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, and lake sturgeon. 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 phenomena 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 2001, and the first gobies documented in a U.S. fisheries assessment program were collected by the USGS Research Vessel *Kaho* at 55 m depth off Olcott in 2002. With the exception of the Griswold Island Double-crested cormorant colony, round gobies have become the dominant prey of cormorants in eastern Lake Ontario and the St. Lawrence River. Gobies have also been identified in the diets of numerous sportfish species, including trout and salmon.

Viral Hemorrhagic Septicemia (VHS) was first documented in the New York waters of Lake Ontario and the St. Lawrence River in 2006. A large 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 2006.

Lower Trophic Level Monitoring

- Lake Ontario embayments are highly productive habitats as evidenced by higher concentrations of total phosphorus, soluble reactive phosphorus, chlorophyll *a*, and volumetric zooplankton density and biomass relative to nearshore and offshore habitats (Section 20).
- For July, embayment zooplankton biomass was more than 12 times greater than nearshore, and more than nine times greater than offshore biomass. Average embayment zooplankton size was significantly smaller than both nearshore and offshore average size (Section 20).
- The exotic zooplankter *Cercopagis pengoi* was first observed in Lake Ontario in June 1998 in the Chaumont Bay area. In 2006, *C. pengoi* was detected in 50.4% of samples from May through October (as compared to 57% - 2005, 45.3% - 2004, 31.8% - 2003 and 31.6% - 2002). In 2006, populations of adult and juvenile alewife were not sufficiently abundant to suppress *C. pengoi* and other, larger sized zooplankton (Section 20).
- The exotic zooplankter *Bythotrephes longimanus* was detected in three samples in 2004 and 34 samples in 2005, after being absent in 2002 and 2003. In 2006, *B. longimanus* was collected in 43 samples from May though October. The emergence of *B. longimanus* in 2005 and 2006 lends further credence to the hypothesis that alewife abundance is currently suppressed.
- Benthic community index sampling was conducted in Lake Ontario from 2000-2006 (Section 19). *Diporeia* densities declined over the survey period and none were found in October 2005 or any 2006 samples. For all years, quagga mussel densities were the highest of all benthic invertebrates, however, a decline in quagga mussel densities was observed in 2006. With a decline in invasive mussels, native sphaeriid clams have been observed where there had been none recently.

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).
- Abundance indices for adult alewife (age-2 and older) in 2006 were about 71% lower than in 2005 and 94% lower than their peaks in the 1980s. The numerical abundance index for age-1 alewife in 2006, however, was 5-fold higher than that of spring 2005, approximately double the long-term mean (very similar to recruitment model predictions). In 2007, we expect strong recruitment of age-2 fish from the large 2005 year class to increase adult alewife abundance indices to 2002-2004 levels (Section 12).
- Geographical differences in fish abundance detected by acoustic sampling and bottom trawling were similar and acoustic sampling did not identify any potentially large sources of error (Section 12).
- The abundance index for age-1 and older rainbow smelt in 2006 was lower than that recorded in 2005, and is the second lowest population index in the 29-year time series. The number of age-1 rainbow smelt caught in 2006 (2005 year class) was an increase of more than 50% from the number caught in 2005 (2004 year class), but was still the third lowest age-1 smelt index since 1995 (Section 12).
- In October 2006, we continued use of the tickler chain modification to resume the slimy sculpin index survey. Catches of slimy sculpins in 2006 were lower than in 2005 for all depths. During

2006 sampling, we caught 16 deepwater sculpin *Myoxocephalus thompsonii* [52 - 108 mm (2.0 - 4.3 in)], continuing the 2005 trend of increased catches of this species, once thought to be extirpated from Lake Ontario (Section 12).

- The numerical abundance index for round goby in 2006 was similar to that in 2005, but the weight index continued to increase (Section 12).
- The 2006 hydroacoustic survey consisted of five cross-lake transects and an Eastern Basin transect. To improve identification and vertical distribution of small targets, a remotely opening/closing Tucker trawl was used in addition to the 57 m^2 (613.5 ft^2) midwater trawl (Section 3).
- The 2006 hydroacoustic estimate of age-1 and older alewife abundance (1.03 billion fish) rebounded from the record-low level observed in 2005. This year's acoustic estimate for alewife abundance was equal to the number observed in 2000, when the strong 1998 and 1999 year classes began recruiting to the yearling and older alewife population. A modal shift in peak target strength from -39 dB to -42 dB also suggests an increase in smaller targets in 2006 (Section 3).
- The 2006 hydroacoustic estimate of smelt was 126 million fish. The smelt population declined by 42% from 2005, and was the 3rd lowest on record from the acoustic survey. Abundance and biomass were 38% and 49%, respectively, below the long term averages (Section 3).

Coldwater Fisheries Management

- Fish stocking in the New York waters of Lake Ontario in 2006 included 1.83 million Chinook salmon, 265,000 coho salmon, 644,650 rainbow trout,117,820 lake trout, 391,440 brown trout, and 28,800 Atlantic salmon. (Section 1).
- In 2006, 117,820 lake trout and 31,690 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 ($P=0.323$, $R^2=0.048$) and age-3 ($P=0.686$, $R^2=0.008$) are not statistically significant. While the relationship at age-3 had been marginally significant, inclusion of the 2002 and 2003 year classes eliminated any significance. These year classes produced an age-3 relative harvest estimate nearly twice as high as other stocked year classes of similar size (Section 2).
- The reductions in Chinook salmon growth observed in 2003 - 2005, as measured in the open lake fishery, reversed trend in 2006 (Section 2).
- Mean weights of age-2 and age-3 Chinook salmon (13.3 and 18.3 lbs respectively) returning to the Salmon River hatchery in 2006 rebounded from record low levels observed in 2005. The mean weight of age-1 Chinook males (jacks, 5.4 lbs) increased significantly in 2006 following three successive years of poor growth. Condition of fish sampled in the hatchery also improved in 2006 as the predicted weight of a 36 inch Chinook rose to 16.1 lbs, following the record low (14.8 lbs) observed in 2005, but still remains relatively low (Section 9). Improvements in Chinook growth and condition in 2006 are probably a result of abundant yearling alewives.
- Since the institution of seasonal base flows in the Salmon River, a dramatic increase in natural reproduction of Chinook salmon continues to be documented. Densities of young-of-year Chinook salmon were at a record high in 2006 (Section 8). Mean flow during the preceding October appear to be an important factor explaining year class strength. Higher flows may also create more difficult fishing conditions, providing more protection to spawning fish.
- A total of 84,800 steelhead (Washington and Skamania strains) were raised at eight pen sites, comprising 13.1% of NYSDEC's Lake Ontario rainbow trout/steelhead stocking allotment in 2006.

Five pen-rearing sites raised a total of 313,100 Chinook salmon, representing 18% of NYSDEC's 2006 Chinook salmon stocking allotment. The ninth year of pen-rearing steelhead and Chinook salmon along the New York shoreline of Lake Ontario was very successful due to relatively low fish mortality at most sites, and a relatively high percentage of fish reaching target weights (Section 18).

Lake Trout Restoration

- In 2006 the total catch of one age-2 lake trout was the lowest recorded and the survival index was 99% below the average for the 1983-1989 year classes. In four out of the last six 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 505 adult lake trout were captured in the September 2006 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 2006 CPUE (7.3)for adult fish rebounded somewhat to a level 58% below the 1986-1998 mean and 33% below the 1999-2004 mean (Section 5).
- Sea lamprey wounding rates on lake trout remain much lower than pre-1985 levels, but have been above the planned target level of two A1 wounds per 100 fish for seven of the last ten years. A1 wounding rate in 2006 was 2.9 wounds per 100 fish (Section 5). Numbers of lampreys observed by anglers was 22.0% higher than the 2001-2005 average but was 36.3% lower than the 2005 record high (Section 2).
- In 2006, seven naturally produced (wild) age-2 (6) and age-3 (1) lake trout were caught with bottom trawls. They ranged in length from 193 to 328 mm (7.6 to 12.9 in). Survival of naturally produced lake trout to the fingerling stage in summer and fall occurred each year during 1993-2004 representing production of 12 consecutive year classes. We caught no wild yearling lake trout in 2005 or 2006 and have no evidence of a naturally produced year class in 2005. Low numbers of small (<100 mm, 3.9 in), wild fish captured in recent years (1997-2003) 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 2006 was unchanged from 2004-2005 values, remaining at the lowest level recorded since 1993.
- The annual harvest of lake trout from U.S. waters of Lake Ontario declined over four fold since the protected slot limit (635 to 762 mm, 25 to 30 in) was re-instated in 1992 compared to years without size limits. In 2006, lake trout harvest (2,964), catch (8,656), and harvest rate were the lowest on record, but total trout and salmon angling effort was also the second lowest observed since the creel survey began in 1985. The relatively poor fishing for lake trout in 2006 may have been related to the declines in adult population size since 2004, but also was likely related to good fishing for Chinook salmon (Section 2).
- A study evaluating the effect of location (onshore vs. offshore) and timing (May vs. June) of stocking on the survival of lake trout is being conducted at Olcott and Sodus, New York. Results from ongoing evaluations indicate combined age-2 through age-7 returns from Olcott favor offshore

stocking over shore stocking in either May or June by a 1.9 : 1.0 : 1.1 margin. In addition, lake trout stocked at Olcott yielded catches 5.8 fold higher than those stocked at Sodus (Section 11).

Warmwater Fisheries

- A total of 123,125 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 2006 Eastern Basin index gill netting program was comparable to the 2005 estimate and 37.2% higher than the 1995-2004, 10-year mean (Section 4).
- Smallmouth bass abundance in the eastern Basin was similar to 2005, and was 148.6% higher than the previous 5 year mean. 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 2006 was 11% higher than the previous 5 year mean (Section 4) .
- Walleye abundance in 2006 was comparable to the previous 5 and ten year means (Section 4).
- Lake sturgeon have been collected in the Eastern Basin in ten of the last twelve years, suggesting improvements in population status.
- Round gobies first appeared in this Eastern Basin assessment in 2005 and, in 2006, appeared in greater frequency in both gill nets (n=5) and in smallmouth bass stomachs (20.3% of non-empty stomachs) (Section 4).
- Index gill netting in the Thousand Islands region of the St. Lawrence River during 2006 showed that northern pike and yellow perch remain below their respective, long-term levels of adundance, and smallmouth bass abundance increased to its highest level since 1988 (Section 6).
- Yellow perch abundance in 2006 Lake St. Lawrence index gill netting decreased 17% from 2005 (Section 7). Smallmouth bass abundance in 2006 was well below the long-term average. In 2006, walleye abundance increased 33% from 2005 and was well above average. The walleye catch was dominated by age-1 and age-2 fish.
- An exploratory survey was conducted in 2006 to delineate collection sites for spawning lake sturgeon in mid migration in the lower Black River. A total of five sturgeon (four males, one presumed to be female) were collected and catch per unit effort was 0.07 fish/hour. Operations in 2006 demonstrated that sturgeon could be intercepted downstream of the primary spawning site in the Black River (Section 21).

Sport Fishery Assessment

- Chinook salmon fishing success (catch/angler hour) declined from the record high reached in 2005 but was still the fourth highest on record. Total trout and salmon fishing success (harvest per boat trip) was down 14.8% compared to the record high observed in 2005 (Section 2). An estimated 39,439 (+/- 26.3%) Chinook salmon were harvested in the open lake, a 42.8% decrease from the 2005 estimate.
- 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 2006, total effort was estimated at 66,906 fishing boat trips [95% confidence interval ± 13.6%], 23.4% below the 2001-2005 average and the lowest recorded in the history of the census.
- An estimated 49,223 boat trips [± 16.8%] targeted trout and salmon in 2006 (73.6% of fishing boat trips). Trout and salmon fishing effort in 2006 was the second lowest estimate among the years

censused and 12.5% below the 2001-2005 average.

- The number of lampreys observed per 1,000 trout and salmon caught was estimated at 32.3 in 2006, a 46.2% increase compared to the 2001-2005 average.
- Fishing boat trips targeting smallmouth bass during the open season declined to 13,586 (+/- 22.9%) in 2006, 48.2% below the 2001-2005 average and the second lowest estimate among years censused. Smallmouth bass was the most commonly harvested species in the census from 1995-2003, however, Chinook salmon harvest increased dramatically from 2004 through 2006 while smallmouth bass harvest declined indicating a possible shift in angler preference. The 2006 smallmouth bass harvest (17,759 +/-61.3%) was the lowest seasonal harvest among the years censused and a 62.8% decrease relative to the 2001-2005 average.
- Data on smallmouth bass fishing in Lake Ontario collected from the 1985-2006 censuses were analyzed in more detail as part of the evaluation of the impacts of Double-crested cormorant predation on fisheries (Section 2). From 1985-90, harvest rates at Henderson Harbor were nearly equal to or greater than the lake-wide average harvest rates and averaged 1.16 smallmouth bass harvested/angler hour. From 1991-2005, smallmouth bass harvest rates at Henderson Harbor, adjacent to the Little Galloo Island cormorant colony, were all below the lake-wide average. In 2006, the smallmouth bass harvest rates at the Henderson Harbor site increased to the highest rate observed at that site since 1989 (see also section 14).
- For the first time since 1984, a comprehensive survey of Lake Ontario tributary fisheries was conducted in 2005-2006 and is being repeated in 2006-2007. Results from 2005-2006 are reported (Section 10) , and interim results for the September to the end of November 2006 period are reported (Section 16), with highlights below.
- For the fall 2005-spring 2006 period, total estimated effort for all tributaries was 1,025,994 angler hours (Section 10). Estimated effort for the tributary fishery (September through April/mid-May) was 1,025,994 angler hours, or about 92% of the open lake effort. The Salmon River accounted for 59% of the total with 605,772 angler hours.
- On the Salmon River, 72% of the anglers interviewed were very satisfied with the current Lake Ontario New York tributary fishing regulations. On the other tributaries, the majority (63%) of the anglers also indicated that they were very satisfied with the current tributary regulations. For all tributaries, at least a portion of the anglers indicating that they were not satisfied with the regulations wanted more restrictive creel limits (Section 10).
- In fall 2006 (Section 16), the total estimated effort for all tributaries was 757,141 angler hours. The Salmon River accounted for 66% of the total with 500,456 angler hours. The overall effort for all non-Salmon River tributaries in 2006 declined 17% to 256,685 (308,534 hours in 2005), however the 2006 Salmon River effort increased 3% to 500,456 hours (from 483,792).
- The total number of estimated angler trips from all 29 tributaries was 228,938, representing an 11% decline from 2005 (256,907). The Salmon River accounted for 36% (83,409) of the total trips. Three other tributaries accounted for large shares of the effort: Eighteenmile Creek in Niagara County, Oak Orchard Creek in Orleans County, and South Sandy Creek in Jefferson County (Section 16).
- Twenty-four of 29 tributaries surveyed had reported catches of Chinook salmon (Section 16). The estimated catch and harvest of Chinook salmon on all tributaries surveyed in 2006 was 151,273 and 56,351, respectively. The catch of Chinooks declined slightly from the 2005 estimate (155,960), but the harvest increased (48,671).
- The estimated catch of Coho salmon increased markedly in 2006, with 18,164 fish being caught from

12 tributaries compared to 2005 when only 5,914 fish were caught (Section 16).

- Twenty of the 29 tributaries surveyed had reported catches of steelhead (Section 16). For all tributaries surveyed, the total estimated catch and harvest was 34,468 and 8,974, respectively. Both the catch and harvest of steelhead increased from 2005 (27,155 and 3,409 respectively). Other tributaries producing substantial steelhead catches included Eighteenmile and Oak Orchard Creeks, each with estimated catches exceeding 5,000 fish.
- Seventeen of the 28 waters surveyed had reported catches of brown trout (Section 16). For all tributaries surveyed, estimated brown trout catch and harvest were 27,419 and 10,179, respectively. The estimated catch declined from 2005 (40,192, Section 10), however the number harvested roughly doubled (from 5,588). The catch (14,895) and harvest (6,265) on Eighteenmile Creek were markedly higher than for any other tributary. Oak Orchard Creek was second with an estimated catch and harvest of 2,877 and 1,318 respectively.
- Seventy percent of the anglers surveyed on the Salmon River were non-New York State residents, while 44% of the anglers on all "high-use" tributaries (including Salmon River) were non-NYS residents. By contrast, non-residents comprised only 35% and 28% of the anglers surveyed on "medium use" and "low use" tributaries, respectively (Section 10).

Diets of Double-crested Cormorants and Impacts on Sportfish Populations

- For the eighth 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 adults birds by shooting was employed again in 2006. Nest destruction and culling of adult birds were utilized to discourage nesting on Bass and Gull Islands. A total of 170 cormorants were culled by shooting at Bass Island, and 620 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 (Section 13).
- Egg oiling on Little Galloo Island in 2006 reduced cormorant chick production by approximately 97%, thereby reducing the number of cormorant feeding days by 340,000. The resulting reduction in fish consumption was estimated at 90,000 smallmouth bass and 338,000 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 45.2 million fish including approximately 8.3 million yellow perch and 2.2 million smallmouth bass that were not consumed by cormorants (Section 15).
- Smallmouth bass abundance in the Eastern Basin as measured in index gill nets increased in 2005 and 2006 (Section 4), possibly indicating a population response to reduced cormorant predation. The 2006 smallmouth bass harvest rate in the Eastern Basin increased to the highest level since 1989 (Section 2).
- Estimated total fish consumption by cormorants from the Little Galloo Island colony in 2006 was 10.1 million fish including among other species 6.9 million round goby, 1.01 million alewife, 0.96 million yellow perch, 0.34 million rock bass and 0.31 million pumpkinseed and 0.14 million smallmouth bass (Section 14).
- Estimated total fish consumption by cormorants from three upper St. Lawrence River colonies (Ontario waters) in 2006 (7.32 million fish) was the highest observed over the last six years. Average annual fish consumption by cormorants from Griswold, McNair, and Strachan Islands since 1999 is 6.16 million fish. Total, combined consumption in 2006 included 1.7 million yellow perch, 2.6 million round gobies, 470,000 rock bass, 400,000 pumpkinseeds, and 60,000 smallmouth bass.

Since 1999, Double-crested cormorants from these colonies have consumed an estimated 49.28 million fish including 23.18 million yellow perch, 8.12 million rock bass, 4.91 million cyprinids, 4.12 million pumpkinseed, 0.49 million smallmouth bass, and 0.31 million esocids (Section 17).

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