Executive Summary

The Lake Ontario ecosystem has undergone dramatic change since early European settlement, primarily due to human influences on the Lake and its watershed (Smith 1968; Christie 1973). The native fish community was comprised of a diverse forage base underpinned by coregonids (whitefish family) and sculpins, with Atlantic salmon, lake trout and burbot as the dominant piscivores (fish-eaters) in the system. The nearshore waters were home to a host of warmwater fishes including yellow perch, walleye, northern pike, lake sturgeon, and American eel. The dominant prey species in nearshore areas included emerald and spottail shiners.

Habitat and water quality degradation, overfishing, and the introduction of exotic species played major roles in the decline of the native fish community. By the 1960's, these impacts culminated in the virtual elimination of large piscivores, the reduction or extinction of other native fishes, and uncontrolled populations of exotic alewife, smelt, and sea lamprey (Stewart et al. 1999). Since the early 1970's, water quality improvements resulting from the Great Lakes Water Quality Agreement (International Joint Commission 1994), sea lamprey control, and extensive fish stocking programs in New York and Ontario have resulted in increased diversity in the Lake Ontario fish community and a robust sportfishery. In 1996, anglers fishing Lake Ontario and its tributaries contributed over $75 million to the New York State economy (Connelly et al. 1997).

In recent years, the Lake Ontario ecosystem has undergone dramatic changes resulting primarily from the introduction of exotic zebra and quagga mussels (*Dreissena polymorpha* and *D. bugensis*, respectively). In addition, improvements in wastewater treatment have reduced excessive nutrient concentrations to historic, more natural levels, thereby lowering the productive capacity of the Lake Ontario ecosystem. Surveys conducted by the U.S. Geological Survey (USGS) documented further deterioration in abundance and distribution of the deepwater amphipod, *Diporeia*. This phenomenon is thought to be directly linked to the range expansion of quagga mussels into deeper waters. The effects of these ecosystem changes on the Lake Ontario fish community have not been manifested completely, nor are they fully understood.

The exotic round goby (*Neogobius melanostomus*) was first documented in the New York waters of Lake Ontario in 1998 and was first detected in standard fisheries assessment trawling in 2002. Since then, abundance and biomass of round goby has grown exponentially, and it is now found now throughout Lake Ontario. With the exception of Griswold Island, round gobies have become the dominant prey of cormorant colonies in eastern Lake Ontario and the St. Lawrence River. Gobies have also been identified in the diets of numerous sportfish species including smallmouth bass, yellow perch, walleye and lake trout.

Viral Hemorrhagic Septicemia (VHS) was first documented in the New York waters of Lake Ontario and the St. Lawrence River in 2006. A substantial round goby mortality event was observed, as well as small numbers of dead muskellunge, smallmouth bass, and a moribund burbot. VHS has also been identified in surveillance testing of “healthy” fish, including rock bass, bluegill, brown bullhead, emerald shiners and bluntnose minnows. Another exotic species was also identified in Lake Ontario in 2006. *Hemimysis anamola*, a small freshwater shrimp, was found near Oswego, NY. As with other aquatic invasive species in the Great Lakes system, the full impacts of these new “invaders” are unknown.

This report summarizes cooperative research and monitoring activities conducted on Lake Ontario and the St. Lawrence River by the New York State Department of Environmental Conservation, U.S. Geological Survey, Ontario Ministry of Natural Resources, and Cornell University in 2007.

Lower Trophic Level Monitoring (Section 19)

- 2007 populations of adult and juvenile alewife apparently were not sufficiently abundant to suppress larger sized zooplankton species like *Cercopagis pengoi* and *Bythotrephes longimanus.* Offshore zooplankton size (0.74mm) was significantly greater than the average size of nearshore and embayment samples. The average size of zooplankton was not significantly different in embayments (0.41mm) and nearshore samples (0.52mm).
- Biomass of the exotic zooplankter *Bythotrephes longimanus* in nearshore and embayment habitats were at all time highs in 2007 (0.98 ug/L and 0.23 respectively, section 19); biomass in the offshore remained high too (0.80 ug/L), but was similar to levels observed in 2005-2006. The frequency of *Bythotrephes* occurrence in zooplankton samples is also increasing.
- During July-August, average embayment zooplankton density (96.2/L) and biomass (105.6µg/L) were significantly greater than the density (11.7/L), and biomass (21.8µg/L) of nearshore samples. Offshore zooplankton biomass (33.9µg/L) was significantly different than biomass of nearshore (21.8µg/L) and embayment (105.6µg/L) samples.
- Power and trend analyses were conducted on the 12-year data series. Of the twelve parameters evaluated for trends, only three were significant ($p<0.1$): summer chl *a* increased significantly in nearshore habitats and declined significantly in embayment habitats from 1995-2007. Summer zooplankton biomass declined significantly by 14% per year in offshore habitats.

Prey Fish Assessments

- Lake Ontario preyfish trawling assessments are incorporating several methods to improve accuracy, including hydroacoustic evaluation of areas between trawl transects, and informed allocation of sampling effort (Section 12).
- In spring 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 (Section 12). The 2007 weight and abundance indices were equal to 28% and 32 % of the long-term means, respectively, and 11% and 14 % of the record highs. Age-2 fish made up 78% of the adult catch. Abundance of age-1 alewife was also low, the third smallest of 29 year classes measured, and about 10% of the long-term mean. Adult condition was the best since 1979 suggesting that the alewife population was at a level that does not 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.
- The abundance index for age-1 and older rainbow smelt in 2007 was lower than that recorded in 2006, and is the second lowest population index in the 30-year time series (Section 12). The number of age-1 rainbow smelt caught in 2007 was lower than in 2005 or 2006, and is similar to the record low age-1 catch 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.
- In the 2005 and 2006, the slimy sculpin index survey used a tickler chain modification to the 18-m (59 ft) bottom trawl permitting shallower tows and longer tows at deeper depths without the trawl fouling with dreissenid mussels. However, significant problems encountered in 2007 indicate that the tickler chain adversely impacts net performance and should no longer be used in this assessment. Alternative sampling gears will need to be evaluated in 2008 (Section 12).
- In 2007, round goby indices for numbers and weight increased, and we estimate that the biomass of round goby now exceeds that of rainbow smelt (Section 12).
- In 2008 and 2009, pelagic preyfish abundance in Lake Ontario is likely to remain low (Section 12). Adult alewife abundance is expected to remain near 2006-2007 levels because of a low adult

spawning stock and a weak 2006 year class. Although the rainbow smelt population has demonstrated considerable resiliency in the past, it is unclear if it will be able to rebound from current low levels of spawners and recruits as it did in 2003.

- The 2007 hydroacoustic survey Lake Ontario preyfish populations consisted of four cross-lake transects and an Eastern Basin transect. The survey period began several weeks later than usual because the dark-moon phase in July conflicted with other surveys, and in August, strong winds delayed the survey one week, forcing the modification of one transect and the elimination of another.
- The 2007 abundance and biomass of yearling and older (YAO) alewife declined from 2006 to the lowest values on record for the acoustic survey. Abundance and biomass were 13% and 15%, respectively, of the 10-year averages, and 93% and 94% below the 10-year maximum values (Section 3).
- The 2007 midsummer acoustic estimate of YAO smelt in Lake Ontario was 146 million fish, the fourth lowest estimate in the eleven year history of the survey. Using catch per unit effort (CPUE) weighted average mass of YAO smelt (9.85 grams), the total biomass estimate of smelt in Lake Ontario was 1,434 metric tons (Section 3).
- During the 2007 midsummer acoustic survey, the CPUE of threespine sticklebacks was at a record low 0.007 fish per 100m compared to the long-term mean of 5.6 fish per 100m. Sticklebacks were caught in only 26% of 2007 trawl tows compared to at least 60% in most years. The disappearance of sticklebacks from trawl catches during the acoustic survey coincides with increased catches of round goby in other surveys (Section 3).

Coldwater Fisheries Management

- Fish stocking in the New York waters of Lake Ontario in 2007 included 1.81 million Chinook salmon, 245,000 coho salmon, 602,050 rainbow trout, 453,149 lake trout, 376,120 brown trout, and 51,700 Atlantic salmon. (Section 1).
- In 2007, 453,149 lake trout and 123,220 brown trout were stocked offshore by military landing craft in a continuing effort to reduce predation on newly stocked fish by Double-crested cormorants and predatory fish (Section 1).
- The relationships between the number of Chinook salmon fingerling equivalents stocked and relative harvest at age-1 ($P=0.271$, $R^2=0.057$) and age-3 ($P=0.764$, $R^2=0.004$) are not statistically significant. While the relationship at age-3 had been marginally significant, inclusion of the 2002, 2003, and 2004 year classes eliminated any significance. These year classes produced an age-3 relative harvest estimate nearly twice as high as other year classes stocked at similar numbers (Section 2).
- Growth of age-3 Chinook salmon, as measured by the open lake boat fishery, was below average in 2007, the second lowest estimate among the 17-year data series and comparable to the reductions in growth observed in 2003 - 2005 (Section 2).
- Weights of age-2 and age-3 Chinook salmon of both sexes returning to the Salmon River Hatchery were at record lows (Section 9). Age-2 fish were 3.5 pounds (male mean 10.1 lbs) and 4.2 pounds (female mean 10.9 lbs) below their long-term averages and age-3 fish of both sexes (mean 15.25 lbs) were about 4.5 pounds below their historical averages. Condition of fish sampled in the hatchery also declined in 2007 as the predicted weight of a 36 inch Chinook dropped to 15.5 pounds, compared to a mean of 16.7 pounds in 2006. Poor growth in 2007 is likely the result of relatively low adult alewife abundance in Lake Ontario.
- Since the institution of seasonal base flows in the Salmon River, a dramatic increase in natural reproduction of Chinook salmon continues to be documented (Section 8). The 2007 year class appears to be relatively strong with a combined mean catch of 270 young-of-the-year (YOY) Chinook per seine haul for the three consecutive weeks with the highest catches. Mean Salmon River flow during the preceding October continues to be an important factor explaining year class strength. Based on extremely low flows of October 2007, we expect that the 2008 year class of wild Chinook

will be small.

- The tenth year of pen-rearing steelhead and Chinook salmon along the New York shoreline of Lake Ontario was very successful due to low fish mortality at all sites, and a relatively high percentage of fish reaching target weights. Eight pen-rearing sites raised a total of 84,300 steelhead (Washington and Skamania strains) comprising 14% of NYSDEC's Lake Ontario rainbow trout/steelhead stocking allotment in 2007. Five pen-rearing sites raised a total of 313,100 Chinook salmon, representing 18% of NYSDEC's 2007 Chinook salmon stocking allotment (Section 18).

Lake Trout Restoration (Section 5)

- In 2007 the juvenile lake trout survival index was 87% below the average for the 1983-1989 year classes. In four out of the last nine years the survival index (for the 1997, 1999, 2000, and 2002 year classes) was about 3.5 times higher than the lows seen for the 1994–1996 year classes. Although this modest increase in the survival index was encouraging, it has not persisted and nearly all of the age-2 fish caught in those years were from sites near the western end of the lake suggesting that yearling survival in western Lake Ontario is higher than in eastern Lake Ontario.
- A total of 266 adult lake trout were captured in the September 2007 gill net survey. The CPUE of mature lake trout had remained relatively stable from 1986 to 1998, but then declined by 31% between 1998 and 1999 due to the poor recruitment of the weak 1993 year class. Declines in adult numbers after 1998 were likely due to poor survival of hatchery fish in their first year post-stocking and lower numbers of fish stocked since the early 1990's. After the 1998-1999 decline, the CPUE for mature lake trout remained relatively stable during 1999-2004 (mean = 11.0), but then declined by 54% in 2005. The 2007 CPUE (3.4) for adult fish declined further to a level 80% below the 1986-1998 mean and 69% below the 1999-2004 mean. The 2007 mature lake trout CPUE was similar to the 1982 and 1983 values which predated effective sea lamprey control and recruitment from the first large stocking in 1979 (Section 5).
- Sea lamprey wounding rates on lake trout remain much lower than pre-1985 levels, but have been above the target level of two A1 wounds per 100 fish for eight of the last eleven years. A1 wounding rate in 2007 was 4.7 wounds per 100 fish (Section 5). Numbers of lampreys observed by anglers was the highest estimated in the 23-year data series and was 135.1% higher than the 2002-2006 average (Section 2).
- In 2007, five naturally produced (wild) age-2 (n=3) and age-3 (n=2) lake trout were caught with bottom trawls. They ranged in length from 204 to 393 mm (8.0 to 15.5 in). Survival of naturally produced lake trout to the fingerling stage in summer and fall occurred each year during 1993-2005 representing production of 13 consecutive year classes. We caught no wild yearling lake trout during 2005-2007 and have no evidence of a naturally produced year class in 2006. Low numbers of small (<100 mm, 3.9 in), wild fish captured in recent years (1997-2007) may be due in part to a change in bottom trawl gear that was necessary to avoid abundant dreissenid mussels (Section 5).
- Condition of adult lake trout (weight of a 700 mm or 27.6 in total length fish) in 2007 increased from 2003-2006 values, and was only 42.4 g (0.09 lbs) below the 1996-1999 mean.
- In 2007, lake trout harvest (2,570), catch (7,147), catch rate and harvest rate were the lowest on record. Relatively poor fishing for lake trout in 2007 may have been related to the declines in adult population size since 2004, but also was likely related to good fishing for Chinook salmon, coho salmon and brown trout (Section 2).

Warmwater Fisheries

- A total of 31,128 fingerling walleye were stocked into Lake Ontario embayments, the Lower Niagara River and the St. Lawrence River (Section 1).
- Total catch of warmwater fish in the 2007 Eastern Basin index gill netting program was14.0% below the 2005-2006 mean (highest CPUEs observed since 1994), however was 6.1% higher than the previous10-year mean (Section 4).
- Smallmouth bass abundance in the Eastern Basin as measured in index gill nets was a 41.3% compared to the 2005-2006 average (highest CPUEs observed since 1994), however, was 52.0% higher than the 2000-2004 average (the period of lowest CPUEs on record). Growth of smallmouth bass has increased in recent years, and condition was at record high levels for all length increments examined (Section 4).
- Yellow perch abundance in 2007 was the highest since 1985, a 89.3% increased compared to the 1989-2006 mean and a 57.6% increase compared to the previous 5-year mean (Section 4).
- Walleye abundance in 2007 was 24.8% and 27.9% below previous 5-year and 10-year averages, respectively.
- Lake sturgeon were collected in the Eastern Basin in eleven of the last thirteen years, suggesting improvements in population status.
- Round gobies first appeared in this Eastern Basin assessment in 2005, increased in number in gillnets and predator diets in 2006, and, in 2007 appeared in greater frequency in both gill nets (n=10) and in smallmouth bass stomachs (28.2% of non-empty stomachs; Section 4).
- Index gill netting in Lake Ontario near Pultneyville during 2007 showed that smallmouth bass abundance (CPUE=54.2) decreased 36% compared to 2000-2001, but was well above smallmouth bass abundance in the Eastern Basin of Lake Ontario (2007 CPUE=6.4) (Section 11).
- Index gill netting in the Thousand Islands region of the St. Lawrence River during 2007 showed that smallmouth bass and yellow perch abundance remain relatively high. With the exception of 2006, northern pike abundance remains relatively low. While walleye are typically not well represented in this survey, catches have increased markedly since 2004 (Section 6).
- Yellow perch abundance in the 2007 Lake St. Lawrence index gill netting increased 88% from 2006 (Section 7), while smallmouth bass abundance remains well below the long-term average. In 2007, walleye abundance also declined below the long-term average.

Sport Fishery Assessment

- Total trout and salmon fishing success (catch per boat trip) was the highest estimated among the 23 years surveyed (Section 2). Five of the seven highest catch rates occurred during the last five years. Catch rates were at or near the highest recorded for Chinook salmon (third highest recorded), coho salmon (highest recorded) and brown trout (highest recorded). An estimated 53,336 ($\pm$ 28.3%) Chinook salmon were harvested in the open lake, the second highest harvest estimate since 1994.
- Total fishing boat trips, and trips targeting trout and salmon have declined significantly since the 1990 peak. Largest declines in effort occurred between the 1990-91 seasons (-31,537 trips) and the 1991-92 seasons (-43,826 trips), before reductions in the Lake Ontario stocking program were discussed.
- In 2007, total effort was estimated at 79,752 fishing boat trips [95% confidence interval $\pm$13.8%], a 19.2% increase compared to the record low in 2006, but comparable (-1.2%) to the 2002-2006 average.
- An estimated 58,204 boat trips [$\pm$17.7%] targeted trout and salmon in 2007 (73.0% of fishing boat trips). Trout and salmon fishing effort in 2007 was the fifth lowest estimate among the years surveyed, however, was a 9.1% increase compared to the 2002-2006 average.
- The number of lampreys observed per 1,000 trout and salmon caught was estimated at 44.2 in 2007, a

76.6% increase compared to the 2002-2006 average.

- Fishing boat trips targeting smallmouth bass during the traditional open season (3rd Saturday in June through September 30 when the creel census ends) was an estimated 14,509 (± 22.4%) in 2007, 36.2% below the 2002-2006 average and the third lowest estimate among years surveyed. A regulation change, effective October 1, 2006, permitted pre-season catch and release of smallmouth bass. From April 1-June 16, 2007 there were an estimated 496 fishing boat trip (± 74.2%) targeted at smallmouth bass. Smallmouth bass was the most commonly harvested species in the census from 1995-2003, however, Chinook salmon harvest increased dramatically from 2004 -2006, making smallmouth bass the second most commonly harvested species during those three years. In 2007, smallmouth bass became the fifth most commonly harvested species, preceded by Chinook salmon, brown trout, round goby (most are killed and discarded) and yellow perch. The 2007 smallmouth bass harvest (19,058 fish) was the second lowest seasonal harvest among the years surveyed and a 50.8% decrease compared to the 2002-2006 average.
- A comprehensive creel survey of the New York tributaries was conducted on all of the major tributaries to Lake Ontario in New York from September through April in both 2005-2006 (year one) and 2006-2007 (year two) (Section 16). Twenty-nine tributaries from Fourmile Creek in Niagara County to the Black River in Jefferson County were surveyed to estimate angler effort, catch and harvest of lake-run trout and salmon species.
- Total estimated effort for all New York Lake Ontario tributaries in 2006-2007 was 933,029 angler hours, which was a slight decline from 1,025,994 angler hours the previous year (Section 16). The Salmon River in Oswego County accounted for 605,772 (59% of total) and 595,267 (64% of total) of the angler hours for years one and two, respectively. Combined estimates from the four highest use tributaries: Salmon River, Oak Orchard and Eighteenmile creeks, and the Oswego River, accounted for 81% of the angler hours in the first year and 82% in the second.
- High use tributaries comprised 69% of the year one angler trips and 65% in year two. These "high use" tributaries generally drew anglers from greater geographic distances. Non-New York State residents accounted for 60% of the anglers on the Salmon River in both study years and from 33% to 49% of the anglers on the other "high use" tributaries. Tributaries with lower levels of use generally had lower proportions of non-resident anglers.
- The Salmon River accounted for 52% and 63% of the Chinook salmon catch and 53% and 60% the harvest in years one and two, respectively. For coho salmon, the Salmon River represented 81% and 50% of the catch and 82% and 62% of the harvest in years one and two, respectively. The overall estimated catch of coho approximately tripled between years increasing from 6,080 to 18,047. Eighteenmile Creek had the highest estimated catch of steelhead (28% of total) in year one, while the Salmon River had the highest catch (38%) in year two.
- The release rate for steelhead on all tributaries combined was 80% in year one and 77% in year two (87% and 82% respectively on the Salmon River). The catch and harvest of brown trout on Eighteenmile Creek were higher than for any other tributary in the first year, with an estimated 21,828 and 4,298 fish, respectively. The Salmon River had the second highest catch in year one (20,705), and the highest in year two (21,489). Eighteenmile Creek had the second highest estimated catch of brown trout in year two at 11,836, followed by Irondequoit Creek with 6,442.

Diets of Double-crested Cormorants and Impacts on Sportfish Populations

- For the ninth consecutive year, cormorant population control was continued through oiling of eggs with food grade vegetable oil at the Little Galloo Island colony, and culling of adult birds by shooting was employed again in 2007. Nest destruction and culling of adult birds were utilized to discourage nesting on Bass and Gull Islands. A total of 124 cormorants were culled by shooting at Bass Island, 20 at Gull Island and 709 at Little Galloo Island. Target levels of fish consumption by cormorants, as measured by the Weseloh and Casselman feeding day model, were very nearly reached in 2006 and management was adjusted for 2007 to keep fish consumption within the target range. In 2007, however, peak nest numbers increased, probably due to immigration of birds from other nesting colonies (Section 13).
- Egg oiling on Little Galloo Island in 2007 reduced cormorant chick production by approximately 92%, thereby reducing the number of cormorant feeding days by 410,688. The resulting reduction in fish consumption was estimated at 56,000 smallmouth bass and 402,000 yellow perch (Section 15).
- Since 1999, the cormorant egg oiling program on Little Galloo Island has reduced fish consumption by chicks at the colony by 50.8 million fish including approximately 8.7 million yellow perch and 2.3 million smallmouth bass that were not consumed by cormorants (Section 15).
- Smallmouth bass abundance in the Eastern Basin as measured in index gill nets declined 41.3% in 2007 as compared to the 2005-2006 average, however, the 2007 index of abundance was still 52.0% higher than the 2000-2004 average (the period of lowest CPUEs on record; Section 4). Recent trends may indicate a population response to reduced cormorant predation.
- Estimated total fish consumption by cormorants from the Little Galloo Island colony in 2007 was 14.5 million fish including 10.39 million round goby, 1.36 million yellow perch, 1.21 million alewife, 0.82 million pumpkinseed, 0.25 million rock bass and 0.11 million smallmouth bass (Section 14).
- Estimated total fish consumption by cormorants from three upper St. Lawrence River colonies (Ontario waters) in 2007 was the highest observed over the last seven years (8.17 million fish). Average annual fish consumption by cormorants from Griswold, McNair, and Strachan Islands since 1999 is 6.38 million fish. Total, combined consumption in 2007 included 2.95 million yellow perch, 2.5 million round gobies, 970,000 rock bass, 850,000 pumpkinseeds, and 80,000 smallmouth bass. Since 1999, Double-crested cormorants from these colonies have consumed an estimated 57.45 million fish including 26.13 million yellow perch, 9.09 million rock bass, 5.45 million cyprinids, 4.97 million pumpkinseed, and 1.29 million smallmouth bass (Section 17).
- Estimated total fish consumption by cormorants from the Pigeon and Snake Island colonies in 2007 was 22.8 million fish including 16.94 million round goby, 2.42 million yellow perch, 2.24 million alewife, 0.14 million pumpkinseed, 0.27 million rock bass and 0.05 million smallmouth bass (Section 16).

References

Christie, W.J. 1973. A review of the changes in the fish species composition of Lake Ontario. Great Lakes Fishery Commission Technical Report 23. 66 p.

Connelly, N.A., T.L. Brown, and B.A. Knuth. 1997. New York statewide angler survey 1996. Angler effort and expenditures. New York State Department of Environmental Conservation, 107 p.

International Joint Commission United States. 1994. Great Lakes Water Quality Agreement of 1978, Agreement with Annexes and Terms of Reference between the United States and Canada signed at Ottawa, November 22, 1978, and Phosphorus Load Reduction Supplement signed October 16, 1983, as amended by Protocol signed November 18, 1987. Office Consolidation, International Joint Commission, United States and Canada, reprinted February 1994.

Smith, S.H. 1995. Early changes in the fish community of Lake Ontario. Great Lakes Fishery Commission Technical Report 60. 38 p.

Stewart, T.J., R.E. Lange, S.D. Orsatti, C.P. Schneider, A. Mathers, M.E. Daniels. 1999. Fish community objectives for Lake Ontario. Great Lakes Fishery Commission Special Publication 99-1. 56 p.