Status of Important Prey Fishes in the U.S. Waters of Lake Ontario, 2007

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 of the three surveys 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 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 assessments confirmed our assumption of random distribution within geographic areas and differences among geographic areas in acoustically measured density of alewife-strength targets 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 getting the most precise estimate of relative abundance even though the variance of the estimated relative abundance will be biased (ICES 2004).

Presented at: Great Lakes Fishery Commission
Lake Ontario Committee Meeting
Niagara Falls, Ontario Canada
March 18, 2008

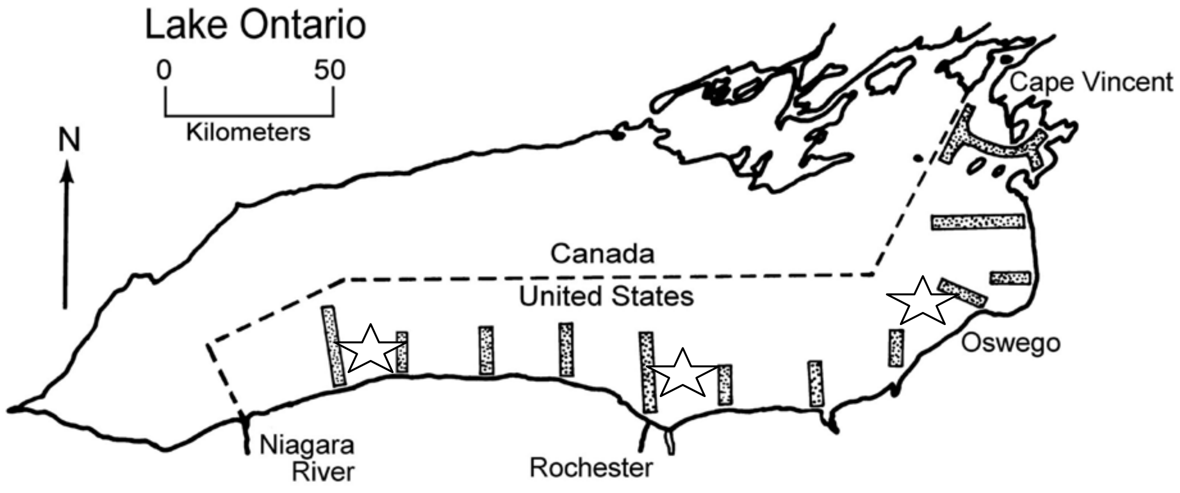

Figure 1. − Lake Ontario showing 12 transects sampled with bottom trawls. Transect names, from west to east, are: Olcott, Thirty Mile Pt., Oak Orchard, Hamlin, Rochester, Smoky Pt., Sodus, Fair Haven, Oswego, Mexico Bay, Southwick, and Cape Vincent. The six transects sampled during the slimy sculpin 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 2004-2007. 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 does not perform adequately and should no longer be used in this assessment (see Status of Sculpins and Round Goby below).

In 2007, the number of trawl hauls made for assessment of alewife, rainbow smelt, and slimy sculpin totaled 248 ─ 94 during April 17 - May 5 (7 additional tows were made to maintain a long-term record of the fish community in southeastern Lake Ontario), 105 during May 29 - June 7, and 49 during October 9 - 26. 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**.** Trawling effort during the rainbow smelt assessment was similar to that in 2006, 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 led to increased effort (minutes towed) during the slimy sculpin assessment in 2005 and 2006 (Walsh et al. 2006, 2007b). However, despite apparent successful implementation of this modification, in 2007 we again encountered problems with dreissenid mussels that led to a 16% decrease in effort as well as equipment damage and loss (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 will be used on other assessment cruises 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, 2007

R. O'Gorman, T. Strang, P. Golod
U.S. Geological Survey, Great Lakes Science Center, Lake Ontario Biological Station
Oswego, New York 13126

and

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

Abstract

In spring 2007, age-2 fish made up 78% of the catch of adult (age-2 and older) alewife Alosa pseudoharengus *in the U.S. waters of Lake Ontario. Condition of the adults was the best since 1979. Although adult alewife abundance indices were two (weight index) to three (number index) fold higher than in 2006, they were still among the lowest values recorded since annual assessments began in 1978. Abundance of age-1 alewife was also well below average, about 10% of the long-term mean. In 2008 and 2009, adult alewife abundance is likely to remain near 2006-2007 levels because the 2006 year class is the third smallest of 29 year classes measured at age 1 and because the recruitment model predicts that the 2007 year class is also likely weak due to low spawner abundance.*

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

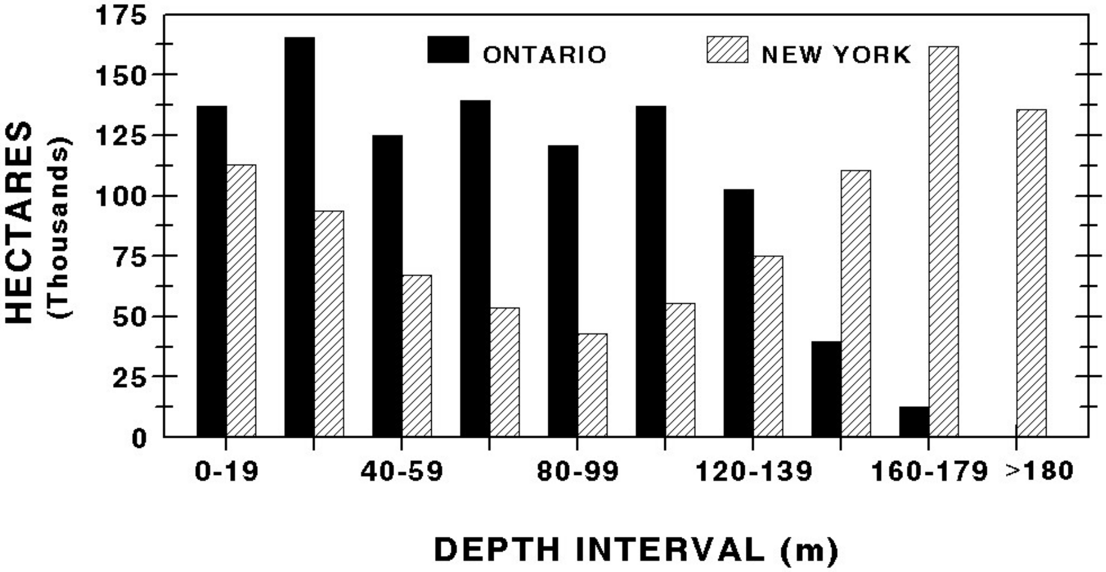

Figure 1. - Area of Lake Ontario in various depth strata in the province of Ontario and the state of New York. 1 m = 3.28 ft and 1 hectare = 2.47 acres.

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 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

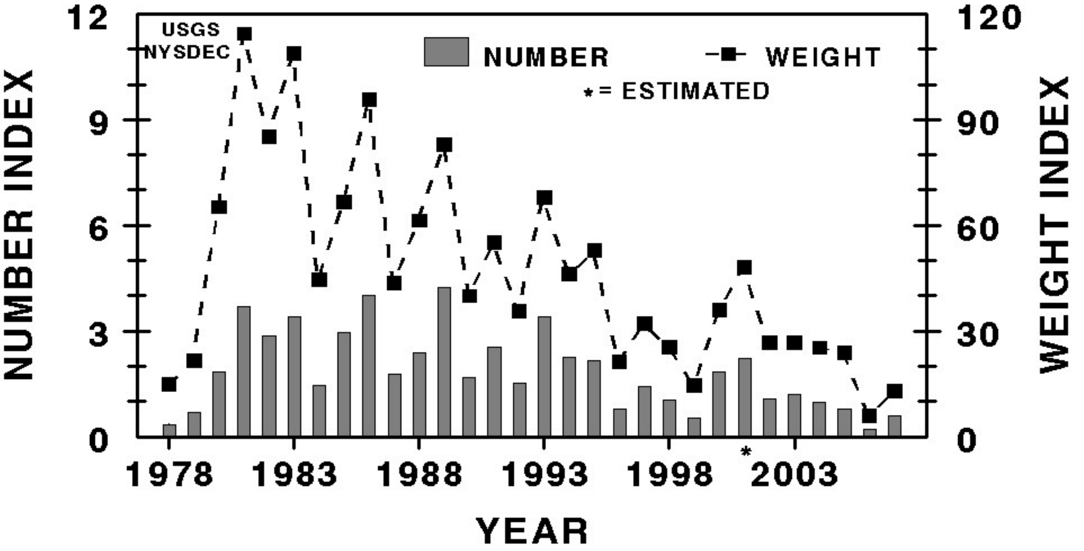

Figure 2. – Abundance indices for adult (age-2 and older) alewife in the U.S. waters of Lake Ontario during late April – early May, 1978-2007.

the historical period. Therefore, spring catches were used only for biological information on Alewives - 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 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).

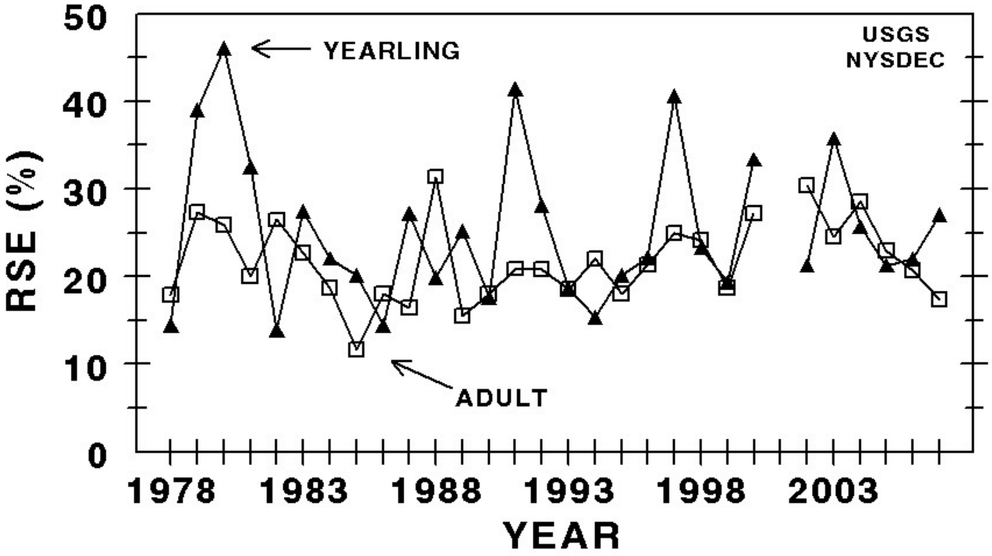

*Figure 3. – Relative standard error (RSE) for yearling and adult alewife abundance indices in the U.S. waters of Lake Ontario, 1978-2007. The RSE (RSE = 100% * {standard error of the index / the index}) is a measure of variability in abundance indices.*

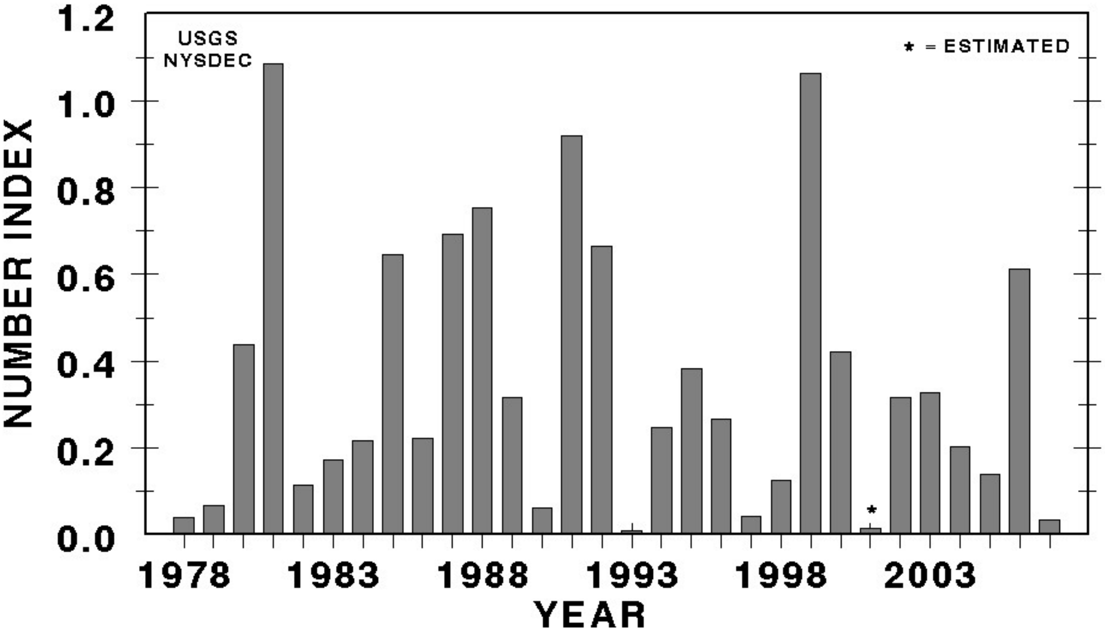

Figure 4. - Abundance indices for yearling alewife in the U.S. waters of Lake Ontario during late April – early May, 1978-2007.

Status of Alewife

In April – May 2007, the abundance of adult alewife (age-2 and older) in U.S. waters of Lake Ontario was among the lowest values recorded since annual assessments began in 1978 (Figure 2). The 2007 weight index was equal to 28% of the long-term mean, 11% of the record high of 1981, and 213% of the record low of 2006. The 2007 numerical index was equal to 32% of the long-term mean, 14% of the record high of 1989, and 296% of the record low of 2006. Age-2 fish made up 78% of the adult catch, age-3 fish made up 7%, age-4 fish made up 6%, age-5 fish made up 3%, and age-6 fish made up 4%. About 1% of adults were age 7 and older.

We use the relative standard error (RSE; RSE = 100% * {standard error of the index / the index}) as a measure of variability in abundance indices. The RSE's for number and weight indices are similar. In 2007, the RSE of the adult weight index was 17%, which was the smallest since 1999 and below the long term mean (22%) (Figure 3). The RSE of the yearling number index was 27%, which was the largest since 2003 and above the long term mean (25%).

The numerical abundance index for age-1 alewife in 2007 (2006 year class) was equal to 6% of the numerical index in spring 2006 and equal to 10% of the long term mean (Figure 4). Observed abundance of age-1 alewife was substantially lower than the ±15% of the long term mean predicted by our recruitment model, i.e. (O'Gorman et al. 2004, 2007). However, using the 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 thus we had no basis for predicting the influence of a spawning stock this small on reproductive success (i.e., we are using the model to extrapolate an outcome outside of the range of observations used to build the model). Thus, there was more uncertainty than usual about predictions of the magnitude of the 2006 year class. 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

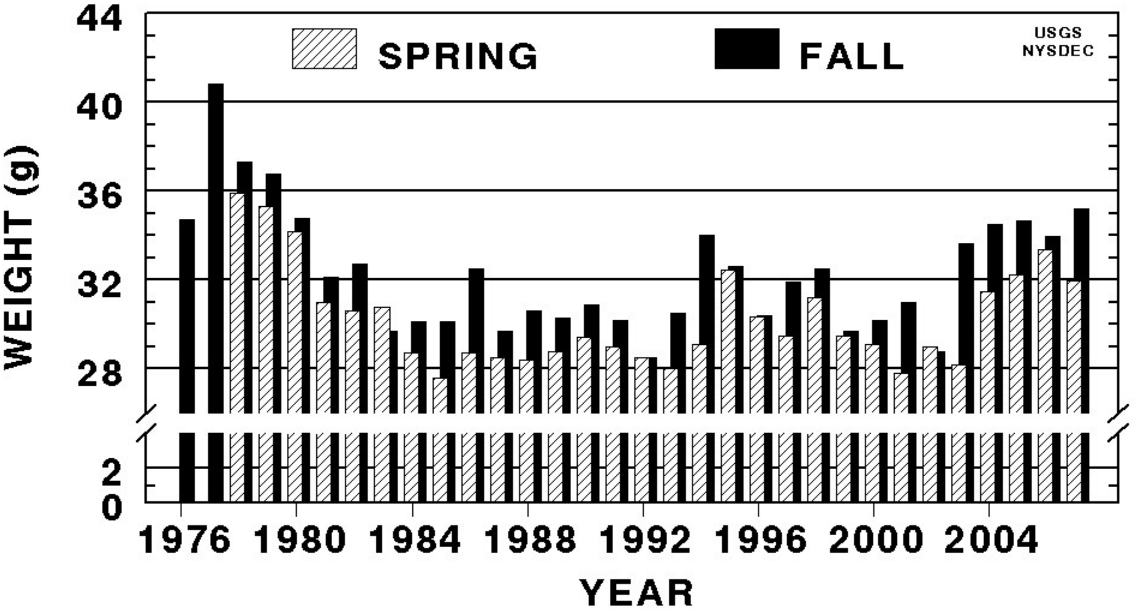

Figure 5. – Wet weight of a 165-mm (6.5 in) alewife (predicted from annual length-weight regressions) in spring and fall, Lake Ontario, 1976-2007. 1 gram = 0.035 ounce.

correlated with the catch 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, $r = 0.74$, $P < 0.0001$). The weak 2006 year class, third smallest out of 29 year classes measured at age 1, will provide few age-2 recruits in 2008 and thus the numbers of adult alewife in 2008 will be lower than that in 2007. The weight index may rise, however, because the bulk of the population in 2008 will be larger, heavier age-3 fish.

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 2007 was the heaviest since 1979 (Figure 5). During 2003-2007, condition in fall has been higher than in any five-year period since the late 1970's. Elevated condition each fall during 2003-2007 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.

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 2007, May − July water temperatures were the seventh warmest of the last 32 springs (1976-2007) indicating favorable conditions for reproduction. Moreover, the duration of winter 2007-2008 is apparently going to be about average indicating favorable conditions for survival of juveniles. But 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. In 2007, the spawning stock was similar to that in 2006 because, although adult numbers were higher in 2007, the preponderance of adults were age 2 and <150 mm long and not considered part of the spawning stock. Thus, for the second year in a row there is more uncertainty than usual about predictions of the magnitude of the youngest alewife year class. Model output indicates that, at age 1, the 2007 year class will be weaker than average with an abundance index, at best, no greater than 72% of the long term mean and most likely about 36% of the long term mean.

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Status of Rainbow Smelt in the U. S. Waters of Lake Ontario, 2007

M. G. Walsh and T. Strang
U.S. Geological Survey, Great Lakes Science Center, Lake Ontario Biological Station
Oswego, New York 13126

and

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

Abstract

The abundance index for age-1 and older rainbow smelt Osmerus mordax *in 2007 was lower than that recorded in 2006, and is the second lowest population index in the 30-year time series. The number of age-1 rainbow smelt caught in 2007 was lower than either the value for 2005 or 2006, and is similar to the 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 three small year classes in succession in 2004 -2006 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 rainbow smelt were lower in 2007 than in 2006, and were markedly lower than in 2004 when the abundance indices were the highest since 1998 (Figure 1). In 2007, the numerical index was less than 12% of the value for 2004, and the weight index about 25% of the value for 2004. The 2007 index values are the second lowest observed over the 30-year time series (Figure 1), and are only slightly higher than the all-time lows observed in 2003. 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 it increased to 40.1% (Figure 2). This increase in RSE is likely related to the low and variable catches in 2007; further evaluation of the new stratification is necessary to determine if it needs additional revision, although if catch rates remain low, 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-

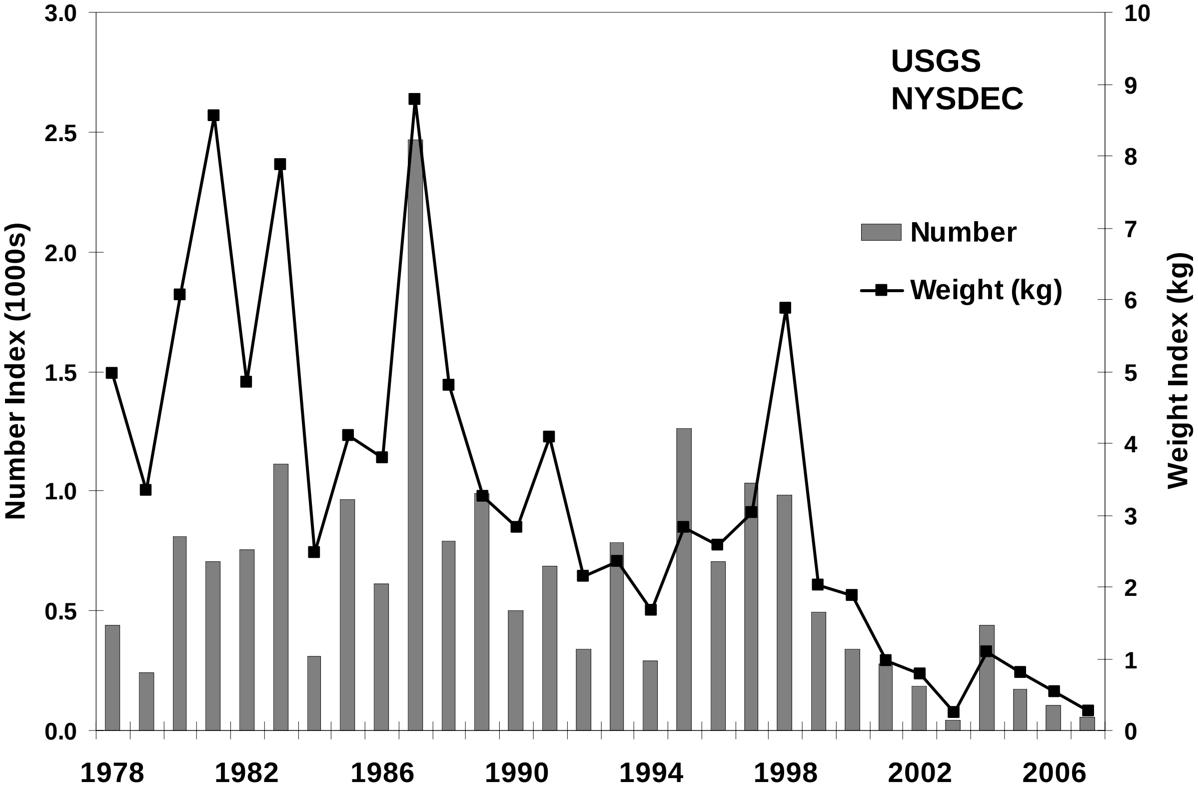

Figure 1. − Stratified mean catch of rainbow smelt (age-1 and older) with bottom trawls in the U.S. waters of Lake Ontario shoreward of the 140-m (459 ft) bottom contour in late May-early June, 1978-2007. For the weight index, 1 kg = 2.2 lb.

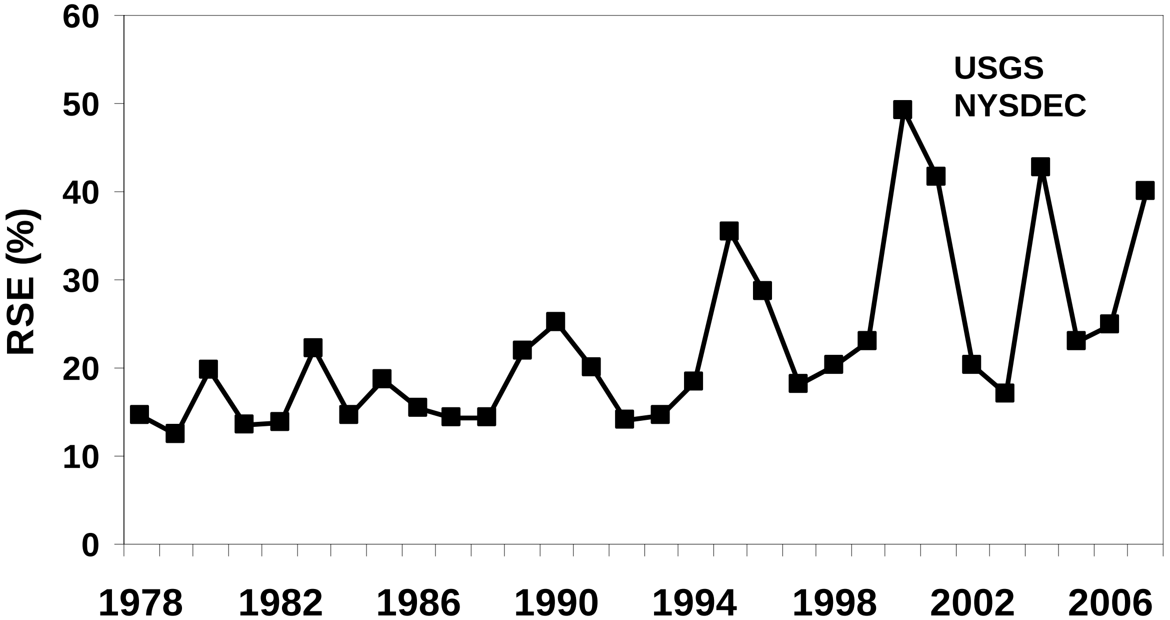

Figure 2. − Relative standard error (RSE) for age-1 and older rainbow smelt abundance indices in the U.S. waters of Lake Ontario, 1978-2007. The RSE [RSE = 100(standard error of the index/the index)] is a measure of variability in the abundance index.*

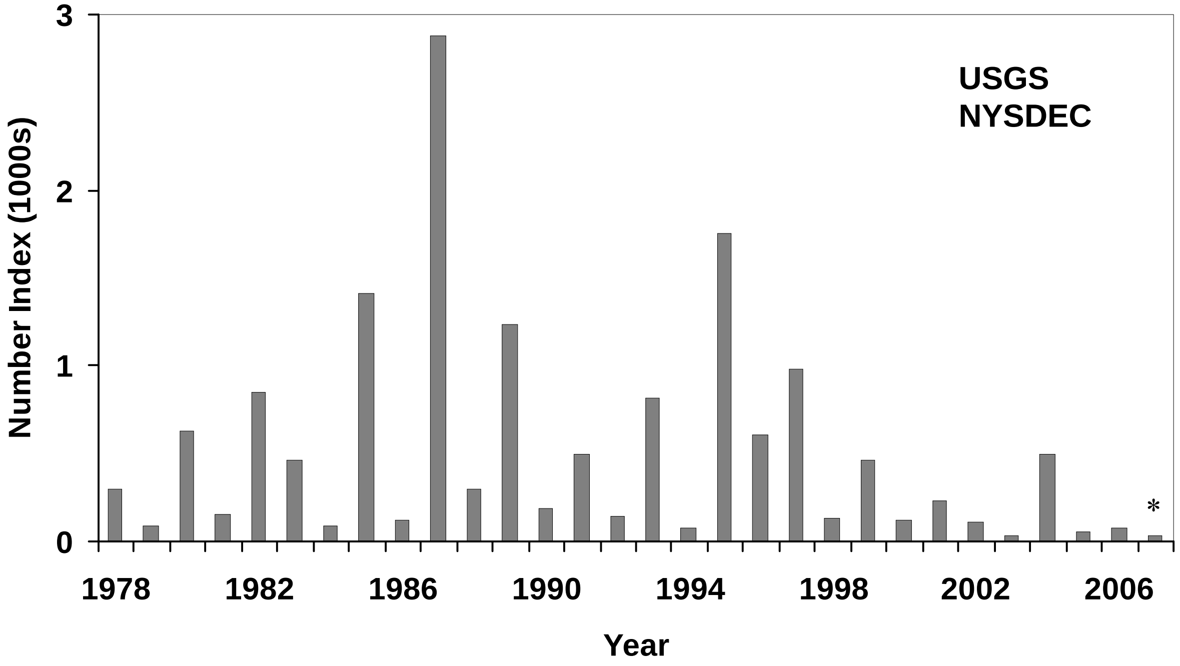

Figure 3. − Stratified mean catch of age-1 rainbow smelt with bottom trawls in the U.S. waters of Lake Ontario shoreward of the 140-m (459 ft) bottom contour in late May-early June, 1978-2007. The 2007 estimate (*) is based on 2001-2005 age-length keys.

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 2007 was smaller than the indices in 2005 and 2006, and is similar to the extremely low level observed in 2003 (Figure 3). Small year classes in 2004-2006 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 2007. Large rainbow smelt composed less than 3% of the population during 1989-2007 (range: 0.1 to 2.8%); in both 2006 and 2007 they made up about 2.5% of the population. The stratified mean catch per tow of large rainbow smelt ranged from 1 to 14 during 1989-2005 and was 1 in 2007. 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 1989-2007 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 be fully recruited in 2008.

In the previous two years we have forecast that rainbow smelt abundance indices for all age groups combined would rebound and increase because we anticipated production of a strong year class after two 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, 2007

M. G. Walsh, R. O'Gorman, B. F. Lantry, T. Strang, P. Golod
U.S. Geological Survey, Great Lakes Science Center, Lake Ontario Biological Station
Oswego, New York 13126

and

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

Abstract

In 2004, after dreissenid mussels Dreissena spp. *precluded towing the 12-m (39 ft, headrope) trawl historically used to assess slimy sculpin* Cottus cognatus, *we used the 18-m (59 ft, headrope) bottom trawl, but results were inconsistent. In 2005 and 2006, we used a tickler chain modification to the 18-m (59 ft) 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 indicate that the net with the tickler chain does not perform adequately and should no longer be used in this assessment, and alternative sampling gears will have to be evaluated in 2008. During 2007 sampling, we caught seven deepwater sculpins* Myoxocephalus thompsonii *(73 - 145 mm [2.9 – 5.7 in]), continuing the recent trend of increased catches of this species, once thought to be extirpated from Lake Ontario. Both the abundance and biomass indices for round goby* Neogobius melanostomus *in 2007 increased from 2006 values. We estimate that the biomass of round goby now exceeds that of rainbow smelt.*

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 few 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

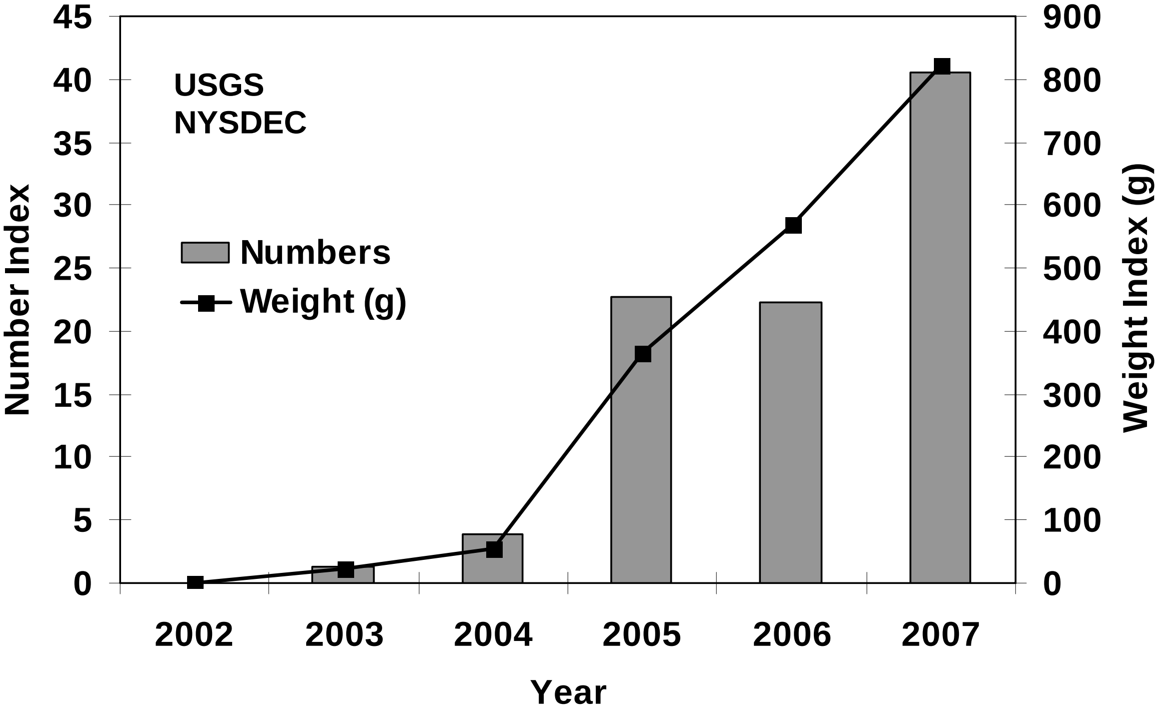

Figure 1. - Stratified mean catch of round goby with bottom trawls in the U.S. waters of Lake Ontario shoreward of the 160-m (525 ft) bottom contour in late April - early May, 2002-2007 (no round gobies were caught prior to 2002). For weight index, 454 g = 1 lb.

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 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 (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 that could jeopardize field work in 2008. Because we were unable to effectively sample slimy sculpins in 2007, we present no information on slimy sculpin abundance or lengths. Alternative methods for sampling slimy sculpin will be investigated and evaluated in 2008.

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 two were caught in Canadian waters, and among these deepwater sculpins, young, small individuals were numerically dominant (Walsh et al. 2006; Lantry et al. 2007). Increased catches of deepwater

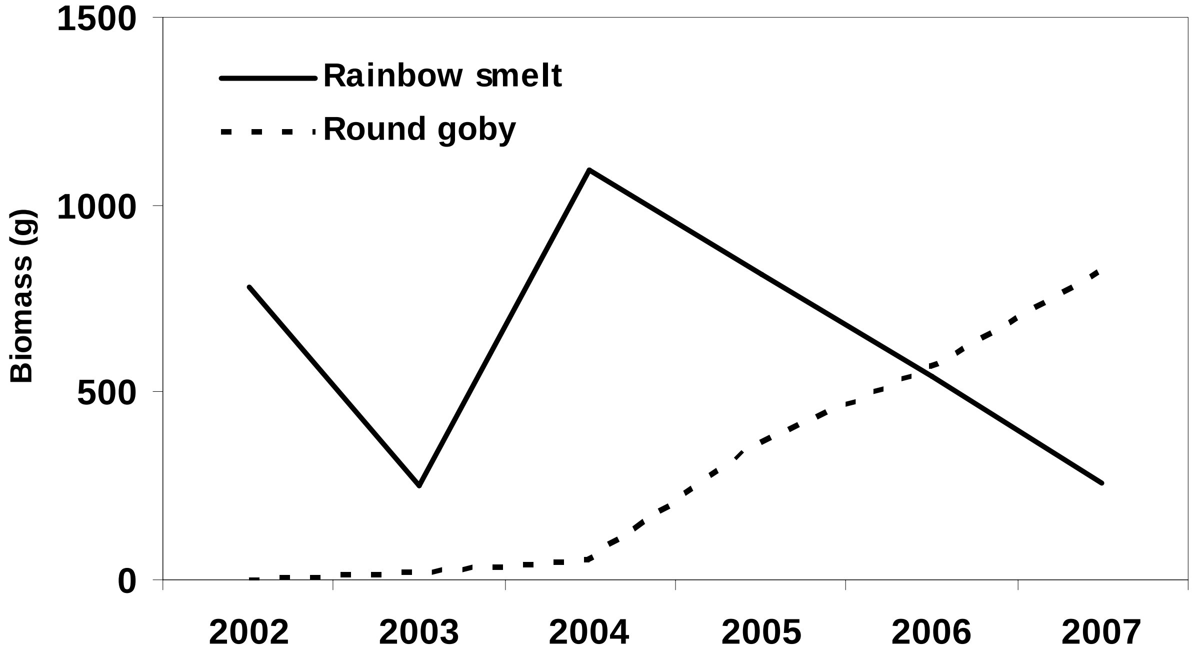

Figure 2. − Weight indices of round goby and rainbow smelt in the U.S. waters of Lake Ontario, 2002-2007.

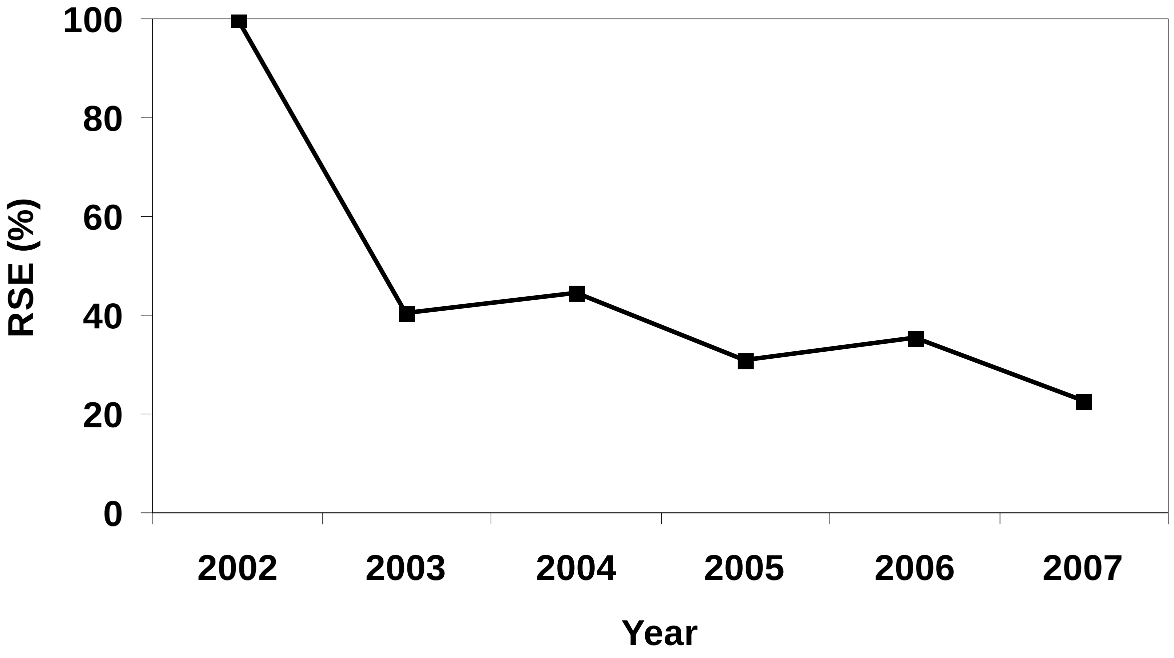

Figure 3. − Relative standard error (RSE) for round goby abundance indices in the U.S. waters of Lake Ontario, 2002-2007 (no round goby were collected before 2002). The RSE [RSE = 100*(standard error of the index/the index)] is a measure of variability in the abundance index.

sculpins and presence of small individuals continued in 2006 with a total catch of 18 deepwater sculpins in U.S. waters of Lake Ontario (Walsh et al. 2007a). In 2007, we collected seven deepwater sculpins (73 - 145 mm [2.9 – 5.7 in]), during joint USGS/NYSDEC assessment cruises, and one additional deepwater sculpin was caught in U.S. waters by Environment Canada while collecting fish for contaminant monitoring (Mike Keir, personal communication). The 2007 catch is a slight decrease from that in 2005 and 2006, but this may be due to the decreased effort on the slimy sculpin assessment, particularly a reduction in tows in southeastern Lake Ontario, where 12 deepwater sculpins were collected during the 2006 field season. Nonetheless, the continued presence of juvenile deepwater sculpins 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 burbot (*Lota lota*) and lake trout (*Salvelinus namaycush*), benthic piscivores (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 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, in 2005 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 (Walsh et al. 2006). The round goby number and weight indices show an exponential increase through 2005, followed by an apparent plateau in numbers but continued increase in the weight index (Figure 1). In 2007, the index for both numbers and weight increased again (Figure 1), and we estimate that the biomass of round goby now exceeds that of rainbow smelt (Figure 2). Because round goby colonized the south shore of the lake from west to east, the relative standard error of the initial abundance indices was high, but it has decreased through time to 23% in 2007 (Figure 3). 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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