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, smallmouth bass, 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 in 2006, and has since spread in Lake Ontario and the St. Lawrence River. 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 2008.

Lower Trophic Level Monitoring

- From 1995-2008, the biomonitoring program in Lake Ontario has measured indicators of lower food web status with the primary objective of evaluating temporal and spatial patterns in total phosphorus, soluble reactive phosphorus, chlorophyll a, Secchi depth, and crustacean zooplankton density, biomass, and size structure (Section 17).
- *Bythotrephes* biomass in offshore habitats (4.8 ug/L) was at an all time high in 2008; biomass in nearshore and embayment habitats (2.0 and 0.3 ug/L respectively) was lower than in 2007, but comparable to 2006. The frequency of *Bythotrephes* occurrence (33%) in zooplankton samples continued increasing.
- 2008 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 (0.60mm) was significantly greater than the average size of nearshore and embayment samples. The average size of zooplankton was not significantly different in embayments (0.42mm) and nearshore samples (0.52mm).
- Zooplankton biomass in the offshore epilimnion of Lake Ontario has been significantly declining (linear regression, p=0.03) since the late-1990s at a rate of 15% per year (80% reduction, 1998 - 2008). Offshore summer epilimnetic zooplankton density declined 13% per year from 1981-2008 resulting in a 99% reduction over 28 years; zooplankton densities in 2008 are 1% of the levels found three decades ago.
- Chlorophyll a in nearshore habitats has significantly increased 5% per year from 1995-2008 possibly linked to dreissenid-phosphorus-sediment interactions.

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 2008, the abundance and biomass of adult alewife (age-2 and older) in U.S. waters of Lake Ontario increased from 2007 and were 67% and 69% of long term means, respectively. Abundance of age-1 alewife was higher than anticipated, given the relatively low number of available spawners, and was 62% of the long term mean. During 2003-2008, alewife condition in the fall has been higher than in any other period since the late 1970's 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 (Section 12).
- USGS evaluated a completely new net design for conducting the slimy sculpin assessment, a shorter and lighter 39 ft headrope bottom trawl designed to capture benthic fishes while minimizing fouling of net by dreissenids. They successfully completed all scheduled tows in 2008 (Section 12).
- Standard assessment sampling by USGS/DEC during 2008 caught 30 deepwater sculpins, continuing the recent trend of increased catches of this species, once thought to be extirpated from Lake Ontario.
- In 2008, abundance and weight indices for the invasive round goby continued to increase. Gobies were first detected in 2002 and 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 (Section 12).
- The 2008 hydroacoustic survey Lake Ontario preyfish populations consisted of five cross-lake transects and an Eastern Basin transect. The 2008 abundance and biomass of yearling and older (YAO) alewife rebounded from record low values observed in 2007. Abundance and biomass were 63% and 76%, respectively, of the 10-year average values (Section 3).
- The abundance index for age-1 and older rainbow smelt 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. Larger and older rainbow smelt remained scarce in 2008 (Section 12). 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 2008 midsummer acoustic estimate of YAO smelt in Lake Ontario was 216 million fish, the fifth lowest estimate in the eleven year history of the survey, and 50% of the previous 10-year average. The total biomass estimate of smelt in Lake Ontario was 1,714 metric tons (Section 3).

Coldwater Fisheries Management

- Fish stocking in the New York waters of Lake Ontario in 2008 included 798,780 million Chinook salmon, 245,000 coho salmon, 643,720 rainbow trout, 500,910 lake trout, 415,870 brown trout, and 49,470 Atlantic salmon. Lower than normal Chinook salmon stocking in 2008 (45%) was the result of low egg take and poor fertilization rates of eggs at NYSDEC Salmon River Hatchery in fall of 2007. High temperature and low flow in fall 2007 significantly reduced the numbers of adult salmon entering the hatchery and negatively affected survival of eggs. Stocking in 2009 is expected to be on target for 1.76 million Chinook. (Section 1).
- In 2008, 500,910 lake trout and 116,800 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 ($P=0.241$, $R^2=0.062$) and age-3 ($P=0.771$, $R^2=0.004$) are not statistically significant. While the relationship at age-3 had been marginally significant, inclusion of the 2002-2004 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).
- The 2008 mean length (36.5 in) and weight (21.3lbs) of age-3 Chinook salmon in August, as measured from the open lake boat fishery, were 2.5% and 15.8% increases compare to 2007, respectively. 2008 Chinook salmon condition, as determined from predicted weights of given length (24, 28, 32, 36 and 40 inch) fish, improved dramatically from 2007 levels for all inch groups examined (Section 2).
- The mean weight of age-1 Chinook males (jacks) sampled in 2008 increased markedly from those sampled in 2007 and was about 0.5 pounds above the average for all previous years sampled (Section 9).
- Weights of age-2 and age-3 Chinook salmon of both sexes also increased from the record lows observed in 2007 but remained below their respective long term averages. Age-2 fish were about 1 pound (males) and 1.8 pounds (females) below their long-term averages. Age-2 fish were significantly lighter than 8 (males) and 10 (females) of the previous 22 years sampled. Age-3 fish of both sexes were about 1 pound below their long-term averages. Age-3 fish were significantly lighter than 9 (males) and 13 (females) of the previous years sampling (Section 9).
- Steelhead are sampled in the spring and, unlike Chinook and coho salmon, do not reflect growth during the 2008 growing season. Weights reported here reflect conditions prior to and including 2007. Weights of age-3 fish of both sexes were slightly under a pound lighter than their respective long term averages. Age-4 males were the lightest on record and significantly lighter than those sampled in 15 of the 20 previous years in the data set. Age-4 females were the fourth lightest on record and 1.1 pounds below their long term average. The females were not significantly heavier than those sampled in any of the previous years but they were significantly lighter than those sampled in 11 of the previous 20 years (Section 9).
- Since the institution of seasonal base flows in the Salmon River, a dramatic increase in natural reproduction of Chinook salmon continues to be documented. The 2008 year class of wild Chinook salmon appears to be very weak with a mean peak catch of only 49 YOY Chinook per haul during the

last week of May and the first two weeks of June. Catches throughout the survey were well below average (18% of the long-term mean) and the peak occurred later and was more prolonged than normal. Mean Salmon River flow during the preceding October continues to be an important factor explaining year class strength (r^2=0.86) and the extremely low flows and warm temperatures of October 2007 produced a record low year class (Section 8).

- The eleventh year of pen-rearing steelhead trout 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. A total of 35,000 Washington strain steelhead was raised at four pen sites, comprising 7% of NYSDEC's Lake Ontario rainbow trout/steelhead stocking allotment in 2008. Four pen-rearing sites raised a total of 191,190 Chinook salmon, representing 23% of NYSDEC's 2008 Chinook stocking allotment (Section 10).

Lake Trout Restoration

- In 2008 the juvenile lake trout survival index remained low, similar to recent years, and was 88% below the average for the 1983-1989 year classes. In four out of the last ten 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 (Section 5.
- A total of 407 adult lake trout were captured in the September 2008 gill net survey. The catch-per-unit-effort (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 both 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 2008 CPUE (5.2) for adult fish was 70% below the 1986-1998 mean and 53% below the 1999-2004 mean. The 2005-2008 mature lake trout CPUEs were similar to the 1982 and 1983 values which pre-dated 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 were above the target level of two A1 wounds per 100 fish for eight of the last twelve years. A1 wounding rate in 2008 fell below the target level to 1.47 wounds per 100 fish (Section 5). Numbers of lampreys observed by anglers in 2008 was 29.5% lower than the 2003-2007 average and was comparable to (+8.0%) the previous 10-year average (Section 2).
- In 2008, one naturally produced (wild) age-2 (278 mm, 10.9 in) lake trout was caught during bottom trawling. Survival of naturally produced lake trout to the fingerling stage in summer and fall occurred each year during 1993-2006 representing production of 14 consecutive year classes. We caught no wild yearling lake trout during 2005-2008 and have no evidence of a naturally produced year class in 2007. Low numbers of small (<100 mm, 3.9 in), wild fish captured in recent years (1997-2008) 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 2008 (3676.0 g, 8.1 lb) increased from 2003-2006 values, and was equivalent to the 1996-1999 mean (3679.6g, 8.1 lb; the highest values in the data series).
- In 2008, lake trout harvest (2,875) and harvest rate were the 2nd lowest values recorded and catch (6,757) was the lowest recorded. Relatively poor fishing for lake trout in 2008 was likely due, in part, to the declines in adult population size since 2004 and the relatively good fishing for Chinook

salmon (Section 2).

Warmwater Fisheries

- A total of 55,111 fingerling walleye were stocked into Lake Ontario embayments and the Lower Niagara River (Section 1).
- Catch-per-unit-effort (CPUE) of warmwater fish in the 2008 Eastern Basin index gill netting survey was 74.5% and 94.4% higher than previous 5-year (2003-2007) and 10-year (1998-2007) averages, respectively. This was the highest CPUE since 1992 and is primarily attributable to increased CPUE of white perch (highest since 1991) and yellow perch (highest since 1984) (Section 4).
- Smallmouth bass abundance in the Eastern Basin as measured in index gill nets was 14.9% below the 2005-2006 average (highest CPUEs observed since 1994), however, was 120.4% higher than the 2000-2004 average (the period of lowest CPUEs on record). Recent improved smallmouth bass growth and condition continued in 2008 with record or near record high mean length-at-age for all ages 2-10, and record high condition for most length increments examined (Section 4).
- Yellow perch abundance in 2008 was the highest since 1984, a 129.5% increased compared to the 1989-2006 average and a 74.1% increase compared to the 2003-2007 average (Section 4).
- Walleye abundance in 2008 was 23.3% and 35.5% above previous 5-year and 10-year averages, respectively. The strong 2003 yearclass represented 18.8% of the 2008 catch (mean length=22.8 inches).
- Round gobies first appeared in the Eastern Basin assessment in 2005 in both gillnet catches and smallmouth bass diets. Goby occurrence in predator diets increased each year since, and in 2008, were found in one walleye stomach, two northern pike stomachs, and 51.0% of non-empty smallmouth bass stomachs (208 stomachs examined) (Section 4).
- Index gill netting in the Thousand Islands region of the St. Lawrence River during 2008 showed that smallmouth bass and yellow perch abundance remain relatively high. Increased smallmouth bass and yellow perch growth rates may be related to increased feeding on round gobies. 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).
- In spite of an increased Double-crested cormorant population (DCC), yellow perch abundance in the 2008 Lake St. Lawrence index gill netting increased for a second consecutive year (Section 7). This is likely explained by a strong shift in DCC diet dominance from yellow perch to round goby (see Section 15) while smallmouth bass abundance remains well below the long-term average. In 2007, walleye abundance also declined below the long-term average.
- White perch abundance was more than 6-fold higher than the previous 5-year average and the highest since 1991.
- Lake sturgeon was collected in the Eastern Basin in eleven of the last fourteen years suggesting improvements in population status.

Sport Fishery Assessment

- Total trout and salmon fishing success (charter catch per angler hour=0.17) declined by 16.5% compared to the 2003-2007 average, however, it was comparable to the previous 10-year (1998-2007; -6.9%) and long-term (1985-2007; -5.2%) averages. During 2003-2007 anglers experienced some of the highest catch rates since the survey was initiated in 1985 (Chinook salmon: 2003-2007, coho salmon: 2006-2007, and brown trout: 2003 and 2007). The 2008 charter catch rate of Chinook salmon declined 24.4% compared to the 2003-2007 average, however, it was the 6th highest in the data series. The six highest lake-wide seasonal estimates for Chinook salmon catch rates occurred each year 2003-2008. Charter catch rate for rainbow trout was the highest estimated in the 24 years surveyed, and was 104.6% higher than the 2003-2007 average. Total trout and salmon catch

(127,799 fish) and harvest (79,159 fish) were dominated by Chinook salmon (43.6% and 44.9%, respectively) and rainbow trout (26.7% and 24.9%, respectively) (Section 2).

- Total fishing boat trips, and trips targeting trout and salmon declined significantly after 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. Effort targeting trout and salmon has fluctuated with no significant trend over the last ten years.
- In 2008, total effort was estimated at 70,598 fishing boat trips [±12.5%], which was the 2nd lowest in the data set and an 11.1% decrease compared to the 2003-2007 average.
- An estimated 52,111 boat trips [±15.4%] targeted trout and salmon in 2008 (73.8% of fishing boat trips). Trout and salmon fishing effort in 2008 was the 3rd lowest estimated among the years surveyed, however, was comparable to (-4.3%) the 2003-2007 average.
- The number of lampreys observed per 1,000 trout and salmon caught was estimated at 22.2 in 2008, a 29.5% decrease compared to the 2003-2007 average and comparable to (+8.0%) the previous 10-year average.
- Fishing boat trips targeting smallmouth bass during the traditional open season (3rd Saturday in June through September 30 when the creel survey ends) was an estimated 12,786 (±20.7%) in 2008, 36.3% below the 2003-2007 average and the 2nd lowest estimate among years surveyed. A regulation change, effective October 1, 2006, permitted pre-season catch and release of smallmouth bass. Pre-season effort was low in 2007 (496 fishing boat trips [±74.2%]) and remained low in 2008 (367 fishing boat trips [±64.9%]).
- In 2008, smallmouth bass catch and harvest were the lowest estimated in the 24-year data set (50,811 and 11,104 fish, respectively), and were 71.2% and 67.3% below the 2003-2007 average, respectively. Smallmouth bass was the most commonly caught species in the survey each year 1985-2006. In 2007, smallmouth bass became the 3rd most commonly caught species, preceded by yellow perch and Chinook salmon. In 2008, smallmouth bass became the fourth most commonly caught species, preceded by yellow perch (67,342 caught), round goby (63,407 caught), and Chinook salmon (55,776 caught).
- A roving-roving creel survey of Irondequoit Bay was conducted from April 1, 2007 to March 31, 2008 (Section 11). Total angler effort for 2007-2008 was estimated at 36,757 angler trips or 167,500 angler hours. Yellow perch were the most sought after fish, and comprised 95% of angler harvest.

Diets of Double-crested Cormorants and Impacts on Sportfish Populations

- Egg oiling on Little Galloo Island in 2008 reduced cormorant chick production by approximately 89%, thereby reducing the number of cormorant chick feeding days by 375,684. The resulting reduction in fish consumption was estimated at 23,000 smallmouth bass and 208,000 yellow perch (Section 14).
- In 2008, smallmouth bass abundance in the Eastern Basin as measured by index gill nets was 14.9% below the 2005-2006 average, however, the 2008 index of abundance was 120.4% 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 2008 was 14.15 million fish including 13.13 million round goby, 0.42 million alewife, 0.35 million yellow perch, 0.08 million rock bass, 0.05 million pumpkinseed, and 0.04 million smallmouth bass (Section 14).
- Estimated total fish consumption by cormorants from three upper St. Lawrence River colonies (Ontario waters) in 2008 was the highest observed over the last nine years (10.10 million fish). Average annual fish consumption by cormorants from Griswold, McNair, and Strachan Islands since 1999 is 6.76 million fish. Total, combined consumption in 2008 included 4.69 million round gobies,

2.52 million yellow perch, 1.41 million pumpkinseeds, 950,000 rock bass, and 50,000 smallmouth bass. Since 1999, Double-crested cormorants from these colonies have consumed an estimated 67.6 million fish including 28.6 million yellow perch, 10.1 million rock bass, 9.4 million round goby, 6.4 million pumpkinseed, 5.7 million cyprinids, and 0.6 million smallmouth bass (Section 15).

- For the tenth 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 2008. Nest destruction and culling of adult birds were utilized to discourage nesting on Gull Island, but were not necessary on Bass Island due to landowner activity and the presence of domestic pigs. A total of two cormorants were culled by shooting at Gull Island and 382 at Little Galloo Island, the fewest since full scale culling began. Target levels of fish consumption by cormorants, as measured by the Weseloh and Casselman feeding day model, were very nearly reached each year since 2006 (Section 13).
- Since 1999, the cormorant egg oiling program on Little Galloo Island has reduced fish consumption by chicks at the colony by 56.7 million fish including approximately 9.0 million yellow perch and 2.4 million smallmouth bass that were not consumed by cormorants (Section 14).

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.