

Pelagic Planktivores

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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. Alewives are also important prey for warm water predators, notably, walleye, and for cormorants. The 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. As 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. In 1997, however, stocking levels were moderately increased following public consultation on both sides of the border. Furthermore, since 1997 increased rates of natural reproduction of chinook salmon have been observed. 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; therefore, starting in 1991 hydroacoustic surveys to estimate lake-wide abundance of pelagic prey fish have been undertaken 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

New survey design

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 times, and the limited period 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 (9.6 mi) wide were established (Figure 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.

New midwater trawl

A remotely opening/closing Tucker trawl was tested during the 2005 survey in place of the 57 m² (613.5 ft²) midwater trawl used in previous surveys. The net has a 2 m² (21.5 ft²) square opening and is constructed of 1.6 mm (0.06 in) knotless mesh forming three 8.5 m (27.9 ft) long cod ends. The theoretical advantages of this gear are its ability to catch small fish that are not efficiently captured by the midwater trawl and the ability to sample discrete depth layers without catch contamination during deployment and retrieval. Although the relatively small

opening and fine mesh size of the Tucker trawl make it less suitable for capture of adult alewife and smelt, a need exists to investigate species composition and vertical distribution of smaller acoustic targets detected in great abundance.

The 2005 survey

The 2005 hydroacoustic survey was conducted during the period 25 July to 2 August, and consisted of five cross-lake transects and an Eastern Basin transect (Figure 1). Each night, sampling began approximately one hour after sunset at the 10 m (39.4 ft) depth contour along the New York or Ontario shore, and continued across the lake to the 10 m depth contour on the opposite side. Sampling was usually completed one hour before sunrise. Acoustic data were collected along the transects using a Biosonics DTX 120 kHz split beam echosounder. Temperature profiles were measured at several points along each transect.

Raw acoustic data were stratified based on thermal layer, bottom depth and geographical zone. Data were processed with Echoview software by Sonardata, using -64dB volume backscattering strength and target strength thresholds. The resulting scaled integrated voltage estimates of total target abundance were split into 3dB target strength (TS) bins according to results of single-target analysis. 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 -38dB were assumed to be yearling and older (YAO) alewife. In the lower layer (hypolimnion) all targets larger than -55dB were assumed to be YAO smelt.

Eight midwater tows, each sampling three discrete depths, were made with the Tucker trawl during the survey. An additional three tows were made with the 57 m² midwater trawl at the end of the survey.

Results and Discussion

Consistency across the hydroacoustic survey time series

In 2003 the Simrad EY500 120 kHz split beam echosounder was upgraded to Biosonics DTX 120 kHz split beam, and new analytical software was utilized. Informal comparisons between the two systems in 2004 suggested that the new sonar/software combination yielded lower estimates than the previous system; therefore, results of the 2004 survey were not published. Extensive comparisons between the two systems in 2005 confirmed earlier observations, and revealed complicated relationships between the two systems, dependent upon particulars of the signal processing stage, as well as the composition and depth distribution of the target populations. Due to the aforementioned, correction factors cannot be readily established between the two systems. It appears, however, that the differences are at most 30% (i.e. the new system yielding 30% lower density estimates) but are generally less. The potential bias of this magnitude does not substantially alter interpretation of the population trends; therefore, the results from the two time periods are reported without corrections.

Alewife

The 2005 midsummer abundance estimate of YAO alewife was 72 million fish (Figure 2). Using the average weight of YAO alewife from 1997-2002 (no data available for 2005), this translates into a biomass estimate of 1,797 metric tons (3.96 million pounds). Isolation of acoustic targets corresponding to YAO alewife was especially problematic in 2005 (due to target size overlap and unusually low numbers of YAO targets); therefore, an alternate 2005 estimate was made using target separation criteria from previous years, yielding an estimate of 124 million fish or 3,088 metric tons (6.81 million pounds) (Figure 2).

Either estimate suggests a very low, possibly the lowest, population since the start of the series in 1997 and the third consecutive year of extremely low levels. Corresponding estimates from spring bottom trawls (O’Gorman et al. 2006) also indicate generally low population levels in the

recent years, but not as extreme as seen in the midsummer acoustic series. A high degree of concordance exists between the two series for the years 1997-2002 (unpublished data), but the acoustic series shows a relatively greater decline in the recent years. Anecdotal data from other sources, such as the recent poor condition of Chinook salmon (Ministry of Natural Resources. 2005), and recent high condition of alewife in fall (O’Gorman et al. 2006) is consistent with the possibility of record low alewife levels; therefore, the predator-prey balance in the lake should continue to be closely monitored.

Rainbow smelt

The 2005 midsummer abundance estimate of YAO smelt was 304 million fish (Figure 3). Using the average weight of YAO smelt from 1997-2001 (no midsummer data available for 2002-2005), this translates into a biomass estimate of 2,028 metric tons (4.47 million pounds). The population has increased in 2005 from two previous low years to a level similar to the early 2000s.

Midsummer acoustic smelt estimate trend also agree well with that seen in the spring bottom trawls, with the exception of the low acoustic 2004 estimate (Walsh et al. 2006) (Figure 3). That year, yearlings accounted for a high proportion of the YAO population (O’Gorman et al. 2005), and the method used to isolate YAO targets apparently failed to fully include yearlings either due to their small size or their higher position in the water column. The increased abundance seen in the 2005 acoustic survey is likely due to these fish, now detectable as two-year olds.

Threespine stickleback

The abundance of threespine sticklebacks was previously monitored in the 57 m² midwater trawl catches that accompanied the acoustic survey. due to an insufficient number of 57 m² midwater trawl tows.

Tucker trawl trials

Catches in the Tucker trawl were quite low, averaging 7 fish per 15 min deployment of a cod end (up to three cod ends fished per trawl). Calculation based on typical target densities

estimated from acoustics and volumes filtered by the trawl indicated that these catches were in line with the density of available fish.

It is particularly noteworthy that YOY alewives, smelt, as well as threespine sticklebacks of all sizes were found in all three thermal layers, although the hypolimnion appeared to be the least preferred by all three species. YOY smelt were found evenly throughout the epi- and metalimnion, while threespine sticklebacks were found mostly in the metalimnion. Catches of YOY alewife were lower, and quite similar between the three layers. The majority of fish caught in the Tucker trawl were less than 60 mm (2.4 in) long, but a few adult smelt were caught indicating that the gear may be suitable for monitoring all sizes of smelt. No adult alewives were caught, suggesting net avoidance or low density. Despite the low catches, the Tucker trawl promises to be valuable tool in interpreting the distribution of small targets detected by acoustics.

References

Ministry of Natural Resources. 2005. Section 2.9 *in* Lake Ontario Fish Communities and Fisheries: 2005 Annual Report of the Lake Ontario Management Unit. Ontario Ministry of Natural Resources, Picton Ontario, Canada.

O’Gorman, R., R.W. Owens, S.E. Prindle, J.V. Adams, T. Schaner. 2005. Status of major prey fish stocks in the U.S. waters of Lake Ontario, 2004. Section 12 *in* 2004 NYSDEC Annual Report, Bureau of Fisheries, Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission’s Lake Ontario Committee.

O’Gorman, R., M. Walsh, T. Strang, S.E. Prindle, J.V. Adams, T. Schaner. 2006. Status of major prey fish stocks in the U.S. waters of Lake Ontario, 2005. Section 12 *in* 2005 NYSDEC Annual Report, Bureau of Fisheries, Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission’s Lake Ontario Committee.

Walsh, M.G., R. O’Gorman, A.P. Maloy, T. Strang, and S.E. Prindle. 2006. Status of

rainbow smelt in the U.S. waters of Lake Ontario, 2005. Section 12 in 2005 NYSDEC Annual Report, Bureau of Fisheries Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission's Lake Ontario Committee.

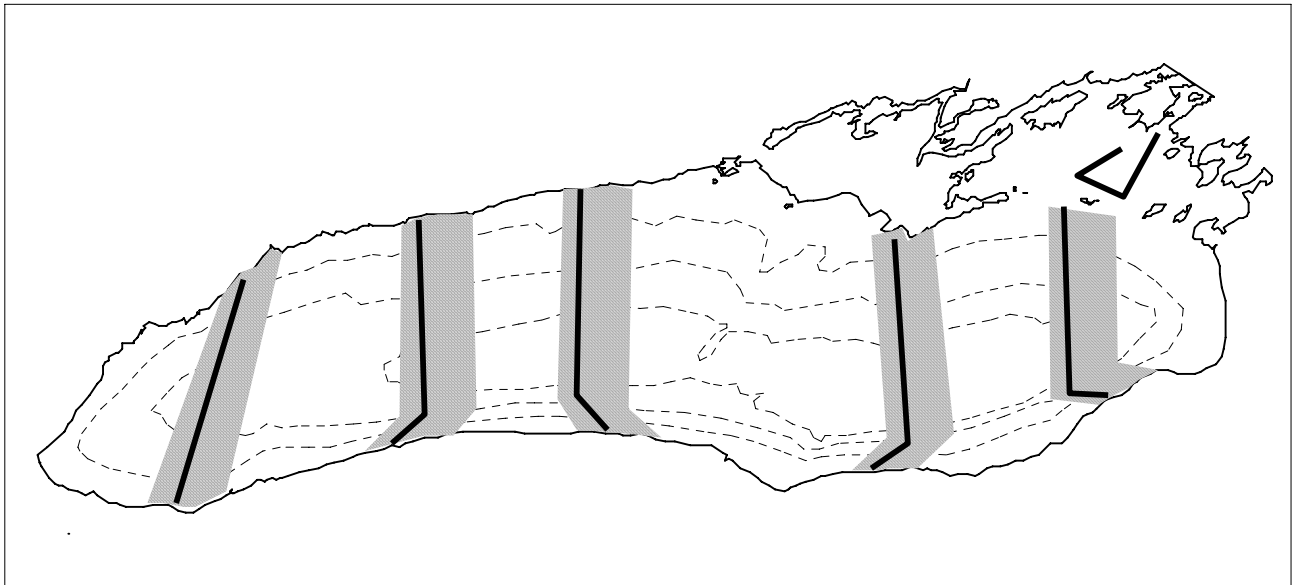


Figure 1. Transects surveyed in the 2005 hydroacoustic survey. Also shown are sampling corridors established in 2005, from which the transects in the main lake are randomly chosen.

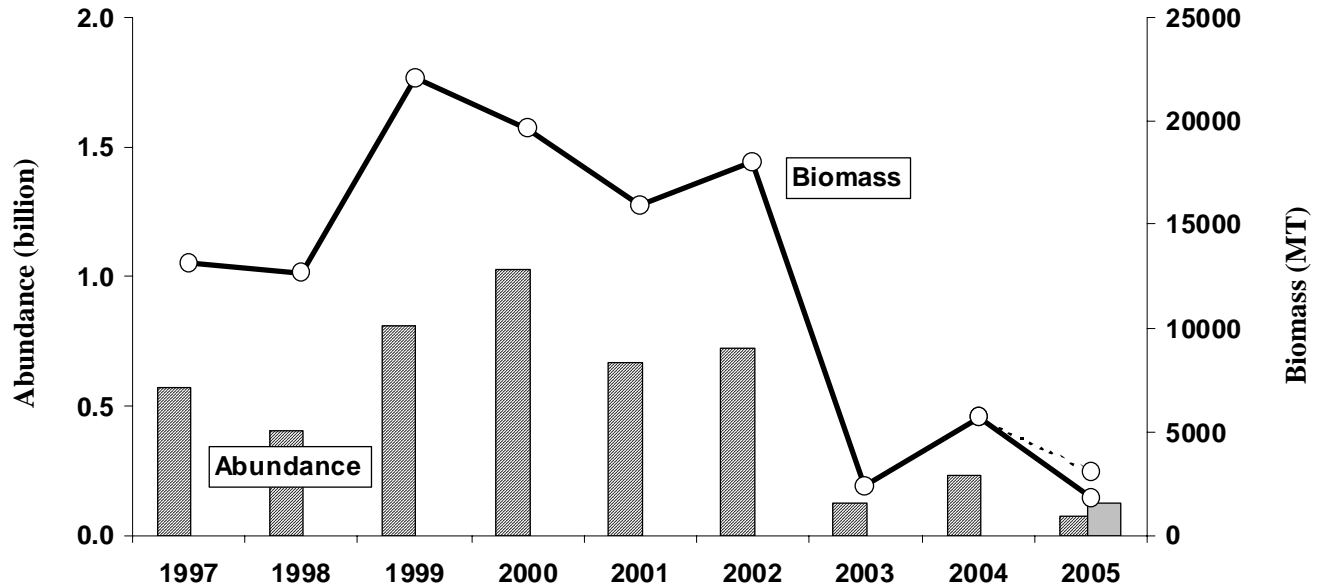


Figure 2. Abundance and biomass of yearling-and-older alewife. Abundance estimates were obtained directly from hydroacoustic surveys, biomass estimates were obtained by applying average weights measured in midwater trawls to abundance estimates. Average weights used in biomass calculations in 2002, 2004 and 2005 were based on pooled data from other years. Two abundance and biomass estimates are shown for 2005; the second (higher) set of estimates was based on peak-separation criteria from other years, and was produced due to uncertainties in separating alewife targets using within-year information.

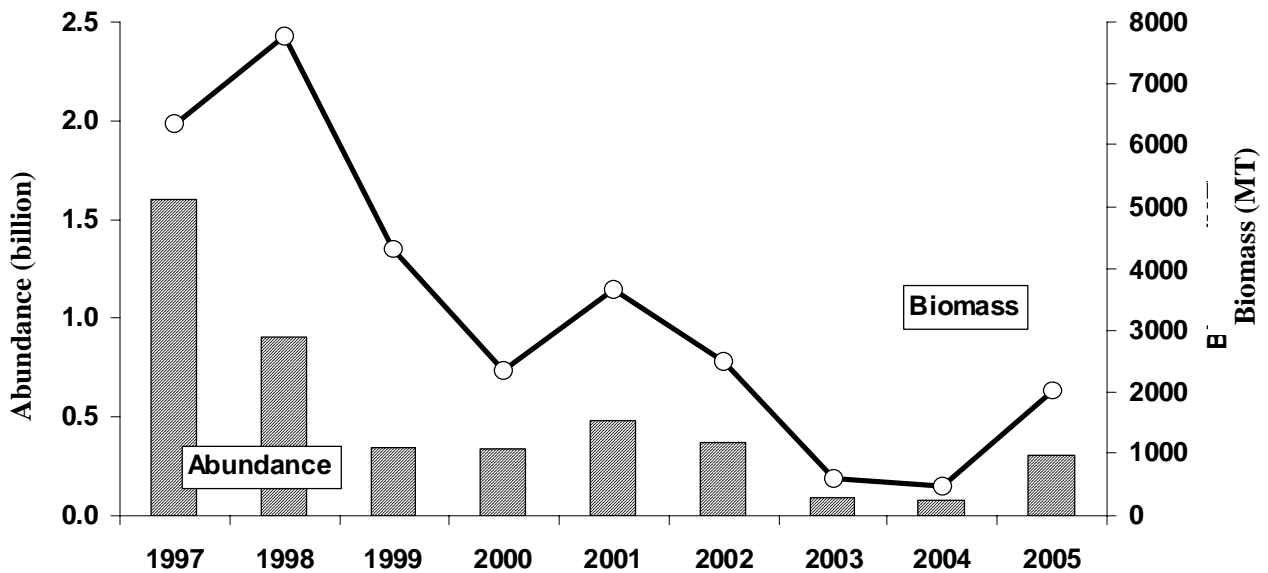


Figure 3. Abundance and biomass of yearling-and-older rainbow smelt. Abundance estimates were obtained directly from hydroacoustic surveys, biomass estimates were obtained by applying average weights measured in midwater trawls to hydroacoustic abundance estimates. Average weights used in biomass calculations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