Item 23

LRA ER Reference 2.3-18

Lantry, B. F., and T. Schaner, The Status of the Pelagic Preyfish in Lake Ontario, 1997, New York State Department of Environmental Conservation Lake Ontario Annual Report, 1997

# The Status of the Pelagic Preyfish in Lake Ontario, 1997

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In 1991, the New York State Department of Environmental Conservation (NYDEC) and the Ontario of Ministry of Natural Resources (OMNR) initiated a hydroacoustic and midwater trawl survey to monitor the status of pelagic prey fish in Lake Ontario. Alewife and rainbow smelt were assessed yearly since the late 1970's with bottom trawls in U.S. waters (O'Gorman et al. 1994), however, extensive areas on the Canadian side cannot be surveyed this way because of the lack of trawlable bottom. Hydroacoustic techniques combined with midwater trawling are not restricted by bottom features, and thus permit lake-wide assessment.

The purpose of this report is to examine recent trends in alewife abundance, reproductive success and recruitment. Smelt data and trends are not as reliable as alewife data for 1991-94 because segregating smelt from mysids in offshore scatterings was not completed. Because of modifications to the hydroacoustics system, the 1997 survey provided the best data for smelt.

## Methods

Three separate night surveys were usually conducted in spring, summer and fall for 1991-96. In 1997 only summer and fall surveys were conducted. For each survey six cross-lake transects and an Eastern Basin transect were planned, although there were modifications dependent on weather and equipment failures (Fig. 1). The transects were established to provide even geographic coverage and to allow easy access to ports. Most transects followed a north-south line with oblique paths in the 0-100 m zone in U.S. waters so that sampling effort would be equivalent on both sides of the lake (area of the 0-100 m zone is much smaller on the U.S. side).

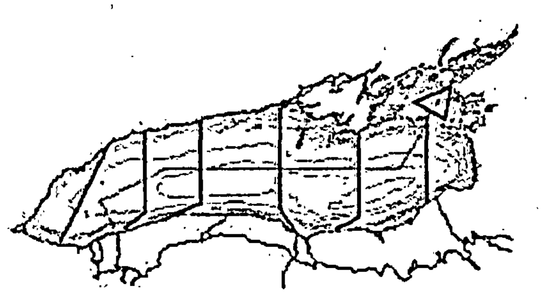

***Figure 1. Lake Ontario map showing locations of transects ran by the NYDEC R/V Seth Green during hydroacoutistics surveys.***

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 usually completed one hour before sunrise to minimize avoidance of fish to the trawls, and to maximize dispersion of fish for the hydroacoustic gear. The research vessel SETH GREEN (NYDEC) conducted both the acoustic sampling and midwater trawling. Acoustic data was usually collected along the full length of the transects at 11 km $h^{-1}$. Temperature profiles were made during the trawling operation.

A midwater trawl with a 57 $m^2$ opening was used for ground-truthing (establishing species and size composition). In 1991-94, tows were normally 30 minutes duration and in 1995-97 were usually 15 minutes, but varied at times depending on conditions. The depth of the net was monitored during the tows with a headrope transducer acoustically linked to the SETH GREEN. Tow speed was generally 6.5 km $h^{-1}$, but varied when the captain tried to maintain a stable depth. Fish captured in trawls were weighed and counted by species, and individual fish were measured for fork length. Catches exceeding approximately 10 kg were subsampled.

For surveys done from 1991 to 1994, we used BioSonics dual beam sounders with a 420 kHz operating frequency. In 1996 and 1997, we used Simrad EY500 split beam sounders (70 kHz in summer and 120 kHz in fall of 1996; and 120 kHz in summer and fall of 1997). Both dual (6X15$^{o}$) and split (11$^{o}$) beam transducers were installed in towed bodies for 1991-96 surveys. In 1997 a 120 kHz split beam transducer was purchased from Simrad and permanently attached to the hull of the SETH GREEN. The approach we use for estimating abundance of pelagic prey fish involved scaling echo integrated voltage with an estimate of average target strength.

Acoustic signals were processed during or after each survey using BioSonics echo signal processing (ESP) and Simrad EP 500 processing software. Signals acquired with BioSonics equipment were also recorded on digital audio tape and archived for future use. Acoustic data acquired with Simrad sounders were stored directly in digital format. BioSonics data were collected using a 40LogR time varied gain correction, and then 20LogR data was reconstructed for echo integration processing. With the Simrad equipment, time varied gain corrections could be applied in post-processing. The continuously collected dual beam acoustic signals were processed by 5 minute segments during echo integration and dual beam analysis, while 20 minute segments were used for the split beam data in 1996. The processed segments were assigned to geographic strata and summarized to obtain stratum and lake-wide abundance estimates. Biomass was estimated by applying the average weight of prey fish captured in trawls to the acoustic estimates of fish abundance.

## Results

Alewife Abundance and Biomass

Numbers of alewives in Lake Ontario declined 80% during October 1991-94 (Fig. 2). The intent of midwater trawling was to identify acoustic scattering layers and was not designed to monitor trends in abundance, nevertheless, the alewife CUE between 1991 and 1994 showed a similar trend -- a 67% decline in relative abundance. These data support the acoustic estimates and collectively suggest that alewife numbers declined dramatically from 1991 to 1994.

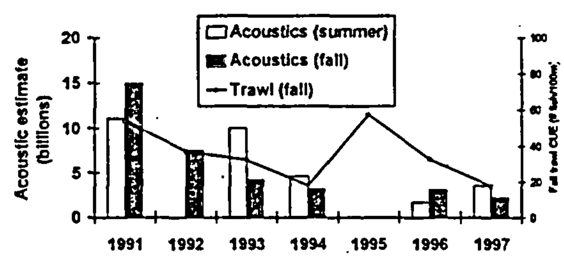


*Figure. 2. Acoustic estimates of abundance, and midwater trawl indices of relative abundance (CUE) of alewife in Lake Ontario, 1991 to 1997. Acoustic estimates for summer 1992, and summer and fall 1995 are not available.*

Although no acoustic estimates were available for 1995, the fall midwater trawl CUE showed a three-fold increase above 1994 alewife numbers, largely attributable to YOYs (Figs. 2 and 3). In 1996, the midwater trawl CUE declined by 43% and numbers were comparable to 1992 and 1993. The 1995 year class dominated the 1996 fall acoustic survey providing much of the estimated 3.2 billion alewives. The acoustic estimate in fall 1997 declined to 2.3 billion fish, the lowest abundance observed. While the midwater trawl catches of YOYs in fall 1997 represented about 50% of alewives caught, their abundance was low and not indicative of a large year class (Fig. 3).

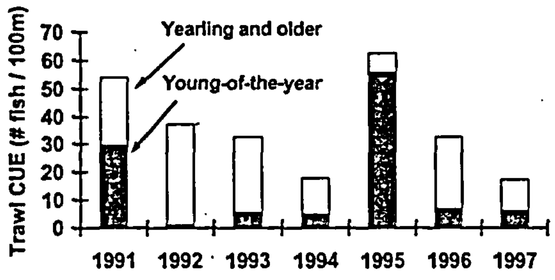


*Figure. 3. Relative abundance (CUE) of young-of-the-year and older alewife in the fall in Lake Ontario, 1991 to 1997.*

Estimated biomass of alewives in 1991 ranged from 235,000 mt in summer to 185,000 mt in fall (Table 1). This represents a standing stock of 12.8 to 10.1 g/m². By fall 1994, biomass declined to 46,000 mt (2.5 g/m²) and current 1997 estimates are the lowest observed at 22,400 mt (1.2 g/m²). These data show that alewife biomass has declined 88% since 1991. The biomass of alewives in 1997 declined by 63% from summer to fall, a quantity consistent with the salmonine predator demand estimated by OMNR biologists (personal communication, T. Schaner, OMNR, Glenora). The fact that current biomass is near the annual predator demand, indicates that Lake Ontario is close to its capacity to sustain current abundances of large predators.

*Table 1. Biomass of alewives in Lake Ontario, 1991-1997.*

| Year | Summer | Fall |
|---|---|---|
| 1991 | 234,928 | 185,174 |
| 1992 | na | 132,109 |
| 1993 | 179,349 | 37,271 |
| 1994 | 85,565 | 45,678 |
| 1995 | na | na |
| 1996 | 41,520 | 50,004 |
| 1997 | 60,000 | 22,400 |

Alewife Year Class Success

During 1991-97, recruitment of alewives to the adult population was not established until the end of their second year of life. Midwater trawl collections of alewives since 1991 revealed that only two of seven year classes survived to the fall of their second year of life (Fig. 4). In three of the six years, alewives produced few young-of-year (YOY). Due to the cold conditions in 1992, very few YOY were produced (i.e., no fish below 85 mm in the fall length distribution). Relatively few YOY were seen in fall 1994 (40 mm peak, (Fig. 4) and these YOY were small. Very few of these fish were observed as yearlings in August 1995. In fall 1996 few YOY were again observed and those fish were absent from the 1997 survey. Production of YOY in 1997 was also low and comparable to the 1992-94 and 1996. In 1994, 1996 and 1997 modal size in October (45 - 65 mm) was also substantially smaller than the years that produced strong classes (1991 & 95, 80 - 85 mm).

During two other years, alewives produced good crops of YOY, but these year classes disappeared by the end of their second year of life. The 1990 year class was well represented as yearlings in May 1991 (80 mm peak, Fig. 4). However by summer, numbers were reduced (100 mm peak) and few were seen in fall (no peak at 100-110 mm). In 1993, YOYs were numerous in the fall collections (Fig. 4) and in 1994 yearlings were prominent in the May catches (70 mm peak, Fig. 4). But again they were reduced by summer and disappeared by fall.

During the seven year data series, only the 1991 and 95 year classes recruited in substantial numbers to the adult population. In 1991, YOY comprised nearly half the catch of alewives in October (75 mm peak, Fig. 4). These fish were observed as yearlings in the following three surveys in 1992 (80, 95 and 110 mm peaks, Fig. 4). Moreover, they made a substantial contribution as new age 2 adults in 1993 (115 mm peaks, Fig. 4). Alewives produced numerous YOY in 1995, as well. As yearlings in 1996, they were prominent in all three survey collections (75, 100 and 110 mm peaks, Fig. 4).

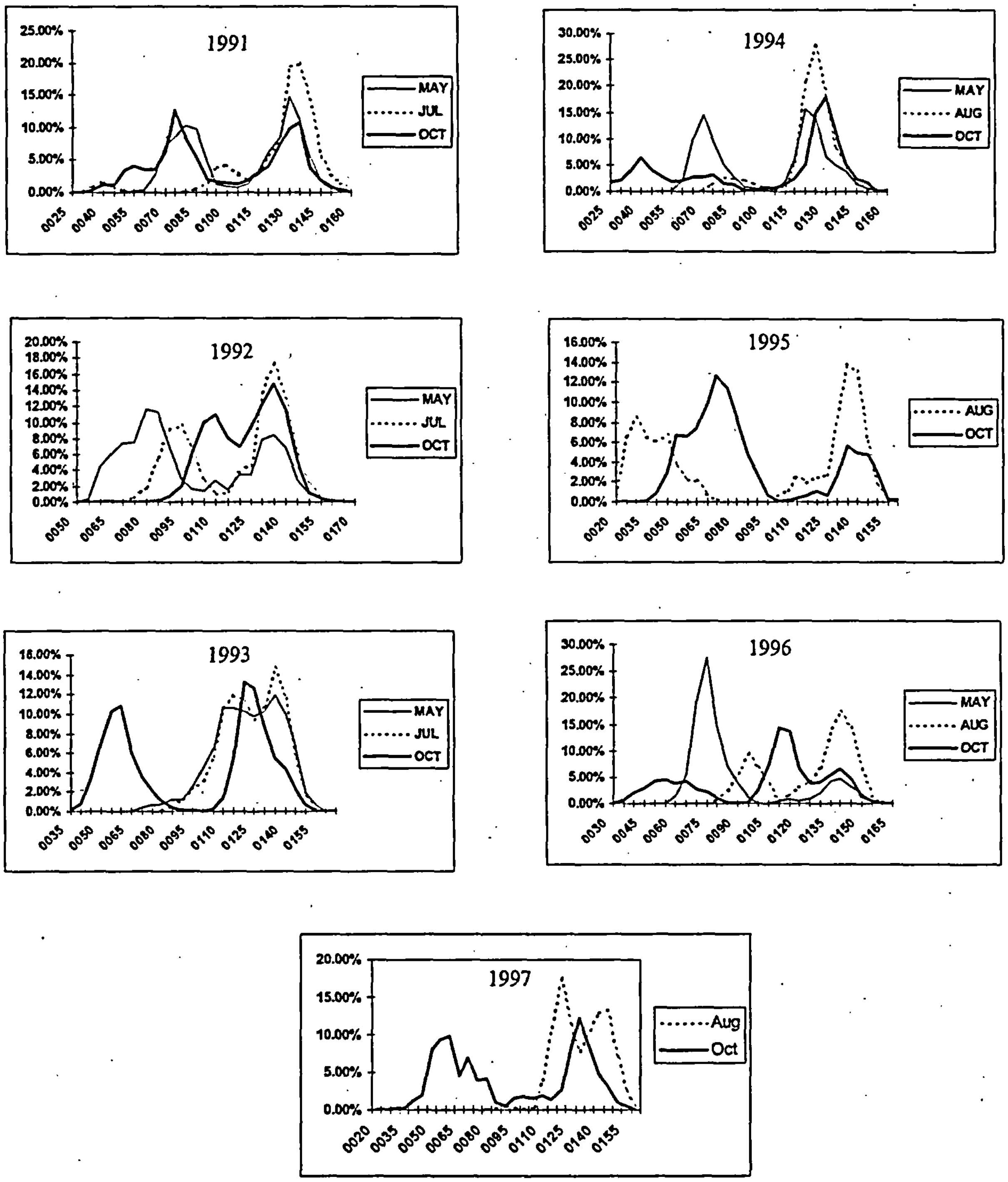


*Figure 3. Length frequency distributions (fork length) for alewives caught in midwater trawls in Lake Ontario, 1991 - 97.*

As age-2 adults the 1995 year class was as abundant as all older fish combined in summer 1997. In the fall of 1997, however, most of the larger adults disappeared leaving only the age-2s from 1995 to provide spawners in 1998.

Smelt Abundance and Biomass

Analysis of the early acoustic surveys (1991-94, 1996) did not facilitate partitioning smelt biomass from background acoustical scattering, caused predominantly by mysids. Hence, discussion of much of the smelt data from early surveys would not be appropriate until acoustic data can be reanalyzed. Much of the midwater trawl effort in those early surveys was also aimed at aggregations of alewives. During times of thermal stratifiaction in summer and fall, however, smelt form a distinct layer in cold water separate from concentrations of alewife in warm water above. Midwater trawl catches from the colder "smelt layer" in thoseearlier surveys can provide useful information on trends in smelt abundance and size composition. The CUEs from the midwater trawls show a pattern of steady increase since 1993 (Fig.5).

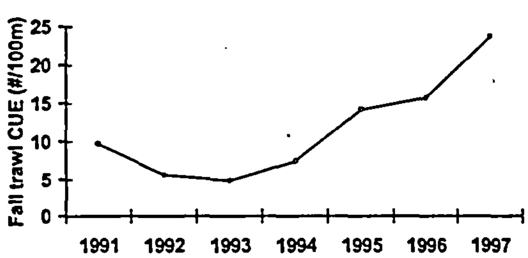


*Figure. 5. Midwater trawl indices of relative abundance (CUE) of smelt in Lake Ontario, 1991 to1997.*

Indexes of smelt abundance from bottom trawl surveys in the 1990s fluctuated without the declines observed in the alewife population. Since 1994, however, smelt abundance has trended upward in bottom trawling surveys (O'Gorman et. al. 1998). The 1997 acoustic estimates of smelt abundance were 4.0 billion fish in the summer survey and 2.8 billion fish in the fall. Using size composition observed in midwater trawls, the numbers translate into biomass estimates of 13,300 and 12,000 metric tonnes. Based on midwater trawl CUE, approximately 90% of the summer and 70% of the fall numbers consisted of yearlings with near zero abundance of adults ≥ 150 mm (Fig. 6).

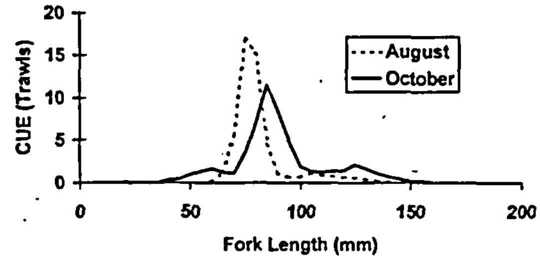


*Figure 6. Length frequency distributions (fork length) for smelt caught in midwater trawls in Lake Ontario, 1997.*

## Discussion

During the period of these acoustic/midwater trawl surveys, alewives were most abundant in 1991, with fall estimates of 12.3 billion fish and 185,000 mt. This was also a year when alewife reproduction was very successful. In the following three years, numbers of alewives declined precipitously to 2.4 billion fish, and only the 1991 year class survived beyond the yearling stage. Evidence that alewife numbers were especially low in 1994 was also observed in other assessments and measurements: chinook salmon growth was poor (Bishop 1997); zooplankton mean sizes and species composition were large (Mills 1995); condition of alewives in fall was exceptional (O'Gorman et al 1997); and cormorant chick production dropped sharply on Little Galloo Island (Ross and Johnson 1995).

Although no acoustic data was available for 1995, the midwater trawl CUE increased three-fold, due to excellent production of YOY alewives (Fig. 3). Likewise, other observations supported the conclusion that alewife numbers increased substantially in 1995: salmon growth rebounded (Bishop 1997); cormorant nesting success increased; zooplankton mean sizes declined (Mills 1997); and alewife condition began dropping (O'Gorman 1997). The improved salmon growth in 1995 came in the latter part of the year (Eckert

1997) when YOY became available. Hence, the rebound in chinook growth seen in 1995 was probably attributable to feeding on YOY alewives.

Acoustic estimates in fall 1996 indicate an alewife population similar in abundance to the 1994 population. Alewife condition, salmon growth and zooplankton sizes, however, remained below levels observed 1994. The spring 1996 bottom trawl survey by USGS and NYDEC indicated, that adult alewives "..had declined to the lowest level since 1979 (O'Gorman et al 1997)." Higher than normal winter mortality during the severe 1995-96 winter was believed to account for the sharply lower numbers. Results from acoustic estimates also indicated that adult abundance was low because of no substantive recruitment since the 1991 year class. Recent reductions in growth and condition (O'Gorman et al 1997) may be indicative of changing system status with increases in abundance of dreisenid mussels; and also may be related to the abundant 1995 year class. The 1995 year class was only moderately represented in spring bottom trawls as yearlings, however, they were abundant in all three acoustic/midwater trawl surveys in 1996. The survival of the 1995 year class through the fall of 1997 was the first successful recruitment since the 1991 year class. In 1997, however, the 1995 year class represented half of the adults in summer acoustic estimates and nearly all of the adults by fall. The absence of a strong 1997 year class and the low overall abundance of adults going into the winter is a cause for concern about the status of the alewife population in 1998. The mild 1997-98 winter may enhance springtime condition of the adults and survival of the YOYs that were small in body size compared to YOYs from strong year classes. The relatively warm winter, however, may also increase the over winter predation rate from large salmonids. Hence, the important concern for management of the salmonine fishery will be the level of reproductive success in 1998 from the remaining members of the 1995 year class.

The biomass of smelt, the second most important prey in the diets of Lake Ontario salmonids, has consistently been lower than alewife. Catch rates from bottom trawl surveys were about 85% lower in biomass for smelt than they were for alewife through 1995. In 1996 and 1997 catch rates were about 60 to 65% lower for smelt. The biomass estimate from the 1997 acoustic survey indicated similar abundances for alewife and smelt, but a 43% lower biomass for smelt. Smelt abundance does not appear to be declining compared to alewife, however,. there also appears to be no compensation by smelt to lower alewife numbers. In addition, both the hydroacoustic and bottom trawl surveys indicate the absence of large older smelt. The Lake Ontario population currently has the appearence of the Lake Erie population with only one spawning age class.

Two other pelagic species, threespine stickleback (*Gasterosteus aculeatus*) and emerald shiner (*Notropis atherinoides*), have become increasingly more abundant in the midwater trawls since the start of the hydroacoustic surveys in 1991 (Fig. 6).

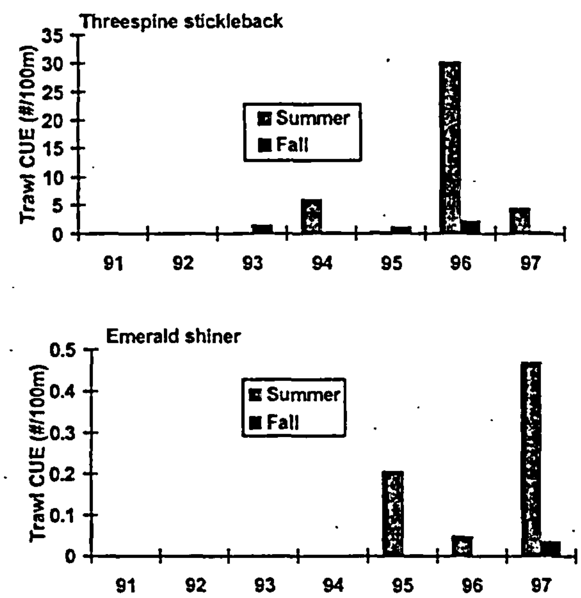


***Figure. 7. Catch rates of threespine stickleback and emerald shiner in midwater trawls in Lake Ontario, 1991 to 1997.***

The trawl catches of the threespine stickleback began increasing in 1993 as we started to encounter occasional large aggregations. In 1996 we were able to identify at least one such aggregation in the acoustic signal. The CUE for sticklebacks rose substantially in 1996, but declined in 1997 back to levels observed in 1993 – 95. Trawl catches of emerald shiner also began to increase in 1995. It is not clear, however, whether this increase represents a fundamental change in abundance, or only a periodic fluctuation in population numbers which seems to charcaterize this species (Scott and Crossman 1973).

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