Acoustic Assessment of Pelagic Planktivores, 2006

M.J. Connerton
New York State Department of Environmental Conservation
Cape Vincent, New York 13618

T. Schaner
Ontario Ministry of Natural Resources
R.R. #4, Picton, Ontario K0K 2T0

Alewife (*Alosa pseudoharengus*) and rainbow smelt (*Osmerus mordax*) are the most abundant pelagic planktivores in Lake Ontario, and the most important prey for salmon and trout. Alewife are also important prey for warm water predators, notably walleye, and for Double-crested cormorants. Abundance of alewife and smelt has declined over the past decade, likely due to reduced nutrient loading, proliferation of non-native dreissenid mussels, and the buildup of stocked salmon and trout. In years when alewife and smelt declined, threespine sticklebacks (*Gasterosteus aculeatus*) have become more prominent. These recent observations signal a change in the pelagic fish community.

Concerns for declining numbers of prey fish were addressed by the Canadian and U.S. management agencies in 1993, when the number of salmonines stocked was reduced to a level that would cut the prey demand by approximately half. Since that time, however, following public consultation on both sides of the border, stocking levels were moderately increased in 1997. Furthermore, since 1997 increased rates of natural reproduction of Chinook salmon have been observed (Bishop et al. 2007). Thus the alewife and smelt populations continue to be under intense predatory pressure.

Sound management decisions regarding predator-prey balance require continued monitoring of prey fish populations. Starting in 1991, hydroacoustic surveys to estimate lake-wide abundance of pelagic prey fish have been conducted jointly by the Ontario Ministry of Natural Resources (OMNR) and the New York State Department of Environmental Conservation (NYSDEC). Information from the hydroacoustic surveys complements information obtained in bottom trawling surveys conducted jointly by NYSDEC and the U.S. Geological Survey (USGS) in the U.S. waters of the lake.

Methods

Before 2005, the surveys followed established transects with only minor yearly modifications due mostly to logistics. This was a practical approach dictated by harbor locations, running time, and limited periods of darkness in the summer. A statistically preferable random-transect design was deemed impractical. In 2005 we modified the fixed transect design to include a random element. Five fixed cross-lake corridors approximately 15 km wide were established (Fig. 1) based on logistic constraints, but within these corridors transects are selected at random. A single east-west offset is randomly chosen, determining the relative position of all transects within their respective corridors, and thus the survey is essentially a systematic survey with a random start. The randomly chosen offset in 2006 was 0.4, meaning that transects were offset 0.4 times the width of the corridors from the western boundaries.

In 2003, the Simrad EY500 120 kHz split beam echosounder was upgraded to Biosonics DTX 120 kHz split beam. At the same time we switched to new analytical software. Comparisons between the two systems suggested that the new sonar/software combination yielded lower estimates than the previous system (by as much as 30% but generally less). The potential bias of this magnitude does not substantially alter the interpretation of the population trends, and therefore the results from the two time periods have been reported without corrections (Schaner and LaPan 2006).

The 2006 hydroacoustic survey was conducted from July 24 to August 2, and consisted of 5 cross-lake transects and an Eastern Basin transect (Fig. 1). Each night, sampling began approximately one hour after sunset at the 10 m depth contour on one side, and continued across the lake to the 10 m depth contour on the other side. Sampling was completed one hour before sunrise or earlier. Acoustic data were collected along transects using a Biosonics DTX 120 kHz split beam echosounder. A temperature profile was measured at several points along each transect.

Raw acoustic data were stratified based on thermal layer, bottom depth and geographical zone. The data were processed with Echoview software by Sonardata, using -64 dB volume backscattering strength and target strength thresholds. The resulting scaled integrated voltage estimates of total target abundance were split into 3 dB target strength (TS) bins according to results of single-target analysis. The abundances of yearling and older fish (YAO) were extracted from the resulting target strength histograms. In the upper layer (epilimnion plus metalimnion) the histograms were processed to identify component modes, and targets in the mode at or below -35 dB were assumed to be YAO alewife. In the lower layer (hypolimnion) all targets larger than -55 dB were assumed to be YAO smelt.

On two nights during the 2006 survey, six tows were made with the large midwater trawl (613 ft^2, 57 m^2) to assess biological attributes of the prey fish. Three tows were completed from Sodus to Rochester, and three were done east of Cobourg. Each tow sampled up to five depths obliquely ranging from 5 to 40 m over an average distance of 7 km per tow. Average masses of alewife and smelt were calculated based on trawl catches. To account for the differences in the proportion of yearlings and adults caught, all means are weighted by catch per unit effort.

In 2006, we also continued evaluating the remotely opening/closing Tucker trawl as a tool for assessing the vertical distribution of small targets in the thermal layers of the water column. This trawl has the ability to catch small fish that are not efficiently sampled by the midwater trawl and it can sample three discrete depth layers without catch contamination during deployment or retrieval. We conducted six tows using the Tucker trawl, each trawl sampled for 10 minutes at three temperatures corresponding to hypo-, meta- and epilimetic layers for a total of 30 minutes per trawl.

Results and discussion

Alewife

The 2006 midsummer acoustic estimate of yearling and older (YAO) alewife was 1.03 billion fish. Using CUE-weighted average mass of alewife (19.2 g), total estimated biomass in Lake Ontario was 19,763 metric tons.

The biomass value, however plausible, should be viewed with some skepticism. The samples used to calculate average mass consisted of approximately equal numbers of yearlings and adult fish; and the relative CUE (2:1) of the two size classes varied considerably between tows (caught either yearlings or older, not both); therefore the true ratio of yearlings to adults cannot be established with confidence based on the limited number of tows. We suspect that the average mass was likely biased high, i.e., adults were overrepresented in the catch.

The 2006 abundance of YAO alewife appears to have rebounded from the low level observed in 2005, which was the lowest on record for the acoustic time series. This year's acoustic estimate for alewife abundance is equal to the number observed in 2000, when the strong year classes of 1998 and 1999 began recruiting to the YAO alewife population. Similarly, this year's high acoustic estimate probably results from a large 2005 year class. Spring bottom trawls in 2006 indicated a strong 2005 year class, with a numerical index of yearling fish equal to the fourth largest of the 29 year time series (O'Gorman et al. 2007). The large yearling population may also explain the apparent shift in the acoustic target strength distribution observed during our acoustic analyses. The mode of the TS histogram in the upper layer corresponding to YAO alewife, normally with a peak detected at -39 dB, was around -42 dB, presumably from a larger proportion of smaller targets, i.e., yearling fish. Unlike the past three years, the number of targets forming the mode was also relatively large, also suggesting increased abundance of alewife sized targets in the lake.

Rainbow smelt

The 2006 estimate of YAO smelt was 126 million fish. Using CUE-weighted average mass of YAO smelt (12.3 grams), the total biomass estimate of smelt in Lake Ontario this year was 1,561 metric tons. The smelt population has decreased in 2006 by 42% from 2005 and it is the 3rd lowest on record from the acoustic survey. Abundance and biomass were respectively 38% and 49% below the long term averages.

The trend seen in the midsummer acoustic smelt survey also agrees well with the trend seen in the spring bottom trawling survey (Walsh et al 2007), which reported a decline in YAO smelt catch per unit effort compared with 2005, including a low abundance of Age-1 fish. We also recorded low catches of yearling-sized smelt in trawls conducted during the acoustic survey, suggesting a weak 2005 year class.

Threespine stickleback

The abundance of threespine sticklebacks was monitored in midwater trawl catches during the acoustic survey. In 2006, we conducted six tows with the traditional gear to assess stickleback abundance. Although sticklebacks were caught in 100% of the tows, the average CUE was very low compared with previous years' catches. Furthermore, in all previous years we found two size classes (~30mm and ~60mm), but in 2006 we only caught fish in the ~60mm size class, suggesting a weak year class of sticklebacks in 2005.

References

Bishop, D.L., S.E. Prindle and J.H. Johnson. 2007. 2006 Salmon River Wild Young-of-Year Chinook Salmon Seining Program. *In:* 2006 Annual Report, Bureau of Fisheries Lake Ontario Unit and St. Lawrence River Unit to the GLFC's Lake Ontario Committee.

O'Gorman, R., T. Strang, J.R. Lantry, J.V. Adams, and T. Schaner 2007. Status of Alewife in the U.S. Waters of Lake Ontario. *In:* 2006 Annual Report, Bureau of Fisheries Lake Ontario Unit and St. Lawrence River Unit to the GLFC's Lake Ontario Committee.

Schaner, T. and S.R. LaPan. 2006. Pelagic Plantivores. *Section 3 in* 2005 Annual Report, Bureau of Fisheries, Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission's Lake Ontario Committee, March 21, 2006.

Walsh, M.G., T. Strang, and J.R. Lantry. 2007. Status of rainbow smelt in the U.S. waters of Lake Ontario, 2006. *In:* 2006 Annual Report, Bureau of Fisheries, Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission's Lake Ontario Committee, March 24, 2007.

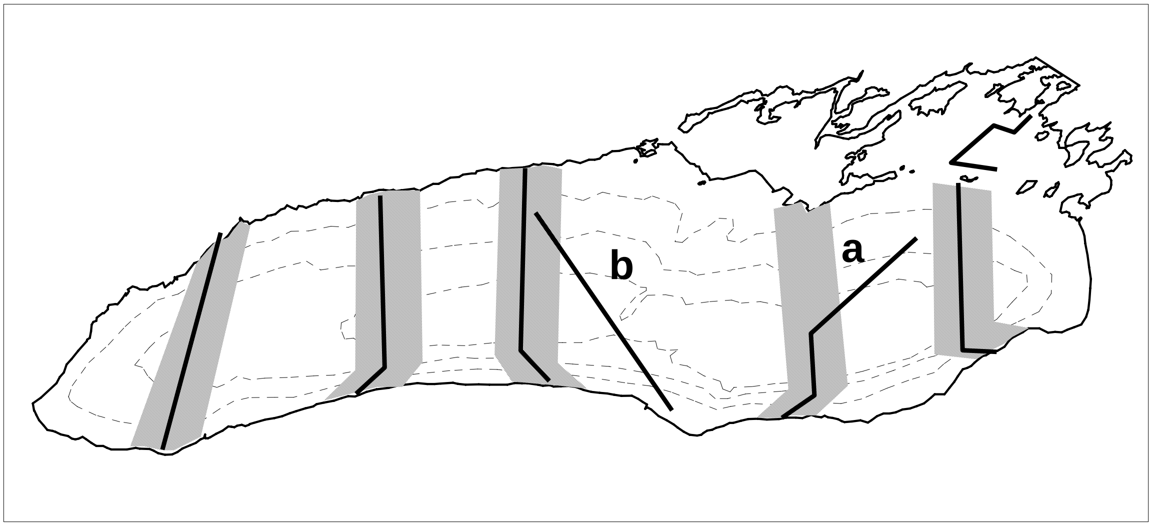

FIGURE 1. Transects surveyed in the 2006 hydroacoustic survey. Also shown are sampling corridors established in 2005, from which transects in the main lake are randomly chosen. Deviations from the corridors in 2006 were due to logistics: one transect (a) was modified and later prematurely terminated due to bad weather, and another transect (b) was not planned, but data were collected during a night of travel.

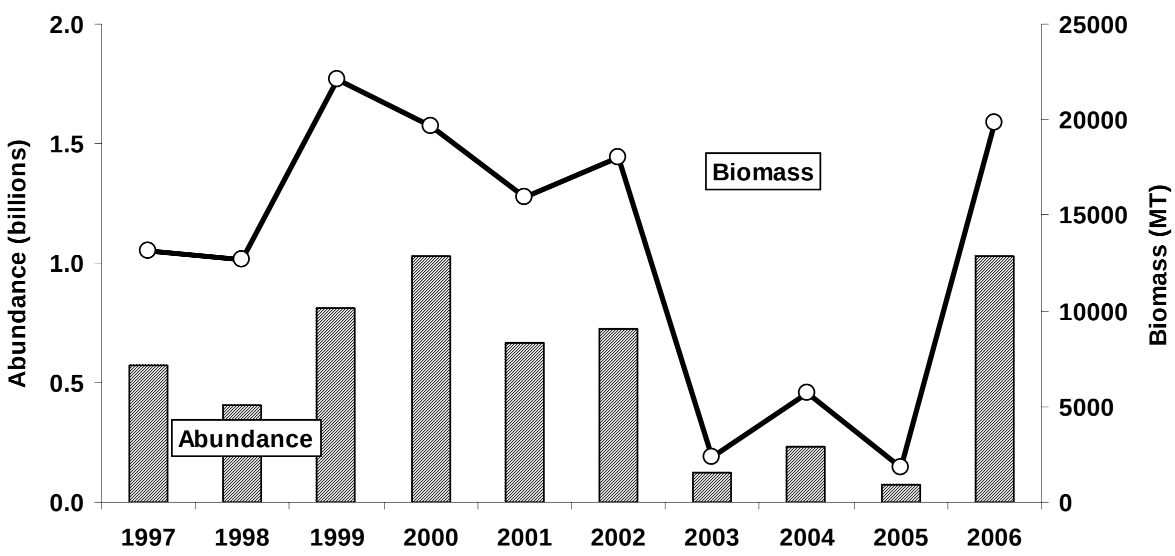

FIGURE 2. Abundance and biomass of yearling-and-older alewife. Abundance estimates were obtained directly from hydroacoustic surveys, biomass estimates were obtained by applying average weights measured in midwater trawls to abundance estimates. Average weights used in biomass calculations in 2002, 2004 and 2005 were based on pooled data from other years.

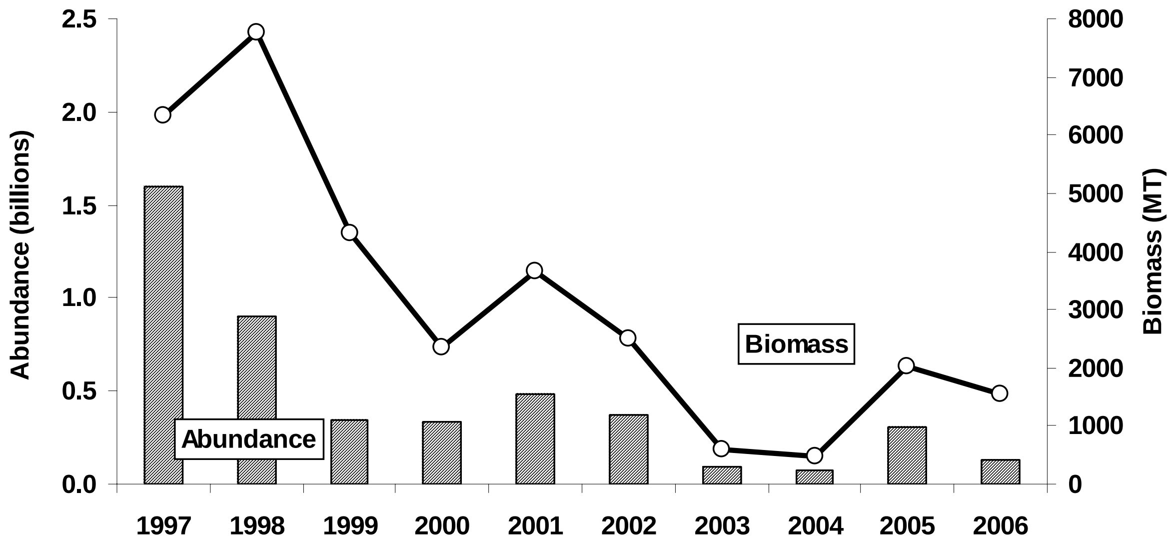

FIGURE 3. Abundance and biomass of yearling-and-older rainbow smelt Abundance estimates were obtained directly from hydroacoustic surveys, biomass estimates were obtained by applying average weights measured in midwater trawls to hydroacoustic abundance estimates. Average weights used in biomass calculations in 2002 through 2005 were based on pooled data from other years.

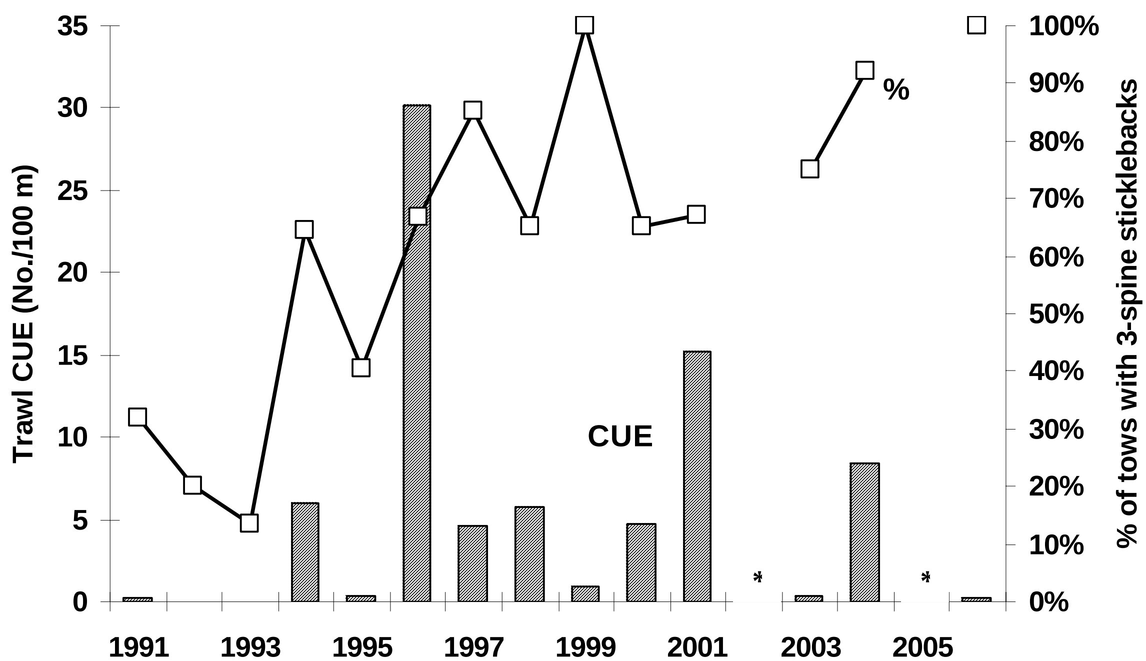

FIGURE 4. Catches of threespine sticklebacks in midwater trawls conducted during the summer of 1991-2006 hydroacoustic surveys. Bars represent yearly catch per unit effort; lines show proportion of tows containing sticklebacks. * No midwater trawls were done in 2002 and 2005.