. offshore stocking in May, and onshore in May vs. onshore stocking in June. Also, the effects of stocking site and year will be tested for each of the 3 treatment types. Biologists were present at each stocking to monitor the relative condition of stocked fish, record water temperatures, depth, and specific location of stocking sites, and collect initial samples of fish. A sample of 100 fish was taken from each experimental lot immediately prior to stocking. These fish were measured for length and weight, and checked for tag presence. These initial data facilitated evaluation of growth and provided an avenue to determine the existence of any size-related differential survival between lots. Blood was also drawn from each fish sampled using heparinized microcapillary tubes for later hematocrit analysis. These data were used to determine packed cell volumes PCVs) which reflect the concentration of red blood cells in the blood. The PCVs were used as an index of the physiological condition of each lot of fish at stocking.

Collections of lake trout for evaluations are being accomplished with targeted surveys using bottom trawls to catch age-1 to age-2 juveniles in late July - early August and using gill nets to catch lake trout age 3 and older in late August -

early September (Lantry et. al. 2006). Further collections will also be made from an annual April - September fishing boat creel census (Eckert 2006) and three bottom trawl surveys that do not target lake trout, but produce lake trout by-catch (O'Gorman et al. 2006). These include: a late April - early May survey targeting alewife; an early June survey targeting rainbow smelt; and a mid-October survey targeting slimy sculpins. In all surveys, except the one targeting sculpins, we fish from 12 to 14 locations spread out along the entire U.S. shoreline including locations near the experimental stocking sites. The sculpin survey does not have sampling locations in the eastern basin of Lake Ontario, but does fish six locations distributed along much of the rest of the U.S. shore and includes locations near both stocking sites. The first opportunity to recapture fish from experimental stockings in 2000 was the bottom trawl survey targeting rainbow smelt in June 2000. Because coded wire tags are retained for the life of the fish, evaluations will be revisited annually until tagged lake trout disappear from survey catches.

Samples of age-1 and age-2 lake trout from experimental stockings and all surveys were also retained for dry weight determination. By measuring the wet and dry weights of these fish an index of energy content {%dry weight = (dry wt. / wet wt.)*100} will be calculated to track body condition.

Results and Discussion

Tagging and Stocking 2000 to 2002

By April of each year from 2000 to 2002, six experimental lots of 40,000 age-1 Seneca strain lake trout (240,000 total) from the 1999 to 2001 year-classes were marked with coded wire tags and adipose fin clips. Because of high water temperatures at the hatchery, furnunculosis killed substantial portions of six experimental lots stocked in 2000.

2000 - All experimental lots were short of the full allotment of 40,000 Seneca strain, yearling lake trout. At Olcott, stockings proceeded without incident with 25,300 fish released offshore on May 23, 38,400 fish released onshore on May 23, and 37,000 fish released onshore on June 6. At Sodus on May 19, wind conditions worsened progressively after daybreak and at stocking time waves were approximately 2.5 m (about 8 ft) high. Because of the high waves all fish were stocked onshore between the channel piers including 25,300 fish that were scheduled for offshore release and 20,600 fish that were scheduled for onshore release. On June 7, 26,600 fish were stocked from shore at Sodus. Fish ranged in length from about 114 to 253 mm (4.5 to 10.0 in) and all fish appeared healthy. Adipose fin clip quality and tag retention were excellent.

2001- All experimental lots stocked contained 40,000 Seneca strain, yearling lake trout. All Olcott stockings on May 22 and June 7 and the Sodus offshore stockings on May 18 proceeded without incident. Later in the day on May 18, as the first of 2 truck loads of lake trout were being stocked at the Sodus shore site, wind speed and direction became unsuitable for shore stocking. Hence, the second truck load of lake trout, about half of the fish scheduled for the shore stocking, had to be diverted to an alternate site 16 km (9.9 mi) west of Sodus where they were released without further incident. Conditions were again poor at Sodus for the June 5 shore stocking and again the fish were diverted to the alternate release site. Fish ranged in length from about 120 to 220 mm (4.7 to 8.7 in) and appeared healthy. Adipose fin clip quality and tag retention were excellent.

2002 - All experimental lots stocked contained 40,000 Seneca strain, yearling lake trout and all Olcott stockings proceeded without incident on May 21 and June 6. Similar to the 2001 stockings, wind direction and wave height necessitated shifting the May shore stockings at Sodus to the alternate location 16 km west. The June shore stockings for Sodus proceeded without incident. Fish ranged in length from about 104 to 220 mm (4.1 to 8.7 in), appeared healthy, and fin clip quality and tag retention were excellent.

For lake trout sampled at stocking in all three years (2000 - 2002), hematocrit analysis indicated that packed cell volumes (PCVs) were above values reported for lake trout in the literature (Krise et al. 1994; Edsall and Swink 2001). It is unclear why PCVs were consistently high, although increased values were likely related to stress from handling and transport (Barton et al. 1985; Benfey and Biron 2000). The PCVs from fish sampled at the hatchery were similar to previously published values. However, PCVs sampled from all stockings were greater than those sampled from fish at the hatchery. Additionally, PCVs were greater for fish sampled from stockings at Sodus, the site farthest from the hatchery, than those from the Olcott site.

Assessment of Post-stocking Performance

All catches of lake trout from the 1999 year-class, stocked in 2000, were adjusted for stocking shortfalls to reflect the expected catch from a 40,000 fish experimental lot. Data for the 2000 stocking of the 1999 year class at Sodus were not used in the analysis because weather that day forced an onshore release of all fish scheduled for barge stocking. To date, a total of 410 age-1 to age-5 lake trout from the 2000 to 2002 experimental stockings have been identified from survey catches. Adjusted returns from the Olcott site outnumbered those captured from Sodus 380 to 59. Of the 410 fish examined to date, data from 398 of those are presented in this analysis.

Examination of the data between years for age-2 catches of lake trout stocked off Olcott indicated similar trends for returns from the three stocking methods for the 1999 and 2000 year classes (Table 1). Catch rates of age-2 barge-stocked fish outnumbered those from May or June shore stockings by about 2-fold for the 1999 year class and by about 4-fold for the 2000 year class. Stocking method, however had no effect on catch rates at age 2 for the 2001 year class.

Early results indicated offshore stocking substantially enhanced catch rates of age-1 stocked lake trout in Lake Ontario. Of fish stocked at Olcott, total catches for all years of age-1 lake trout stocked offshore had an 8.3 : 2.2 : 1.0 advantage over fish stocked from shore in May and June, respectively (Table 2). Those proportions changed with age and by age-4 were 2.5 : 1.3 : 1.0. These results suggest that stocking method affects distribution as well as survival of lake trout in their first year in Lake Ontario. The proportionally lower catches from offshore stockings for fish age-2 and older indicated that the depths fished in the three bottom trawl surveys probably bias the catch of age-1 lake trout toward offshore stocked fish.

The combined age-2 through age-6 returns for the Olcott site favor offshore stocking over stocking from shore in either May or June by a 1.8 : 1.0 : 1.1 margin (n = 94.8, 51.9 and 56 respectively). Although these catches of experimental fish indicate an advantage for offshore stocking, returns at age 2 and older are as yet too small to tell with certainty. The advantage of barge stocking observed for age-2 and age-4 fish disappears for older ages with no clear advantage for any treatment by age-5.

The 6.4-fold higher catches of fish stocked at Olcott (west of Rochester) versus those stocked near Sodus (east of Rochester) further corroborates trends from our lake trout population analyses. Both trawl surveys aimed at lake trout ≤ age 2 and gill net surveys aimed at older fish indicate survivorship and recruitment of stocked lake trout is greater for fish released west of Rochester than for fish released east of Rochester (Lantry et al. 2006).

Although monthly samples available for dry weight determination were small, variability in percentage dry weight (% dry wt. = dry wt. / wet wt.) was small enough that trends were not obscured. For lake trout collected from 2000 to 2003, percentage dry weight varied with fish length and capture date. General trends indicated that during their first year in the lake, larger fish had greater energy content (normal for fish) and energy content declined from May through July and thereafter remained relatively constant into October. Declining energy content for stocked lake trout during their first summer in Lake Ontario is possibly indicative of: artificially high energy content coming out of the hatchery environment; poor ability to feed in the lake environment; or prey limitation. An additional possibility may be that the cold temperatures experienced near the lake bottom (often substantially less than hatchery temperatures) hamper the ability of young stocked fish to feed and grow in their first year in the lake.

Table 1. The annual catch of age-2 lake trout per 40,000 stocked for each of three year classes marked with coded wire tags and stocked by three different methods in Lake Ontario at Olcott, New York.

Year Class	Stocking Method		
	May Offshore	May Shore	June Shore
		Olcott	
1999	17.4	8.3	7.6
2000	24.0	6.0	8.0
2001	7.0	8.0	8.0
2002	48.4	22.3	23.6

Table 2. Recaptures per 40,000 stocked of the 1999 to 2001 year classes of coded wire tagged lake trout stocked in Lake Ontario by three different methods at Olcott and Sodus, New York. The stockings of the 1999 year class at Sodus were omitted from the compilation because all of these fish were shore-stocked. There are three year-classes represented in the catch of age-1 to 4 fish, two for age-5 fish and one for age-6 fish.

Stocking Method	Recaptures per 40,000 stocked						Ages 2 to 6 Totals
	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	
			Olcott				
May Offshore	127.2	48.4	10.2	23.9	10.7	1.6	94.8
May Shore	34.4	22.3	3.0	11.1	11.3	4.2	51.9
June Shore	15.3	23.6	14.8	6.3	11.3		56.0
Total	176.9	94.3	28.0	41.4	33.3	5.7	202.7
			Sodus				
May Offshore	9.0	6.0	2.0	8.0	3.0	0.0	19.0
May Shore	1.0	3.0	5.0	1.0	1.0	0.0	10.0
June Shore	2.0	1.0	1.0	2.0	2.0	0.0	6.0
Total	12.0	10.0	8.0	11.0	6.0	0.0	35.0

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