Status of Rainbow Smelt in the U.S. Waters of Lake Ontario, 2005

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Abstract

We began a re-analysis of our rainbow smelt Osmerus mordax *bottom trawl assessments, conducted annually since 1978. Based on analyses of side-by-side comparison tows conducted in 1980 and 1985-1989, we did not detect a difference in rainbow smelt catches between the R/V* Kaho *and the fiberglass- or steel-hulled R/V* Seth Green. *Preliminary results also indicate no difference in rainbow smelt catches between the 12-m (39 ft, headrope) Yankee trawl and the 18-m (59 ft, headrope) 3-in-1 bottom trawl, but we are still evaluating changes in gear effectiveness with depth. Abundance indices for age-1 and older rainbow smelt in 2005 were lower than those recorded in 2004, and were generally similar to indices recorded in 2001 and 2002. An unusually large catch of yearling rainbow smelt in 2004 (2003 year class) followed by a relatively small catch of age-1 fish in 2005 (2004 year class) appears to signal a resumption of the alternating pattern in year class strength that had been intact during 1984-2000. Larger and older rainbow smelt remain scarce in Lake Ontario, but the population has demonstrated considerable resiliency by rebounding from an extremely low level of spawner abundance in 2003, which suggests that a prolonged population collapse is unlikely.*

Progress on Review of Survey Design and Analysis

Indices of rainbow smelt *Osmerus mordax* abundance are stratified, weighted mean catch-per-tow. Eleven of the twelve transects sampled on the alewife assessment are sampled on the rainbow smelt assessment (only Fair Haven is not sampled, see Figure 1 in the Introduction). Whereas the sampling frame for alewife extends from shore to the 160-m (525 ft) bottom contour in U.S. waters, the sampling frame for rainbow smelt extends from shore to the 140-m (459 ft) bottom contour in U.S. waters because historically few smelt were found at depths >140 m (459 ft). The rainbow smelt sampling frame was divided into six strata by depth and geographic area where catches were homogenous.

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Beginning in 2000, we modified our stratification scheme for calculating rainbow smelt abundance indices and re-allocated sampling effort to account for the shift in distribution of smelt to deeper water (O'Gorman et al. 2000). During 1978-1999, because catches made at depths ≥70 m (230 ft) were uniformly low, the area between the 70-m (230 ft) and 140-m (459 ft) bottom contours was considered one stratum and few trawl tows were made there. After the distribution shift, however, catches at depths ≥70 m (230 ft) were neither low nor homogenous. Therefore, sampling effort at depths ≥70 m (230 ft) was increased and the single ≥70-m (230 ft) stratum was divided into three strata (60 to 79 m [197 to 259 ft], 80 to 99 m [262 to 325 ft], and 100 to 139 m [328 to 456 ft]) in which catches were homogenous.

An independent peer review of the USGS-NYSDEC bottom trawling assessments of prey fishes (primarily alewife) conducted in fall 2003 found that the assessments provided reliable indices of trends in relative abundance and suggested a number of strategies for improving assessment design and data analysis (New York Sea Grant 2005). In response to this review, we completed a thorough re-analysis of the alewife assessment in 2004-2005 (O'Gorman et al. 2005) and we initiated a similar re-analysis of the rainbow smelt assessment in 2005. Using archived data from comparison tows, we reviewed rainbow smelt (all sizes combined) catches to determine if we need to implement correction factors to account for potential differences in fishing power between: 1) the R/V *Kaho* and the fiberglass-hulled R/V *Seth Green* which was retired permanently in fall 1982, 2) the R/V *Kaho* and the steel-hulled R/V *Seth Green* which has been in use since 1986, and 3) the 12-m (39 ft, headrope) Yankee bottom trawl used on the rainbow smelt assessment until 1996 and the 18-m (59 ft, headrope) 3-in-1 bottom trawl adopted on the rainbow smelt assessment in 1997 after biofouling by dreissenid mussels made use of the 12-m (39 ft) Yankee trawl problematic and impractical.

We performed some preliminary analyses to evaluate potential differences in rainbow smelt catches between vessels and gears. First, we graphically examined the data to look for obvious differences in paired catches and evaluated possible relationships between catch differences and depth by creating bubble plots with the size of the bubble scaled according to depth. We also performed paired t-tests on log-transformed catch data to evaluate differences between the two catches on paired tows.

To compare catches between the R/V *Kaho* and the fiberglass-hulled R/V *Seth Green*, a series of 18 side-by-side comparison tows were conducted during April-June 1980 at depths ranging from 23 to 75 m (75 to 246 ft). Eight trawl tows were conducted at depths <50 m (164 ft) and 10 were conducted at depths ≥50 m (164 ft). We did not detect a difference in rainbow smelt catches between the two vessels based on paired t-tests of log-transformed rainbow smelt catches (P = 0.12). Although the number of comparison trawls was low, these are the only data available to evaluate relative fishing power of the two vessels. Results of the analysis indicate that we do not need to use a correction factor to combine historic rainbow smelt catches from these two vessels. Similar results were found in the re-analysis of the alewife assessment (O'Gorman et al. 2005).

To compare catches of the R/V *Kaho* and the steel-hulled R/V *Seth Green*, a total of 56 side-by-side comparison tows were conducted during April-July, 1985-1989 at depths ranging from 8 to 95 m (26 to 312 ft). The number of trawl tows within each 10-m (33 ft) depth increment from 0 to 95 m (0 to 312 ft) ranged from 1-10. We did not detect a difference in rainbow smelt catches between the two vessels based on paired t-tests of log-transformed rainbow smelt catches (P = 0.16), indicating that we do not need to use a correction factor to combine rainbow smelt catches from these two vessels. Similar results were found in the re-analysis of the alewife assessment (O'Gorman et al. 2005).

To compare catches of rainbow smelt using the 12-m (39 ft) Yankee trawl used through 1996 and the 18-m (59 ft) 3-in-1 trawl used starting in 1997, we conducted 97 side-by-side comparison tows during April-June 1995-1998 at depths ranging from 8 to 154 m (26 to 505 ft) Forty-nine tows were conducted with the 12-m (39 ft) trawl on the R/V *Kaho* and the 18-m (59 ft) trawl on the R/V *Seth Green* and 48 tows were made with the opposite configuration of vessels and gears. The number of trawl tows within each 10-m (33 ft) depth increment from 0 to 150 m (0 to 492 ft) ranged from 2-11. We did not detect a difference in rainbow smelt catches between the two trawling gears based on paired t-tests of log-transformed catches (P = 0.23), indicating that we do not need to use a correction factor to account for the change in trawling gear. However, based on our graphical evaluation we saw some evidence that catch differences between the two gears became more pronounced at greater depths. Similar evidence of catch differences between gears was observed during evaluation of the alewife assessment, and re-analysis of those data resulted in a fishing power correction factor being applied to alewife

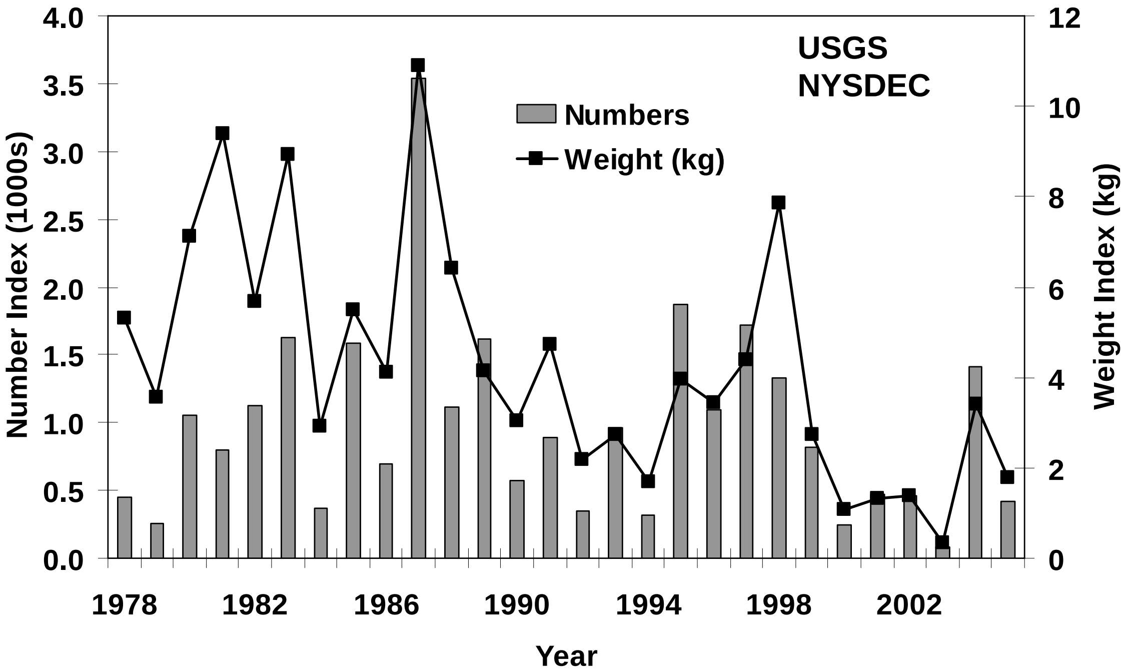

Figure 1. − Stratified mean catch of age-1 and older rainbow smelt with bottom trawls in U.S. waters of Lake Ontario shoreward of the 140-m (459 ft) bottom contour in late May-early June, 1978-2005. For the weight index, 1 kg = 2.2 lb.

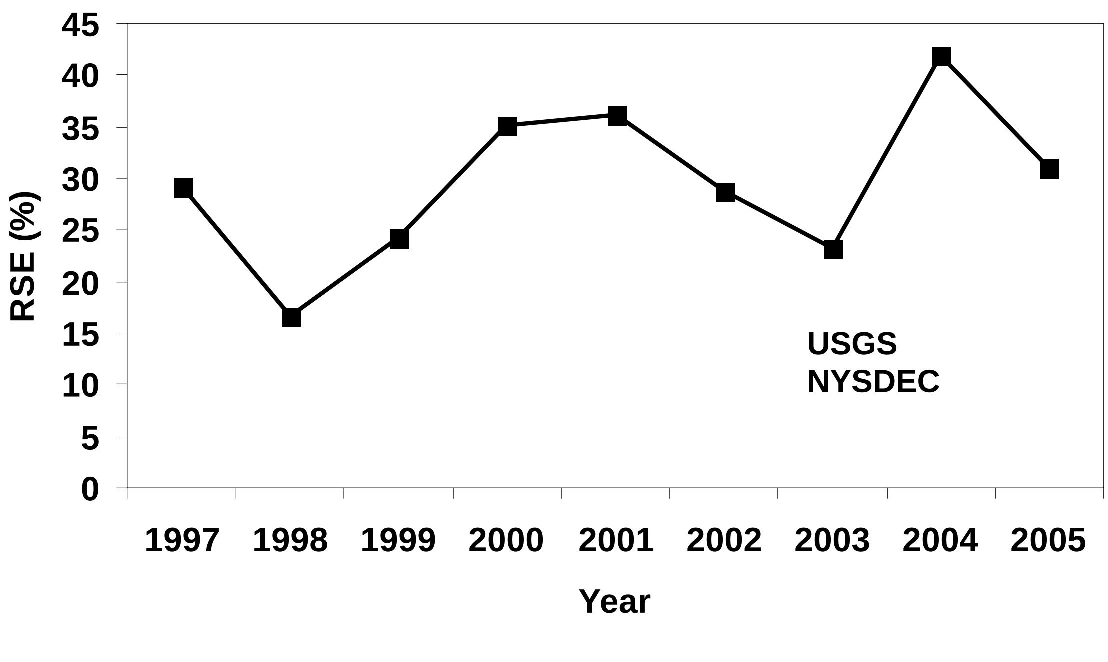

Figure 2. − Relative standard error (RSE) for age-1 and older rainbow smelt abundance indices in U.S. waters of Lake Ontario, 1997-2005. The RSE (RSE = 100*{standard error of the index / the index}) is a measure of variability in the abundance index.

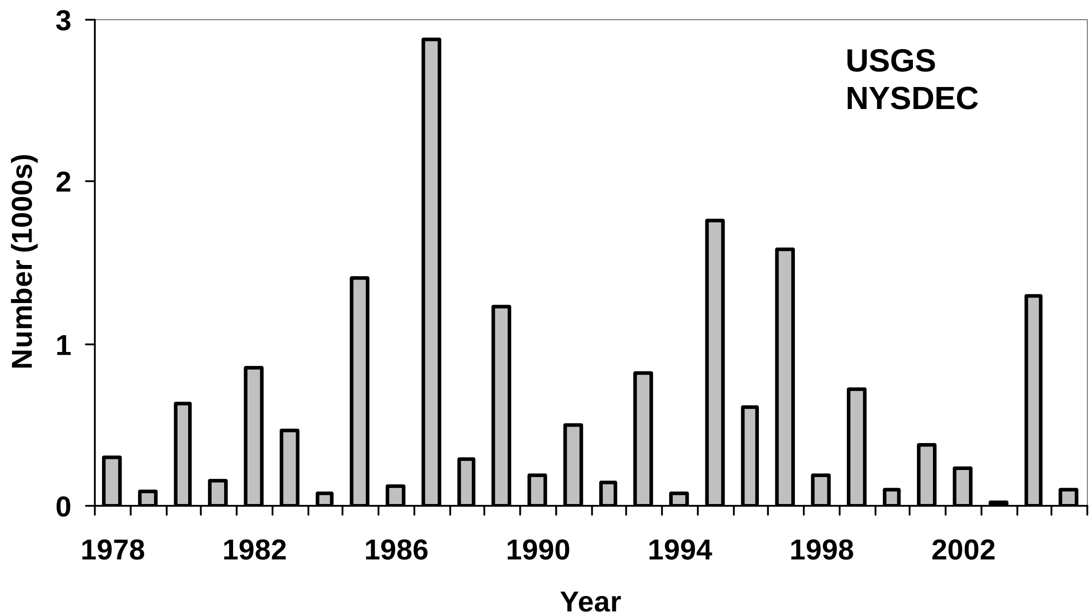

Figure 3. − Stratified mean catch of age-1 rainbow smelt with bottom trawls in U.S. waters of Lake Ontario shoreward of the 140-m (459 ft) bottom contour in late May-early June, 1978-2005. All estimates are age-based.

catches at depths >91.5 m to account for the increased effectiveness of the 18-m (59 ft) 3-in-1 trawl at those depths (O'Gorman et al. 2005). In 2006, we plan to further investigate the change in gear effectiveness with depth by using a decision rule to evaluate the appropriateness of applying a fishing power correction factor to rainbow smelt catches made at the deeper bottom depths.

Status of Rainbow Smelt

Number and weight indices for rainbow smelt were lower in 2005 than in 2004, when the abundance indices were the highest since 1998 (Figure 1). In 2005, the numerical index was 3.4% lower, and the weight index 1.9% lower than in 2004, but both indices were generally similar to values observed in 2001 and 2002 (Figure 1). Relative standard error (RSE, RSE = 100% * {standard error of the index / the index}) of the rainbow smelt abundance index has ranged from 17 to 41% during 1997-2005, the time period following the gear change to the 18-m (59 ft) 3-in-1 trawl (Figure 2). In 2006, we intend to reconstruct and quality check the entire historic rainbow smelt database, after which we will be able to calculate RSEs for the complete time series. We will also re-evaluate the current stratification scheme and number of trawl tows conducted on the rainbow smelt assessment to reduce the level of variability in our population indices.

In 2005 we allocated time and effort to evaluating the methods used in our long-term rainbow smelt aging program, a program which is unique among the Great Lakes. This included developing methods to train new personnel in estimating rainbow smelt ages from sectioned pectoral fin rays, determining smelt ages from fin rays collected on assessments in 2003-2005 while instituting new measures for quality control, and initiating a study to compare the precision and efficiency of using otoliths and fin rays to age smelt. From these efforts, we will produce a standard operating procedure for aging rainbow smelt with fin rays which will be used within the Lake Ontario Biological Station (LOBS) and which will also be available as an instructional tool for other scientists and managers interested in instituting a smelt aging program.

Rainbow smelt year classes generally alternate between strong and weak in Lake Ontario apparently due to cannibalism, primarily by yearling smelt on young-of-year (Figure 3). The alternating pattern was interrupted by two successive weak year classes in 1982-1983 and again in 2001-2002. However, an unusually large catch of yearling rainbow smelt in 2004 (2003 year class) followed by a relatively small catch of yearlings in 2005 (2004 year class) appears to signal a resumption of the alternating pattern in year class strength that had been intact during 1984-2000.

The relative and absolute abundance of large rainbow smelt (≥150-mm or ≥5.9 in) remained low in 2005. Large rainbow smelt made up less than 3% of the population during 1989-2004 (range: 0.1 to 2.8%) and in 2005 they made up about 0.1% of the population. The stratified mean catch per tow of large rainbow smelt ranged from 1 to 14 during 1989-2004 and was only 1 in 2005. In contrast, during 1978-1983, large rainbow smelt were 10 to 26% of the population and mean catch per tow ranged from 55 to 205. The paucity of large rainbow smelt during 1989-2005 was likely due to heavy predation and, more recently, weak year classes in 1999-2002.

We forecast that rainbow smelt abundance indices will be slightly higher for yearlings and all age groups combined in 2006. Any rise in rainbow smelt abundance will probably be short lived without a relaxation of predation pressure. Rainbow smelt have demonstrated considerable resiliency by rebounding from an extremely low level of spawner abundance which suggests that a prolonged population collapse is unlikely.

References

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