Status of Important Prey Fishes in the U.S. Waters of Lake Ontario, 2008

Introduction

The U.S. Geological Survey (USGS) and New York State Department of Environmental Conservation (NYSDEC) have cooperatively assessed Lake Ontario prey fishes each year since 1978. Bottom trawling has been conducted during spring to assess alewife *Alosa pseudoharengus*, summer to assess rainbow smelt *Osmerus mordax*, and autumn to assess slimy sculpin *Cottus cognatus*. Timing of the surveys was selected to correspond with the season in which bottom trawl catches of the target species peaked during May to October trawling conducted in 1972 (Owens et al. 2003). Twelve transects were established at roughly 25-km (15.5 mile) intervals along the U.S. shoreline (Figure 1). Bottom trawling was generally conducted at all transects to assess alewife, at all transects except Fair Haven to assess rainbow smelt, and at six transects to assess slimy sculpin. Although each survey targets one species of fish, catches of non-target fishes are also tracked and they provide information on ecologically important changes in the fish community such as the resurgence of once abundant native species like deepwater sculpin *Myoxocephalus thompsonii* (Lantry et al. 2007) or increasing abundance of recently introduced invasive species like round goby *Neogobius melanostomus* (Walsh et al. 2007a).

The underlying principle of our original sampling plan was to concentrate sampling effort in the depth zone where the target species was most abundant by using our knowledge of each fish species' unique bathymetric distribution. At each transect, we typically made trawl hauls at 10-m depth intervals through the range of depths occupied by the target species. In 1997, however, we modified the number and range of depths fished at each transect, as well as the trawling gear, in response to the invasion of zebra and quagga mussels (*Dreissena polymorpha* and *D. bugensis*, respectively, hereafter referred to collectively as dreissenids) which changed fish distribution in the early 1990s (O'Gorman et al. 2000) and resulted in bottom trawls clogged with shells. Fixed station sampling designs, such as ours, are commonly used for assessing fish populations in the Great Lakes and in northern Europe (ICES 2004). The underlying assumption is that changes in relative abundance at the fixed stations are representative of changes in the whole population. Mean abundance from fixed station surveys will not be biased if the fish are randomly distributed. We have always assumed that the fish are randomly distributed in the geographic area in which a transect is located, and because we have numerous transects spaced at regular intervals around the shore, that our abundance indices are unbiased. Acoustic sampling conducted during the 2004-2006 alewife bottom trawl assessments confirmed our assumption of random distribution within geographic areas. Furthermore, differences among geographic areas in densities of alewife-strength targets measured with acoustics were reflected in the densities of alewife measured by bottom trawl. However, there is no assurance that this has always been true given the large scale shifts in fish distribution since dreissenids proliferated. Although random sampling is preferable for estimating precision, the systematic, fixed-station sampling that we employ in Lake Ontario will often be optimal for generating the most precise estimate of relative abundance even though the variance of the estimated relative abundance will be biased (ICES 2004).

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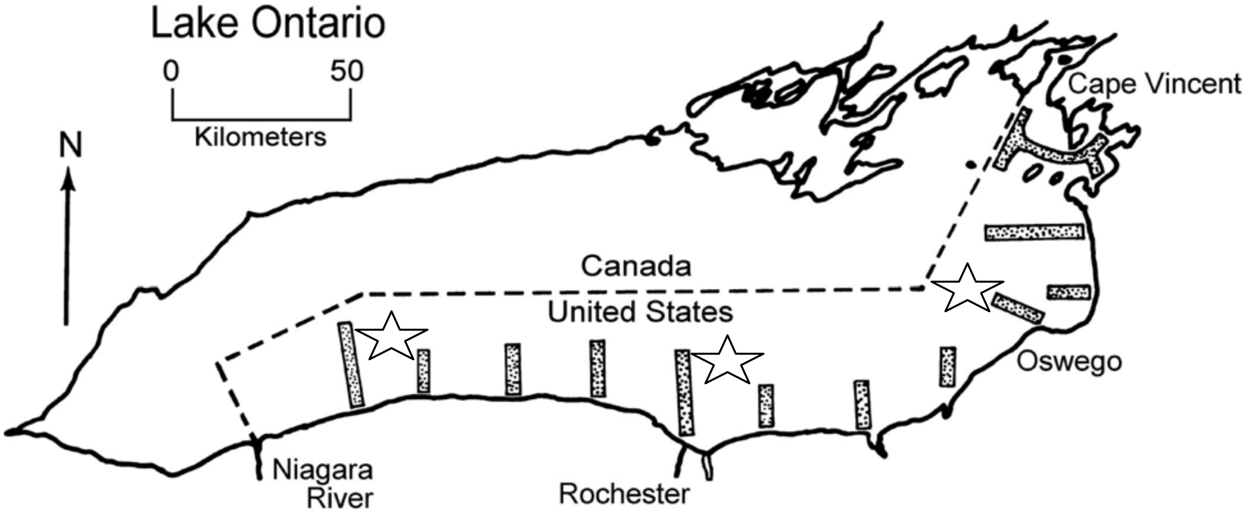

Figure 1. Lake Ontario showing 12 transects sampled with bottom trawls. Transect names, from west to east, are: Olcott, Thirty Mile Pt., Oak Orchard, Hamlin, Rochester, Smoky Pt., Sodus, Fair Haven, Oswego, Mexico Bay, Southwick, and Cape Vincent. The six transects sampled during the slimy sculpin assessment are adjacent to the three stars.

Two vessels participated in prey fish surveys during 1978-1982, the 19.8-m (65 ft), steel hull R/V *Kaho* (USGS) and the 12.8-m (42 ft), fiberglass hull R/V *Seth Green* (NYSDEC). During 1983-1985, all assessment trawling was conducted by the *Kaho* (the fiberglass *Seth Green* was permanently retired in fall 1982). In 1985, the NYSDEC accepted delivery of a new R/V *Seth Green* and this 14-m (46 ft), steel hull vessel participated with the *Kaho* in prey fish surveys during 1986-2002 and in 2004-2008. Because of personnel shortages within the NYSDEC, only the *Kaho* was used to assess prey fish stocks in 2003. Intercalibration studies determined that, for alewife and rainbow smelt, the fishing power of the *Kaho* did not differ from that of either the fiberglass or steel *Seth Green*. Intercalibration studies were not conducted for slimy sculpin because the *Kaho* was the only vessel used to assess slimy sculpin each fall.

A bottom trawl with a 12-m (39 ft) headrope and flat, rectangular trawl doors were used to assess alewife and rainbow smelt until 1997 when fouling by dreissenids forced a change to a 3-in-1 bottom trawl with an 18-m (59 ft) headrope and slotted, cambered V-doors. We made a series of paired tows to determine calibration factors for the two gears to allow comparison of alewife and rainbow smelt catches made by the new gear with those made by our traditional trawling gear. However, up until 2004, we continued to use the traditional trawling gear to assess slimy sculpin in areas where dreissenid density was sufficiently low (mainly in deep water) to allow us to trawl unimpeded. In 2004, the 18-m (59 ft) headrope trawl was used to assess slimy sculpin because increased dreissenid density in deeper water had greatly reduced not only the number of depths at which we could tow a trawl but had also reduced the amount of time we could tow at most depths. Few slimy sculpin were caught in 2004, however, indicating that the 18-m (headrope) trawl, which makes minimal contact with the bottom, was not suitable for assessing benthic sculpin. In 2005-2007, a tickler chain was added to the 18-m (59 ft) headrope trawl to increase bottom contact for the slimy sculpin assessment; although problems encountered in 2007 indicated that the net with the tickler chain did not perform adequately and should no longer be used in this assessment. In 2008 we successfully tested and implemented a new net design for this assessment (see Status of Sculpins and Round Goby below).

In 2008, the number of trawl hauls made for assessment of alewife, rainbow smelt, and slimy sculpin totaled 255 ─ 94 during April 21 - May 7, 103 during May 27 - June 5, and 58 during October 14 – November 4. The number of trawl tows made to assess alewife was about 10% below the 1978-2005 average due to adoption of informed allocation of sampling effort in 2006 (See Status of Alewife below**).** Trawling effort during the rainbow smelt assessment was similar to that in 2007, but greater than in previous years due to a revised stratification scheme and increased sampling effort designed to increase precision of abundance indices (Walsh et al. 2007c). Addition of a tickler chain to the 18 m (59 ft) bottom trawl in 2005 allowed for increased efficiency and led to increased effort (minutes towed) during the slimy sculpin assessment during 2005-2006 (Walsh et al. 2006, 2007b). In 2007 we again encountered problems with dreissenid mussels that led to a 16% decrease in effort as well as equipment damage and loss (Walsh et al. 2008). With our new net design in 2008 we were once again able to complete the full assessment with increased effort at depths <70 m (see Status of Sculpins and Round Goby below).

In 2007, the Great Lakes Science Center purchased a wireless trawl monitoring system for use in Lakes Erie and Ontario. The system was used on the Lake Ontario slimy sculpin assessment in 2007 and on the alewife, juvenile lake trout, and slimy sculpin assessments in 2008 to further evaluate performance of the trawl net.

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Status of Alewife in the U.S. Waters of Lake Ontario, 2008

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Abstract

Adult alewife abundance and biomass indices increased from 2007 and were 67% and 69% of long term means, respectively. Condition of adult alewives remained high and was similar to condition during 2004-2007. Abundance of age-1 alewife was higher than anticipated, given the low number of available spawners, and was 62% of the long term mean. In 2009, adult alewife abundance and biomass may decrease due to a small 2006 year class recruiting as age-3 fish, and will be highly influenced by survival of the large 2005 year class which will be age 4. Even though spawner biomass has increased from the extremely low levels in 2006 and 2007, the recruitment model predicts that the 2008 year class will likely be below average because of the long winter duration in 2008-2009.

Expansion of the Sampling Frame

Lake Ontario has a mean depth of 86 m (282 ft) and a maximum depth of 244 m (801 ft) (Coordinating Committee 1977; Herdendorf 1982). The southern, New York portion of the lake has the deepest water (Figure 1). In New York waters, about 67% of the lake is <160 m (525 ft) deep and about 82% of the lake is <180 m (591 ft) deep. Since the inception of spring alewife assessments in 1978, our sampling frame has encompassed only those waters <160 m (525 ft) deep in New York waters. In the late 1970s and early 1980s, O'Gorman and Schneider (1986) demonstrated that during late April – early May, alewife density in Lake Ontario increases with water depth to a peak at 40-79 m (131-259 ft), and then rapidly declines with depth suggesting that the vast majority of alewife in the lake were within our sampling frame. In 1994, however, the depth distribution of alewife shifted deeper ostensibly due to increased water clarity after zebra and quagga mussels (*Dreissena spp.*) colonized the lake (O'Gorman et al. 2000) raising the possibility that a larger proportion of alewife were outside the sampling frame after the mid 1990s. However, we found that the proportion of alewife in the deepest stratum we sampled (140-159 m; 459-522 ft) was always <3% until 2003 when it rose to 4%. Such small proportions of the population at the fringe of the sampling frame, where density was declining, suggests that the large majority of alewife were indeed within the sampling frame even after the mid-1990s depth shift.

The increase in the proportion of alewife in the 140-159 m (459-522 ft) stratum in 2003 prompted us to expand sampling to the 160-179 m (525-587 ft) depth stratum in subsequent years. However, we never used catches in the 160-179 m (525-587 ft) stratum when calculating alewife abundance because we wanted to maintain continuity of the abundance indices until we obtained observations from a number of years and could evaluate the effect of expanding the sampling frame on abundance indices. Expanding the sampling frame to include catches in the 160-179 m (525-587 ft) stratum would increase the 2004-2007 indices of adult alewife abundance 7% on average (range: 2% - 17%) whereas it would increase the 2004-2007 indices of yearling alewife abundance 10% on average (range: 2% - 19%). Because expanding the sampling frame has the potential

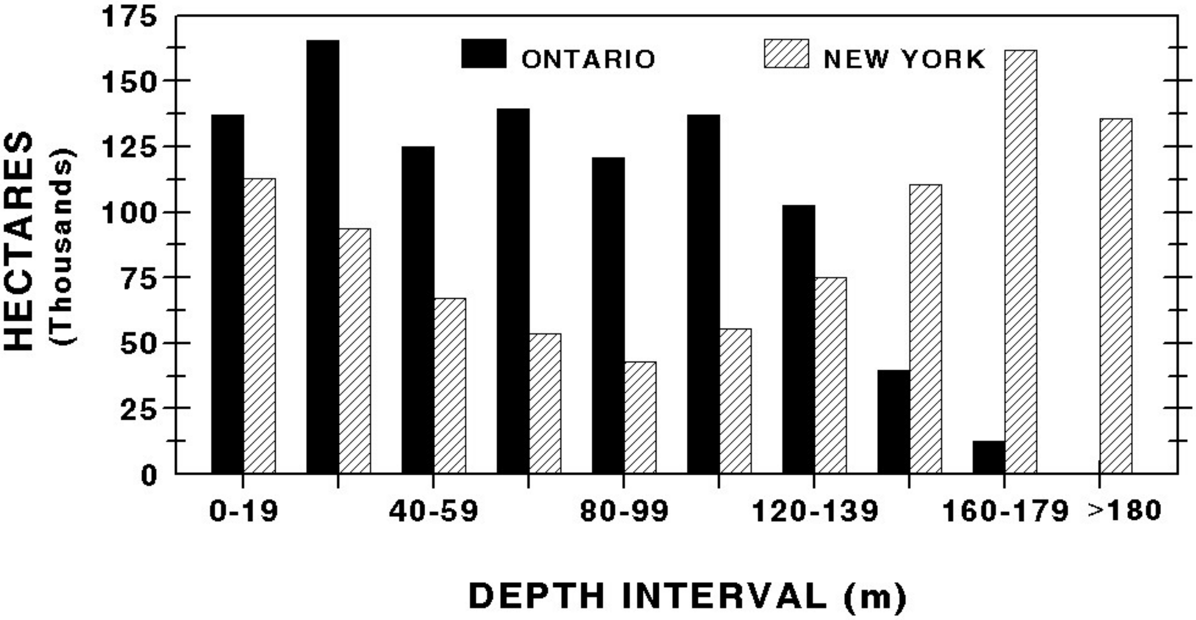

Figure 1. Area of Lake Ontario in various depth strata in the province of Ontario and the state of New York. 1 m = 3.28 ft and 1 hectare = 2.47 acres.

to increase abundance indices >10% in some years, we will continue sampling out to the 180-m bottom contour and we will hereafter use the catches in the 160-179 m (525-587 ft) stratum when calculating abundance indices for those years after 2003.

Calculating Alewife Abundance Indices

Calculation of Indices

Expansion of the area within the sampling frame necessitated modifying how we calculate abundance indices. The sampling frame is divided into 20-m (66 ft) depth strata and abundance indices are simply the weighted mean catch per tow (CPUE), in numbers or weight, within the sampling frame. Previously, mean catch in a stratum was weighted by the proportion of the total sampling frame within that stratum. With the expansion of the sampling frame from the 160-m (525 ft) bottom contour to the 180-m (591 ft) bottom contour, we now weight the mean catch in a stratum by the total number of hectares within that stratum in the sampling frame (U.S. waters) and abundance indices are, for ease of presentation, the weighted means multiplied by 10^{-6}. Although weighting by the number of hectares results in indices with values that differ from those previously used, it does not change the relative differences among indices during 1978-2003. However, weighting by the number of hectares in concert with the expansion of the sampling frame to the 180-m (591 ft) bottom contour does change the relative differences among indices during 2004-2007 and reduces the relative differences between indices in 1978-2003 and those in 2004-2007.

Re-estimating Alewife Abundance in 2001

The *Kaho* did not participate in the spring 2001 alewife assessment because of a mechanical breakdown; all trawling was done by the *Seth Green*. However, the *Seth Green* also encountered mechanical problems and was unable to fish on many days. Consequently, spatial coverage of the sampling frame was incomplete, and timing of sampling in some areas was outside the historical period. Therefore, spring catches

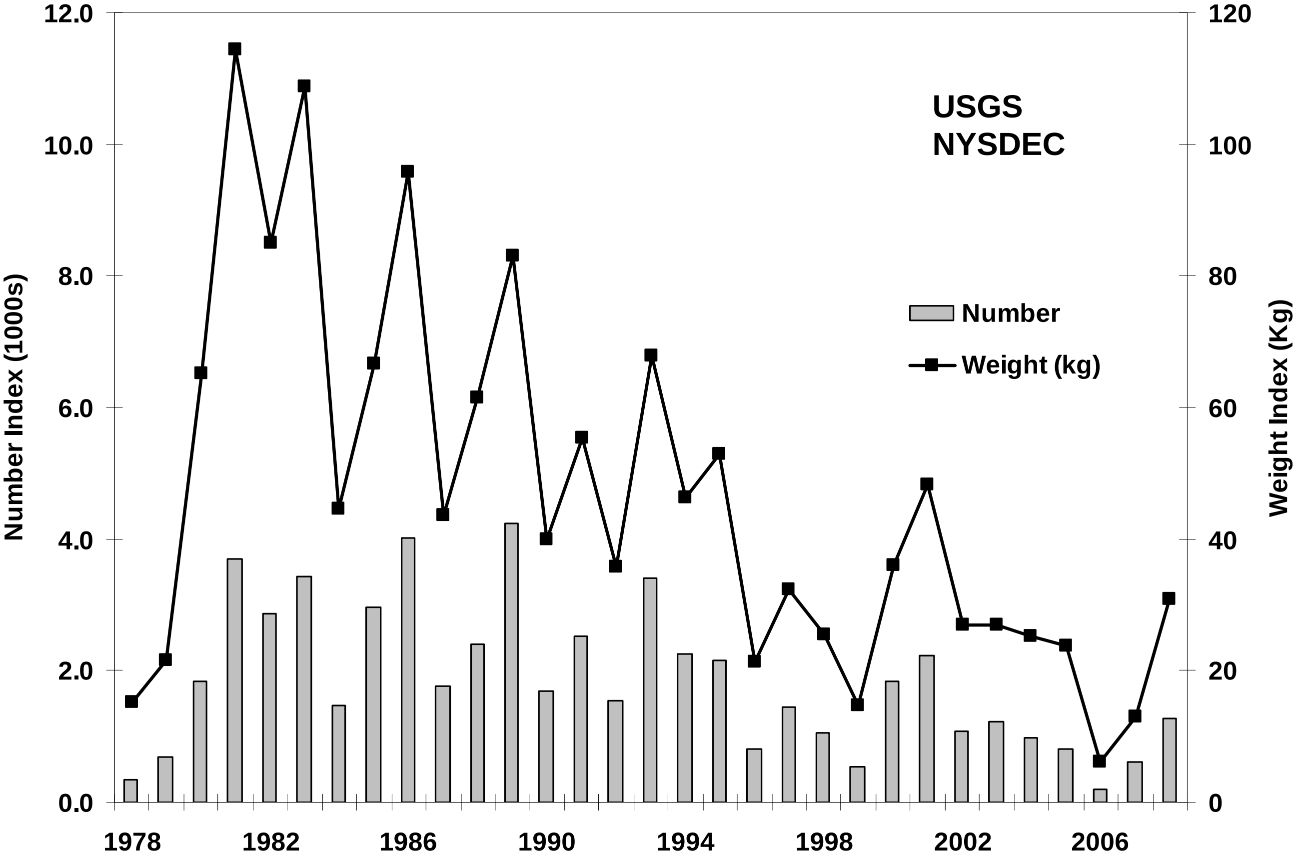

Figure 2. Abundance indices for adult (age-2 and older) alewife in the U.S. waters of Lake Ontario during late April – early May, 1978-2008.

were used only for biological information on alewives (i.e., age composition, growth, and condition) and were not used to determine abundance of alewives. In 2001, we estimated spring abundance of alewives from catches during the May − June rainbow smelt assessment by use of the relationships between alewife catches in May − June to those in April − May. We used regression analysis to define the relationships, forcing the regression line through the origin and using only catch data from 1992-2000, after the shift in alewife depth distribution (O'Gorman et al. 2000). For yearling alewives there was a strong, positive linear relationship between catches in May – June and those in April − May (r^2 = 0.76, $P < 0.01$) whereas for adult alewives there was a weak, positive linear relationship (r^2 = 0.35, P = 0.10). Prior to the shift in depth distribution of the early 1990s, there were no obvious relationships between catches on the two surveys, perhaps because alewife distributions differed more among surveys then than they did after the mid 1990s depth shift.

Our initial estimate of alewife abundance in 2001 was calculated from catches in May − June using the relationship of catches in April − May to those in May − June determined from catches during 1992-2000, a time period when we used both the 12-m (39 ft) headrope trawl (1992-1996) and 18-m (59 ft) headrope trawl (1997-2000). In 2007, we re-estimated the relationship of alewife catches in April − May to those in May − June, only this time we used catches during 1997-2006, a time period when all assessments were conducted with the 18-m (59 ft) trawl. For yearling alewives, there was a strong, positive linear relationship between catches in April − May and those in May − June (r^2 = 0.77, $P < 0.01$), a result similar to our initial calculation. For adult alewives, there was also a positive linear relationship (r^2 = 0.58, $P <$ 0.05), a result which differed from our initial

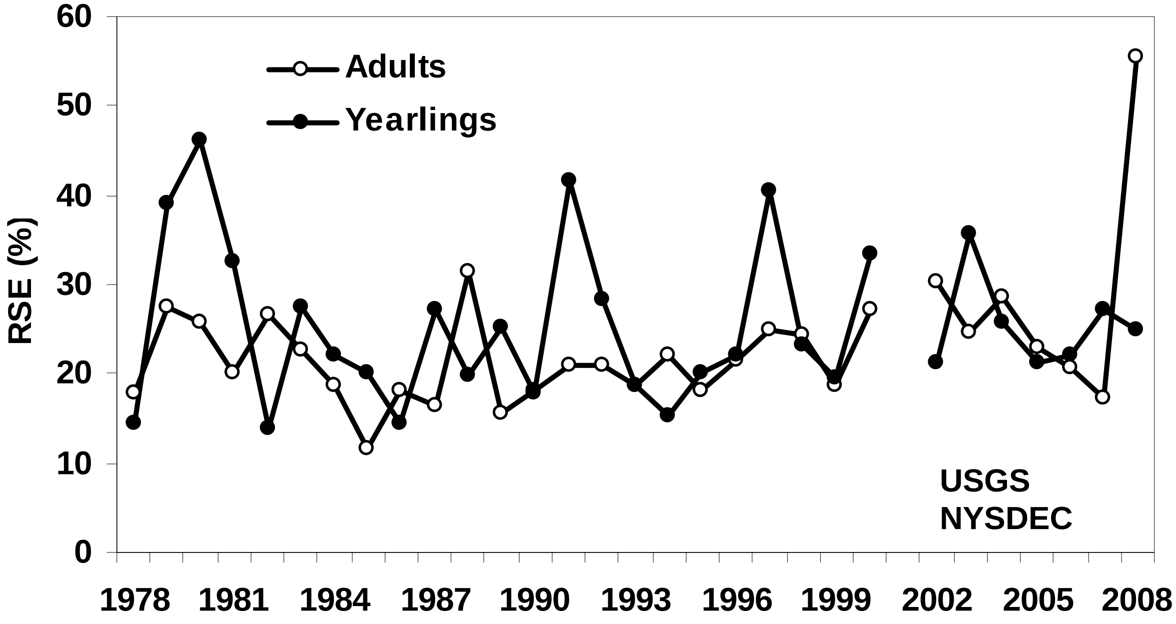

Figure 3. Relative standard error (RSE) for the yearling number index and adult alewife biomass index in U.S. waters of Lake Ontario, 1978-2008. The RSE (RSE = 100 * {standard error of the index / the index}) is a measure of variability in abundance indices.

calculation of a weak, positive linear relationship. Re-estimation of alewife abundance in 2001 using the new relationships among seasonal catches resulted in little change in our estimate of yearling alewife abundance whereas it resulted in a 29% lower estimate of adult alewife abundance (Figure 2).

Status of Alewife

In April – May 2008, the abundance of adult alewife (age-2 and older) in U.S. waters of Lake Ontario was higher than during 2004-2007, and more similar to the index in 2003 (Figure 2). The 2008 weight index was equal to 67% of the long-term mean, 27% of the record high of 1981, and 510% of the record low of 2006. The 2008 numerical index was equal to 69% of the long-term mean, 30% of the record high of 1989, and 622% of the record low of 2006. In the adult population, we anticipate a low percentage of age-2 fish from the weak 2006 year class, and that the population will be dominated by age-3 fish. However, at this time we have only completed age estimates to establish age-1 fish and do not have further quantitative analyses of the age structure of the population.

We use the relative standard error (RSE; RSE = 100 * {standard error of the index / the index}) as a measure of variability in abundance and weight indices. In 2008, the RSE of the adult weight index was 55%, which was markedly higher than the rest of the time series and well above the long term mean (23%, Figure 3). We believe this is due to a few unusually large catches of alewives at shallower depths in the western area. We anticipate that RSE will return to more typical levels next year. However, we will continue to monitor unusual catches for patterns that could indicate distribution shifts. The RSE of the yearling number index was 25%, which was slightly lower than the RSE in 2007 and similar to the long term mean (25%).

The numerical abundance index for age-1 alewife in 2008 (2007 year class) was equal to 652% of the numerical index in spring 2007 and was 62% of the long term mean, which falls within the range (36%-72% of the long term mean) predicted by our recruitment model last year (O'Gorman et al. 2004, 2008; Figure 4). Although yearling alewife are not fully recruited to our sampling gear, we consider the yearling abundance index a reliable indicator of year class strength because the indices are correlated with the catch

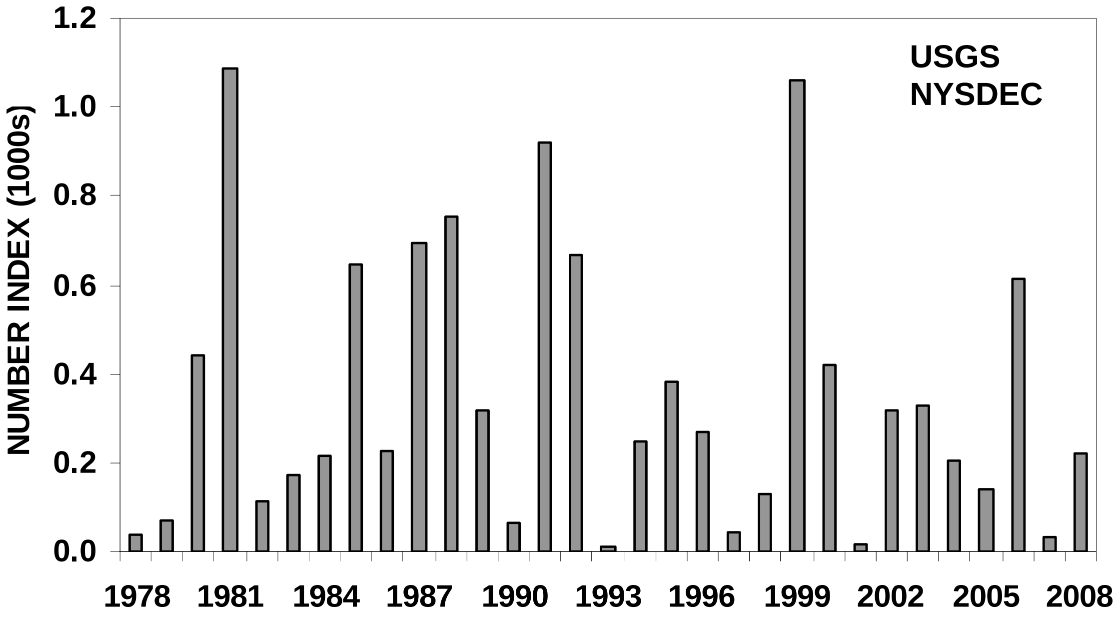

Figure 4. Abundance indices for yearling alewife in the U.S. waters of Lake Ontario during late April – early May, 1978-2008.

rates of the same year class at age 2 (Spearman rank correlation, n = 28, $r = 0.61$, $P = 0.0005$) and age 3 (Spearman rank correlation, n = 23, $r = 0.74$, $P < 0.0001$). Individuals from the 2007 year class were larger than average at age-1, and therefore may survive well to age-2 recruits in 2009. As such, this may contribute toward an increase in numbers of adult alewife in 2009, however both abundance and biomass indices of adults will be heavily influenced by the survival of the large 2005 year class which will be age 4 in 2009.

Our index of adult alewife condition is the wet weight of a 165-mm (6.5-in) alewife predicted from annual length-weight regressions. The predicted weight in fall 2008 was slightly below that in 2007, which was the heaviest since 1979 (Figure 5). During 2003-2008, condition in fall has been higher than in any other period since the late 1970's. Elevated condition each fall during 2003-2008 suggests that the alewife population was not expanding to a level at which it would depress food resources, and that the relatively small alewife population in recent years was more in balance with production from Lake Ontario's lower food web than at any time during 1981-2002. Analyses are ongoing to evaluate environmental influences on alewife condition.

Strength of alewife year classes at age 1 is positively linked to nearshore water temperatures during May − July and negatively linked to the number of days nearshore water is < 4° C (39° F) during the first winter after hatch (an index of winter duration) (O'Gorman et al. 2004). In 2008, May − July water temperatures were less than that during 2005-2007, but above the long-term average, indicating moderate conditions for reproduction.

Moreover, the duration of winter 2008-2009 appears as if it will be longer than average, which may be less favorable for survival of juveniles. Year class strength is also influenced by the abundance of spawners in a curvilinear manner – weak year classes are produced by extremely large and very small spawning stocks whereas strong year classes are produced by spawning stocks of intermediate size (O'Gorman et al. 2004). The effect of spring water temperatures, winter duration, and spawner numbers are combined in the recruitment model by O'Gorman et al. (2004) but, as previously mentioned, using this model to predict the magnitude of the 2006 year class was problematic because the spawning stock in spring 2006 was the smallest we have ever observed and outside of the range of the model. In 2008, the spawning stock increased

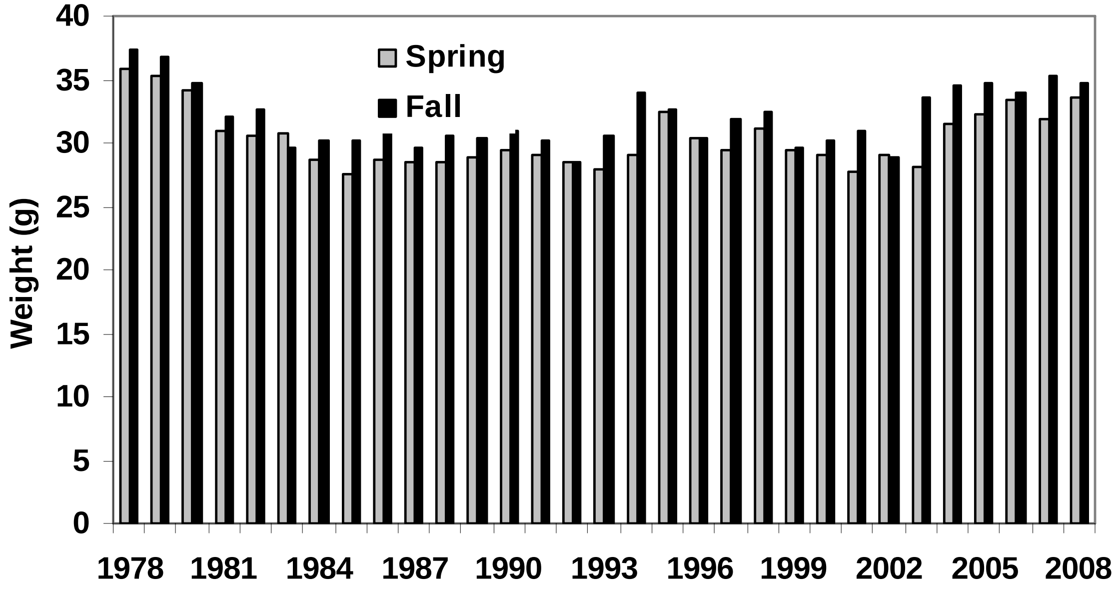

Figure 5. Wet weight of a 165-mm (6.5 in) alewife (predicted from annual length-weight regressions) in spring and fall, Lake Ontario, 1976-2008. 1 gram = 0.035 ounce.

above levels observed during 2006-2007 and back within the range of model prediction. Model output indicates that, at age 1, the 2008 year class could be over double the long term mean at best, but more likely will be <30% of the long term mean based on the anticipated long duration of winter in 2008-2009.

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Status of Rainbow Smelt in the U. S. Waters of Lake Ontario, 2008

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Abstract

The abundance index for age-1 and older rainbow smelt Osmerus mordax *in 2008 was the lowest yet recorded in the 31-year time series. The number of age-1 rainbow smelt caught in 2008 was lower than values for 2005-2007, and is lower than the previous all-time low number of age-1 smelt caught in 2003. An unusually large 2003 year class followed by a relatively small 2004 year class appeared to signal a resumption of the alternating pattern in year class strength that had been intact during 1984-2000, but four small year classes in succession in 2004 -2007 indicate another breakdown in the pattern. Larger and older rainbow smelt remain scarce in Lake Ontario. Although the rainbow smelt population has demonstrated considerable resiliency in the past, it is unclear if it will be able to rebound from these low levels of spawners and recruits as it did in 2003.*

Rainbow Smelt

In 2006, we reconstructed and quality checked the entire rainbow smelt *Osmerus mordax* database by comparing data sheets with database records, and in 2007 we completed correction of all errors identified during quality checking. Therefore, the abundance and biomass index time series included in this report reflect updated and corrected catches of rainbow smelt, 1978-2007, from 12- and 18-m (39 and 59 ft) headrope bottom trawls; previous analyses determined that no correction factor was needed between gears (Walsh et al. 2007). We will continue to quality check and correct database errors annually to preserve the integrity of the existing database.

Status of Rainbow Smelt

Number and weight indices for adult rainbow smelt were the lowest in the 31-year time series (Figure 1). Numbers and biomass of age-1 and older were markedly lower than in 2004 when the abundance indices were the highest since 1998 (Figure 1). In 2008, the numerical index was around 6% of the value for 2004, and the weight index about 18% of the value for 2004. Since the changes in fish distribution observed in the late 1990s after colonization by dreissenid mussels (O'Gorman et al. 2000), relative standard error (RSE, 100*[standard error of number index/number index]) of the rainbow smelt index has increased in value and variability (Figure 2). A strategy to reallocate sampling effort to reduce variability in the index was developed in 2000 and revised in 2006 (Walsh et al. 2007). Under the 2006 sampling design revision, RSE for the number index in 2006 was similar to that in 2005, but in 2007 increased to 40.1% and increased further in 2008 to 55.9% (Figure 2). This increasing trend in RSE is likely related to the increasingly low and variable catches of rainbow smelt in 2007 and 2008; if catch rates remain near current low levels, reduction in the RSE may be difficult or impossible.

Rainbow smelt year classes generally alternate between strong and weak in Lake Ontario (Figure 3), apparently due to cannibalism, primarily by yearling smelt on young-of-year. 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 age-1 fish in 2005 (2004 year class) appeared to signal a resumption of the alternating pattern in year class strength that had been intact during 1984-2000. The age-1 rainbow smelt index in 2008 was

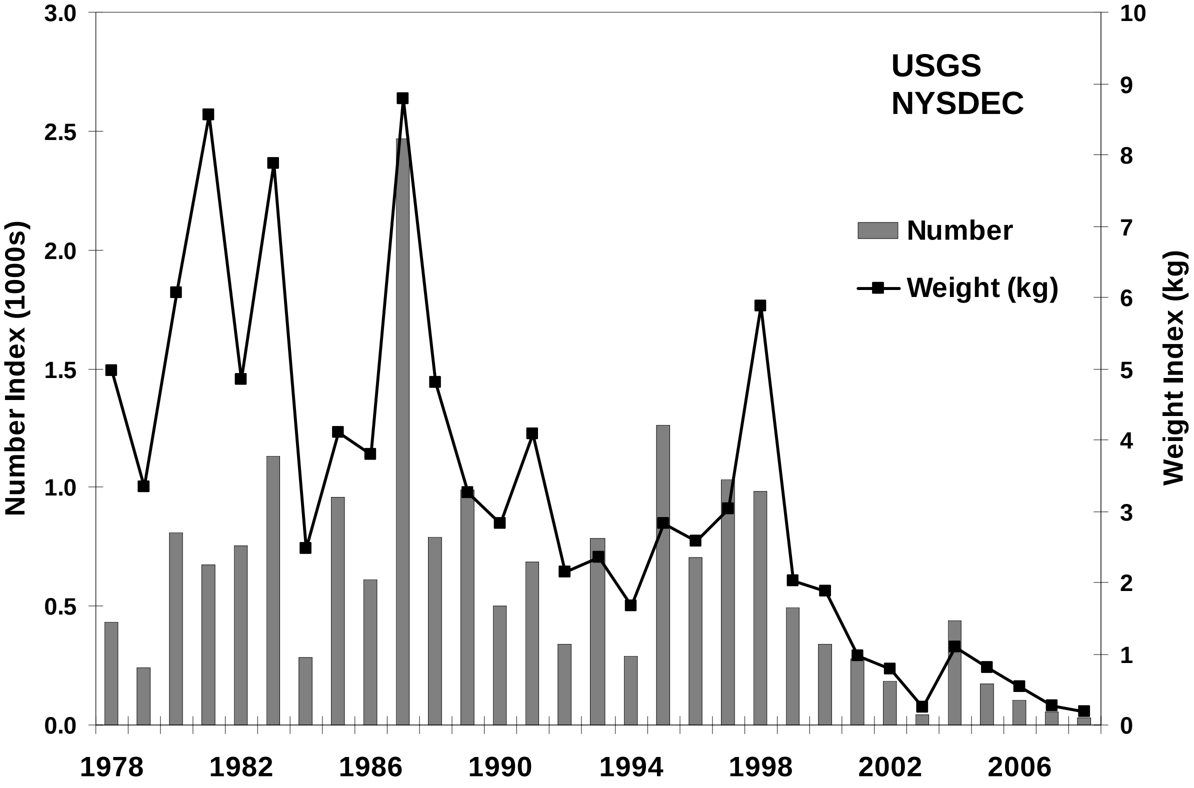

Figure 1. Stratified mean catch of rainbow smelt (age-1 and older) with bottom trawls in U.S. waters of Lake Ontario shoreward of the 140-m (459 ft) bottom contour in late May-early June, 1978-2008. For the weight index, 1 kg = 2.2 lb.

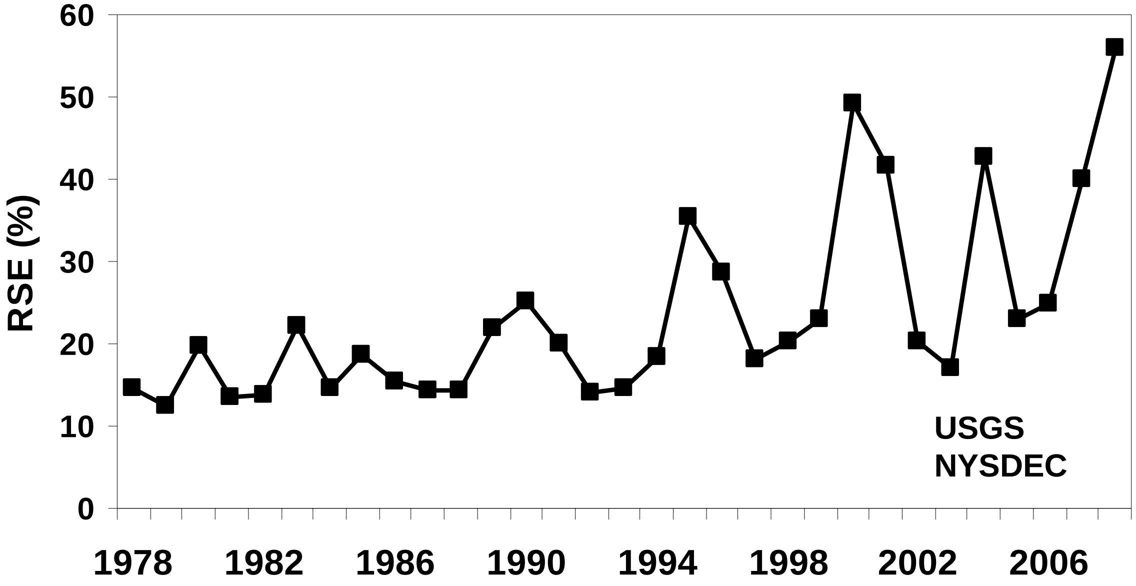

Figure 2. Relative standard error (RSE) for age-1 and older rainbow smelt abundance indices in U.S. waters of Lake Ontario, 1978-2008. The RSE [RSE = 100(standard error of the index/the index)] is a measure of variability in the abundance index.*

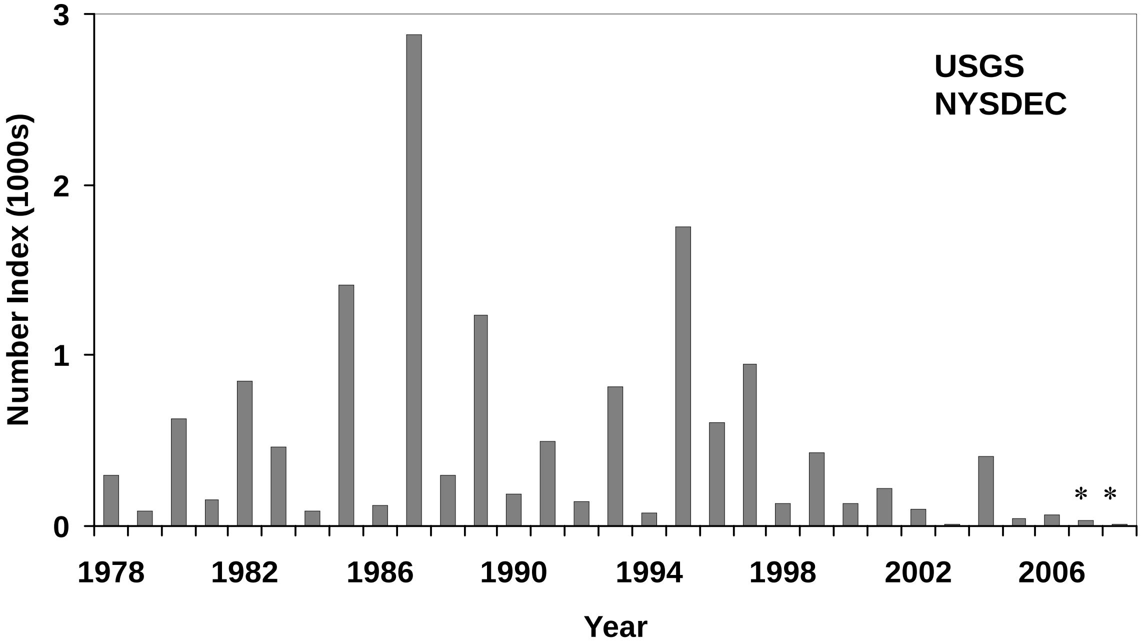

Figure 3. Stratified mean catch of age-1 rainbow smelt with bottom trawls in U.S. waters of Lake Ontario shoreward of the 140-m (459 ft) bottom contour in late May-early June, 1978-2008. The 2007 and 2008 estimates (*) are based on 2001-2005 age-length keys.

the lowest recorded in the 31-year time series (Figure 3). Small year classes in 2004-2007 seem to represent another breakdown in the alternating pattern of year class success and will likely make it difficult for this population to rebound as it has in the past.

The relative and absolute abundance of large rainbow smelt (≥ 150-mm or ≥ 5.9 in) remained low in 2008. Large rainbow smelt composed less than 3% of the population during 1989-2008 (range: 0.1 to 2.8%); during 2006-2008 the proportion of larger smelt has been similar (2.3-2.5% of the populations). The stratified mean catch per tow of large rainbow smelt ranged from 1 to 14 during 1989-2008 and was 1 in 2008. 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 individuals. The paucity of large rainbow smelt during 1989-2008 was likely due to heavy predation and, more recently, weak year classes in 1999-2002. Rainbow smelt from the large 2003 year class should have started recruiting to the ≥ 150-mm (≥ 5.9 in) size class in 2007, and should have been fully recruited in 2008.

In the previous two years we forecasted that rainbow smelt abundance indices for all age groups combined would rebound and increase because we anticipated production of a strong year class after successive years of weak year classes. However, production of a strong year class has not occurred, and the current population index is only slightly higher than it was in 2003, when it appeared the population was at risk of collapse. Rainbow smelt demonstrated considerable resiliency at that time by rebounding from an extremely low level of spawner abundance, but it is unclear if the population will be able to rebound from these low levels again as it did in 2003.

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Status of Sculpins and Round Goby in the U.S. Waters of Lake Ontario, 2008

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Abstract

In 2004, we used an 18-m (59 ft, headrope) bottom trawl, after dreissenid mussels precluded towing our standard 12-m (39 ft, headrope) trawl which was historically used to assess slimy sculpin Cottus cognatus. *Unfortunately, the catches from the 18-m (59 ft, headrope) bottom trawl were inconsistent. In 2005 and 2006, we used a tickler chain modification to the 18-m (59 ft, headrope) trawl that allowed us to both add tows at shallower depths and tow for longer amounts of time at deeper depths without biofouling. However, significant problems encountered in 2007 indicated that the net with the tickler chain no longer performed adequately and should no longer be used in this assessment. In 2008 we evaluated a completely new net design, a shorter and lighter 12-m (39 ft, headrope) bottom trawl. We successfully implemented the new net during the survey and completed all scheduled tows. During 2008 standard assessment sampling, we caught 30 deepwater sculpins* Myoxocephalus thompsonii *(37 - 145 mm [1.5 – 5.7 in]), continuing the recent trend of increased catches of this species, once thought to be extirpated from Lake Ontario. In 2008, both the abundance and biomass indices for round goby* Neogobius melanostomus *increased from 2007 values.*

Sculpins

Slimy Sculpin

The slimy sculpin (*Cottus cognatus*) assessment is conducted at six transects, two in each of three lake areas (western, central, and eastern) in southern Lake Ontario (see Introduction Figure 1). In 1996, we lost our ability to index the slimy sculpin population at depths <70-m (230 ft) along the south shore of Lake Ontario because density of zebra and quagga mussels (*Dreissena polymorpha* and *D. bugensis*; hereafter collectively referred to as dreissenids) had risen to a level that made sampling with our 12-m (39 ft, headrope) trawl problematic. Quantities of dreissenids in the net were so large that they potentially altered the fishing power of the net, hindered catch sorting, and sometimes even precluded winching the catch in the cod end of the net onto the deck. We continued to use the 12-m (39 ft) trawl to assess sculpins at depths >70 m (230 ft) during 1997-2003 although tow times at depths <100 m (328 ft) were continually reduced as the dreissenid population expanded into deeper water. By 2003, in southwestern Lake Ontario, we were unable to trawl at depths <80 m (262 ft) and the standard 10-min tow time had to be reduced to 5 min or less at depths of 85 (279 ft) and 95 m (312 ft). In 2004, we tried to assess slimy sculpin using the 18-m (59 ft, headrope) bottom trawl which catches fewer dreissenids and has been successfully used to assess alewife and rainbow smelt since 1997. Use of this gear to assess slimy sculpins was generally unsuccessful, with catches greatly decreased from previous years. Overall, our impression was that the 18-m (59 ft) trawl performed inconsistently but that with some modification it could be a useful tool for assessing sculpins and other small, demersal fishes on the dreissenid-infested bottom.

Based on 2005 analyses we decided to add a tickler chain (18-m [59 ft] length of 5/16 in chain) to the 18-m (59 ft) trawl as a method to increase slimy sculpin catches (Walsh et al. 2006). A tickler chain is a common trawl modification

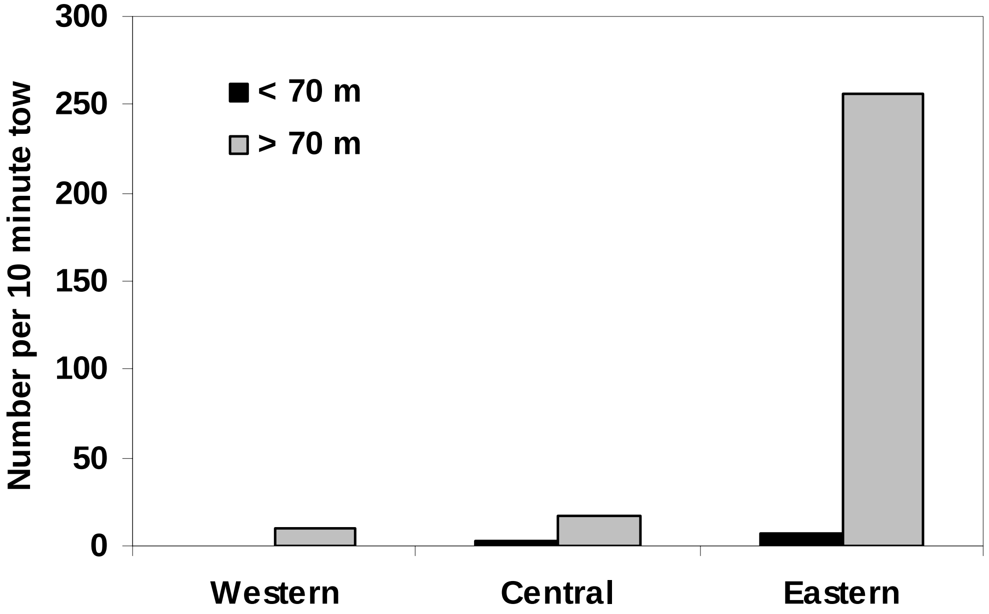

Figure 1. Number of slimy sculpins collected per 10-min bottom trawl tow in U.S. waters of Lake Ontario in fall 2008.

used in commercial fisheries, and consists of a chain attached to the net in such a manner that it drags along bottom in front of the footrope, causing benthic animals to move up off of the sea floor so they can be more easily swept into the trawl net. We successfully implemented this gear change in 2005, and substantially increased trawling effort from that in 2003 (the last year that the 12-m [39 ft] trawl was used), with most added effort at depths ≤ 85 m (279 ft, Walsh et al. 2006). We continued use of the tickler chain on the slimy sculpin assessment in 2006 and effort (55 tows, 512 min) was similar to that in 2005 (59 tows, 502 min). In 2007, we encountered significant problems with dreissenid mussels that led to a 16% decrease in effort (49 tows, 430 min) from 2006. We lost a total of seven tows to dreissenids and gear problems, and at several sites tow times had to be reduced to 5 min to reduce the risk of the net filling with dreissenid mussels. The extensive problems with dreissenid mussels caused significant gear loss and damage and we were forced to end the assessment prematurely to prevent additional equipment losses (Walsh et al. 2008).

In 2008 we tested a new net design for use on only the slimy sculpin assessment. Two smaller, lighter 12-m (39 ft, headrope) trawls with polyethylene mesh (7.6 cm [3 in] wings, 5.1 cm [2 in] body, 1.3 cm [0.5 in] cod end, all stretch mesh) were given to us by Environment Canada. We modified the nets slightly during field testing until we achieved the desired result of the net fishing more heavily on the bottom to target benthic fishes, without retaining an amount of dreissenids that would cause net damage or inhibit our ability to process the catch. The final net design used 0.5 cm (3/16 in) chain, tied every 30.5 cm (1 foot), resulting in loops 14 links long. Additional weights were placed onto the footrope to increase bottom contact. The new net design performed very well during the assessment and we were able to increase our effort back up to 58 tows (547 min). Slimy sculpins were more abundant at depths greater than 70 m at all transects, and more abundant at eastern transects than at central or western transects (Figure 1), but due to recent gear changes we are unable to quantitatively compare abundance in 2008 to previous years.

Deepwater Sculpin

Deepwater sculpin (*Myoxocephalus thompsonii*) were abundant in Lake Ontario in the 1920's and at least common into the 1940's. By the mid 1960's, they were rare and thereafter, some considered the population extirpated. A recent summary of deepwater sculpin records from literature, commercial fishing records, and fisheries surveys in Lake Ontario during 1960 – 2005 documents sporadic captures of deepwater sculpin through 2004 (Lantry et al. 2007). In 2005, 17 deepwater sculpins were caught in U.S. waters of Lake Ontario and 2 were caught in Canadian waters, and among these deepwater sculpins, young, small individuals were numerically dominant (Walsh et al. 2006; Lantry et al. 2007). Catches of deepwater sculpins in standard assessment catches and presence of small individuals continued in 2006 and 2007 (18 and 7, respectively; Walsh et al. 2007a, Walsh et al. 2008). In 2008, we collected 30 deepwater sculpins (37 - 145 mm [1.5 – 5.7 in]) at depths 75 – 170 m (23 – 558 ft), during joint USGS/NYSDEC assessment cruises. The 2008 catch is an increase from previous years, primarily due to the catch of 19 individuals during the slimy sculpin assessment. The increased catch of deepwater sculpin with the new net design further strengthens our assertion that the new net is more effectively targeting benthic fishes. The continued presence of juvenile deepwater sculpins in our assessments indicates that conditions for survival of young deepwater sculpins are favorable, perhaps because of reduced abundance of alewife, which have been linked to depression of deepwater sculpin in Lake Michigan (Madenjian et al. 2005), and benthic piscivores such as burbot (*Lota lota*) and lake trout (*Salvelinus namaycush*, Lantry et al. 2007).

Round Goby

Round gobies (*Neogobius melanostomus*), a suspected ballast water introduction, were first detected in the Great Lakes Basin in the St. Clair River between Lakes Huron and Erie in 1990 (Jude et al. 1992). Round gobies probably moved downstream into Lake Ontario through a navigation canal; they were first reported in southwestern Lake Ontario in 1998 near the entrance to the Welland Canal (Owens et al. 2003), and we first collected round gobies in our standard assessment trawling in 2002 (two individuals). Since then, the round goby population has expanded substantially and round gobies are now found along the entire south shore of Lake Ontario, with the highest population densities in U.S. waters just east of the Niagara

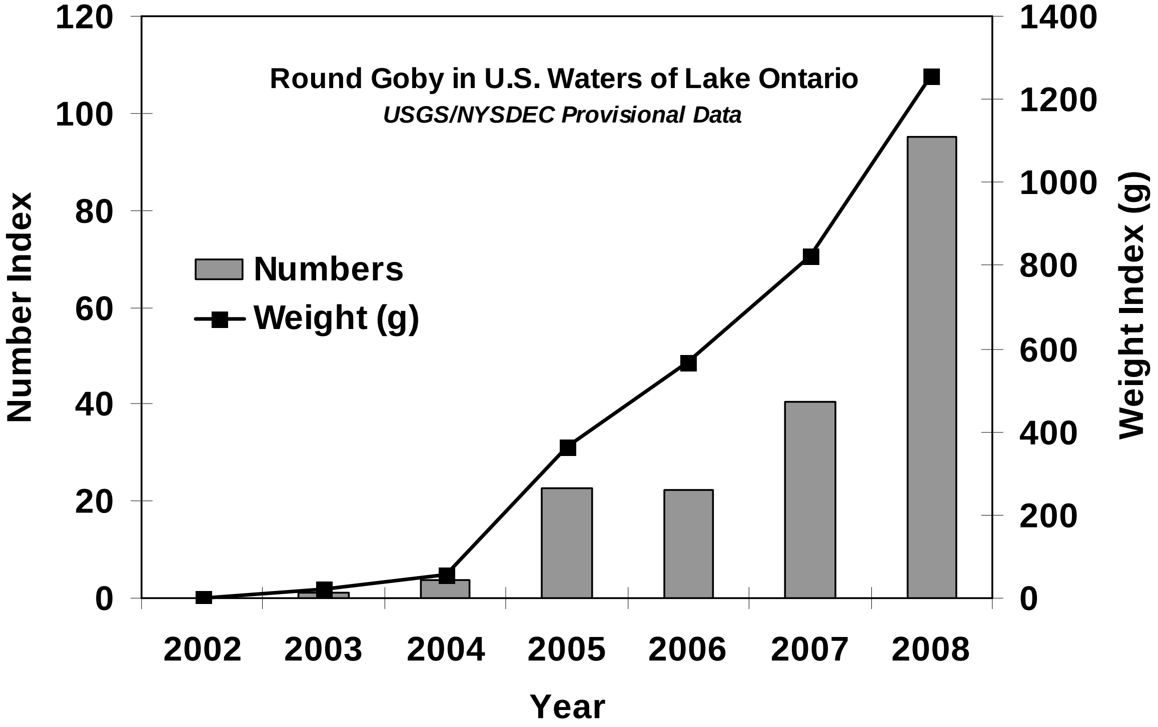

Figure 2.- Stratified mean catch of round goby with bottom trawls in U.S. waters of Lake Ontario shoreward of the 160-m (525 ft) bottom contour in late April - early May, 2002-2008 (no round gobies were caught prior to 2002). For weight index, 454 g = 1 lb.

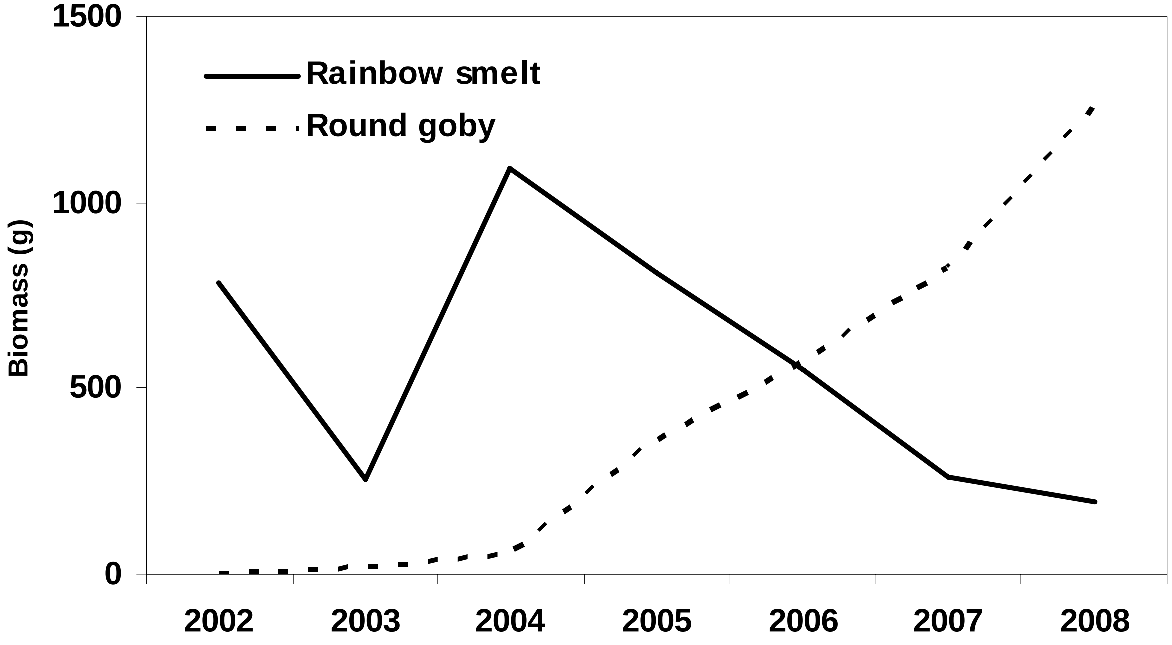

Figure 3. Weight indices of round goby and rainbow smelt in U.S. waters of Lake Ontario, 2002-2008.

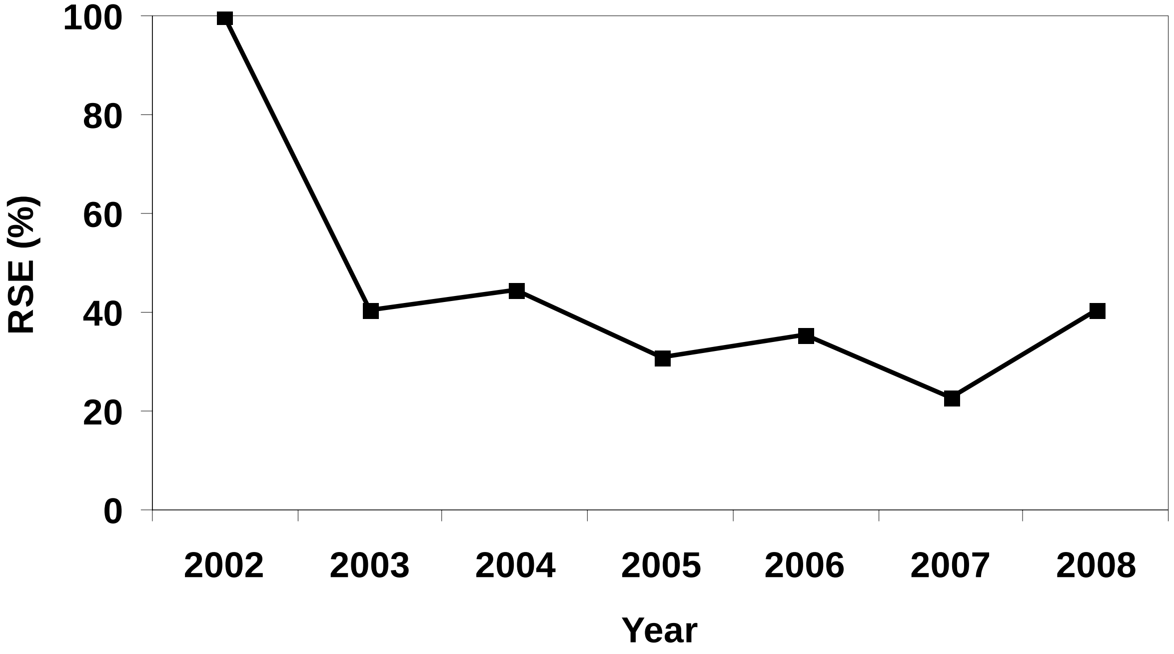

Figure 4. Relative standard error (RSE) for round goby abundance indices in U.S. waters of Lake Ontario, 2002-2008 (no round goby were collected before 2002). The RSE [RSE = 100(standard error of the index/the index)] is a measure of variability in the abundance index.*

River mouth (Walsh et al. 2006, 2007b). Based on our observations on the seasonal and bathymetric distribution of round goby in southern Lake Ontario, it appears that round goby will inhabit profundal waters for at least six months of the year (October through April), and are capable of colonizing to depths of at least 150 m (492 ft, Walsh et al. 2006, 2007b).

Given the potential importance of the round goby as a member of offshore and nearshore fish communities in Lake Ontario, we developed preliminary abundance and weight indices (calculated in the same manner as those for alewife and rainbow smelt, as depth-stratified, weighted means) to track the abundance of round goby in 2005 (Walsh et al. 2006). The round goby number and weight indices show an exponential increase through 2005, followed by an apparent plateau in numbers (2005 - 2006) but continued increase in the weight index (Figure 2). In 2007 and 2008, the index for both numbers and weight increased again (Figure 2). Our 2007 and 2008 estimates of round goby biomass now exceed that of rainbow smelt (Figure 3). Because round goby colonized the south shore of the lake from west to east, causing uneven spatial distribution, the relative standard error of the abundance indices was initially high. The RSE has decreased and remained relatively stable in recent years as the round goby population has increased and is now distributed more uniformly on the south shore of the Lake (Figure 4). Due to uncertainties about the ultimate population dynamics of round gobies in Lake Ontario, we will continue to calculate these indices and evaluate better ways to monitor the round goby population in the future.

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