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 (Christie 1973; Smith 1995). 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 continued 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 numerous, confirmed reports received in 2002 documented the presence of this species from the Lower Niagara River in the west to the Thousand Islands region of the St. Lawrence River in the east. The first gobies documented in a U.S. fisheries assessment program were collected by the U. S. Geological Survey Research Vessel *Kaho* at 55 m depth off Olcott in 2002. Round gobies were documented for the first time in the diets of cormorants from Pigeon and Snake Islands in 2002, and became the dominant prey of Snake Island cormorants in 2003 - 2005. Gobies have now been collected in Eastern Basin index gill nets and in diets of Eastern Basin smallmouth bass.

A number of indicators suggest that predator-prey balance between trout and salmon and forage fish (primarily alewife) in Lake Ontario remains tenuous. Based on spring 2005 bottom trawling, adult alewife abundance was about 30% below that in 2004 and 57% below the long-term mean. Below average abundance of the 2003 and 2004 year classes suggest that adult abundance will decline further 2006. Elevated alewife body condition in the fall of 2005 suggests that alewife numbers were low relative to their zooplankton food supply. The emergence of the large, exotic zooplankter *Bythotrephes* in 2005 to record high levels also suggests suppressed alewife predation on zooplankton. Mean weight of age-3 Chinook salmon decreased to record low levels in 2005, as did wet weight condition factor, while Chinook salmon fishing success (catch per hour) reached a second consecutive record high level. These observations suggest high predator

abundance relative to forage fish abundance.

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 2005.

Lower Trophic Level Monitoring

- Lake Ontario embayments are highly productive habitats as evidenced by higher concentrations of total phosphorus, chlorophyll *a*, and volumetric zooplankton density relative to nearshore and offshore habitats (Section 20).
- From mid-July to mid-August, embayment zooplankton biomass was more than 16 times greater than nearshore, and more than five times greater than offshore biomass. Average embayment zooplankton size was similar to nearshore, but was significantly smaller than offshore average size.
- The exotic zooplankter *Cercopagis pengoi* was first observed in Lake Ontario in June 1998 in the Chaumont Bay area. In 2005, *C. pengoi* was detected in 57% of samples from May through October (as compared to 45.3% - 2004, 31.8% - 2003 and 31.6% - 2002). In 2005, populations of adult and juvenile alewife were not sufficiently abundant to suppress *C. pengoi* and other, larger sized zooplankton.
- The exotic zooplankter *Bythotrephes longimanus* was detected in three samples in 2004, after being absent in 2002 and 2003. In 2005, *B. longimanus* was collected in 34 samples from May though October. The emergence of *B. longimanus* in 2005 lends further credence to the hypothesis that alewife abundance is currently suppressed.

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).
- Adult (age-2 and older) alewife abundance in 2005 bottom trawl surveys declined by approximately 30% relative to 2004, 57% lower than the long term mean. Catches of age-1 alewife in 2005 were approximately 35% below those in 2004, and 60% below the long term mean (Section 12). A potentially large 2005 year class could increase adult alewife abundance in 2007 and 2008.
- Abundance indices of age-1 and older rainbow smelt in bottom trawls were lower than in 2004, indicating a potential return to the alternating pattern of year class strength observed previously. Larger/older smelt remain scarce in Lake Ontario (Section 12).
- Dreissenid fouling of Yankee trawl (39 ft headrope) gear caused the discontinuation of slimy sculpin assessment. A tickler chain was added to the footrope of a 3-in-1 bottom trawl (59 ft headrope) in 2005 to test its effectiveness in sampling slimy sculpin. Although 2005 catches of slimy sculpin with this gear were generally lower than historic catches, the survey can now be reinstituted. Particularly noteworthy in this survey was the catch of 17 deepwater sculpin *Myxocephalus thompsonii* (1.8 - 6.2 in) at depths ranging from 361 - 574 ft. This survey will also assess the status of round goby populations (Section 12).
- An exploratory survey of Lake Ontario's profundal zone (targeting potential remnant stocks of deepwater coregoinids) was undertaken in 2005 using gill nets and 3-in-1 bottom trawls. Gill netting proved ineffective, while limited bottom trawling caught rainbow smelt, slimy sculpin and deepwater sculpin (Section 12).

- During the 2005 hydroacoustic survey, the fixed transect design was modified to include a random element. Five fixed cross-lake corridors approximately 15 km (9.6 mi) wide were established based on logistic constraints, but within these corridors transects were selected at random. A remotely opening/closing Tucker trawl was also tested during the 2005 survey in place of the 57 m^2 (613.5 ft^2) midwater trawl used in previous surveys (Section 3).
- The 2005 hydroacoustic estimate of alewife abundance suggests possibly the lowest population since the start of this index in 1997. Rainbow smelt abundance increased in 2005 to levels similar to the early 2000s (Section 3).

Coldwater Fisheries Management

- Fish stocking in the New York waters of Lake Ontario in 2005 included 1.81 million chinook salmon (14.8% increase over 1997-2003 levels), 254,000 coho salmon, 645,158 rainbow trout, 224,150 lake trout, 391,440 brown trout, and 50,000 Atlantic salmon (Section 1).
- In 2005, 224,150 lake trout and 44,140 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 ($P=0.310$, $R^2=0.054$) and age-3 ($P=0.505$, $R^2=0.024$) are not statistically significant. While the relationship at age-3 had been marginally significant, inclusion of the 2002 year class eliminated any significance. This year class produced an age-3 relative harvest estimate nearly twice as high as other stocked year classes of similar size (Section 2).
- Reductions in Chinook salmon growth in 2003 - 2005, as measured in the open lake fishery, were most evident in age-3 fish (Section 2).
- Mean weights of age-2 and age-3 Chinook salmon returning to the Salmon River hatchery in 2005 were at or near record low levels, as was mean weight of age-1 males (jacks) (Section 9). The predicted weight of a 36 inch total length Chinook (14.9 lbs) also reached a second, consecutive record low level in 2005 (16.1 pounds in 2004). Mean weights of age-2 coho were intermediate among years sampled. Growth of steelhead was near average, however, they are surveyed in the spring of the year and do not reflect growth during 2005.
- Since the institution of seasonal base flows in the Salmon River, a dramatic increase in natural reproduction of Chinook salmon has been documented. Densities of young-of-year Chinook salmon in 2005 were relatively high for the second consecutive year (Section 8).
- 388,100 pre-smolt Chinook salmon and 58,858 rainbow trout were reared by cooperating sportsmen in net pens within Lake Ontario tributaries (Section 18).
- Chinook pen rearing evaluations for Oak Orchard Creek and the Lower Niagara River are complete. Separate lots of marked Chinook salmon from the Salmon River and Caledonia Hatcheries (40,000 each) were stocked into the Lower Niagara River (2000 and 2002) and Oak Orchard Creek (1999 and 2001) to assess differential effects of hatchery origin and pen rearing vs. traditional stocking on performance in the fishery (Section 19). Returns of the 1999 and 2001 year classes stocked at Oak Orchard indicate that pen-reared Salmon River Hatchery origin Chinook returned the greatest yield to Oak Orchard Creek. Direct-stocked Caledonia fish returned better than direct-stocked Salmon River fish for the 1999 year class, but the opposite was true for the 2001 year class. Returns of the 2000 and 2002 year classes stocked at the Niagara River are in contrast with the Oak Orchard study, with Salmon River, direct stocked fish returning best. Pen-reared Salmon River fish returned to the Niagara River at an intermediate level, with Caledonia direct stocked fish returning the poorest.

Particularly noteworthy in the evaluations was the dominance of unmarked Chinooks (strays or wild fish) at both sites.

Lake Trout Restoration

- Catch of age-2 lake trout in 2005 (2003 year class) declined by 87% from 2004(Section 5). Nearly all of the age-2 fish were caught in western Lake Ontario, suggesting higher survival there relative to eastern Lake Ontario.
- A total of 355 adult lake trout were captured in the September 2005 gill net survey, down 47% from 2004. Catch rates for mature lake trout remained remarkably stable from 1986 to 1998. The catch per unit of effort (CPUE) of mature fish, however, declined by 30% between 1998 and 1999. In comparison to the 1986-1998 and 1999-2004 averages, the catch per unit effort (CPUE) of mature lake trout in 2005 was down by 71% and 54%, respectively.
- 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 eight years. A1 wounding rate in 2005 was 3.9 wounds per 100 fish, the highest level observed since 1984 (Section 5). Record high numbers of lampreys were observed attached to fish caught by boat anglers participating in the 2005 boat census (Section 2).
- In 2005, six naturally produced yearling lake trout (7.1 to 10.6 in total length) were caught during bottom trawling. Survival of naturally produced lake trout to the fingerling stage in summer and fall occurred each year during 1993–2003. Further, survival to older ages has also been apparent. The distribution of catches of wild fish suggests that lake trout are reproducing throughout New York waters. No wild yearling lake trout were collected in 2005 (Section 5).
- The estimated annual harvest of lake trout from U.S. waters of Lake Ontario since the slot limit (25 to 30 in) was re-instated in 1992 has been more than four times lower than previous years when no size limits were in effect. Harvest in 2005 declined to a third consecutive record low level (4,181 lake trout harvested). Recent low lake trout harvest may be due to exceptional Chinook salmon fishing success. The percentage of lake trout harvested by anglers that were of trophy size (> 762mm or >30 in) reached a record high 48.5% in 2003, and was 34.2% in 2005 (Section 2).
- Condition of adult lake trout (weight of a 700 mm or 27.6 in total length fish) in 2005 was unchanged from 2004, remaining at the lowest level recorded for the last 14 years.
- 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-6 returns from Olcott favor offshore stocking over shore stocking in either May or June by a 1.8 : 1.0 : 1.1 margin. In addition, lake trout stocked at Olcott yielded catches 6.4 fold higher than those stocked at Sodus (Section 11).

Warmwater Fisheries

- 104,258 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 2005 Eastern Basin index gill netting program increased to the highest level observed since 1994 (Section 4). Three-year moving average catches for smallmouth bass, walleye, pumpkinseed, brown bullhead, and white sucker are increasing, whereas the same for yellow perch and northern pike are relatively stable. Growth of smallmouth bass has increased in recent years. Lake sturgeon have been collected in nine of the last eleven years, suggesting improved population status. For the first time in this assessment, round gobies were documented in both gill nets (n=2) and in smallmouth bass stomachs (n=16).

- Index gill netting in the Thousand Islands region of the St. Lawrence River revealed continued low abundance northern pike and yellow perch, but a marked increase in smallmouth bass abundance (Section 6).
- Yellow perch abundance in 2005 Lake St. Lawrence index gill netting rebounded from record low levels observed in 2004 (Section 7). Smallmouth bass abundance in 2005 increased above the long-term average. Age-frequency distribution of the 2005 walleye catch suggests strong 2002 and 2003 year classes.
- An exploratory survey was conducted in 2005 to assess lake sturgeon spawning activity and habitat in the lower Black River. A total of 12 ripe adult sturgeon (11 males, 1 female) were collected in a three day period, and lake sturgeon egg deposition was documented on an egg trap and with underwater video (Section 21).

Sport Fishery Assessment

- Chinook salmon fishing success (catch/angler hour) in 2005 reached a second consecutive record high level. Total trout and salmon fishing success (harvest per boat trip) also reached a record high level in 2005 (Section 2). An estimated 67,957 (+/- 32.5%) Chinook salmon were harvested in the open lake, the highest harvest since 1991.
- 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 2005, total effort was estimated at 85,576 fishing boat trips [95% confidence interval ± 12.6%], 4.5% below the 2000-2004 average and the third lowest recorded in the history of the census.
- An estimated 59,000 boat trips [± 15.3%] targeted trout and salmon in 2005 (68.9% of fishing boat trips). Trout and salmon fishing effort in 2005 increased 23.2% compared to the 2003 record low, and was nearly equal to the 2000-2004 average.
- The number of lampreys observed per 1,000 trout and salmon caught was estimated at 37.2 in 2005, an 179.8% increase compared to the 2000-2004 average.
- Fishing boat trips targeting smallmouth bass during the open season declined to 22,108 (+/- 22.9%) in 2005, 19.3% below the 2000-2004 average. Long-term smallmouth bass effort, however, shows a variable but statistically significant upward trend. Smallmouth bass was the most commonly harvested species in the census from 1995-2003, however, Chinook harvest increased dramatically in 2004 and 2005 while smallmouth bass harvest declined. The 2005 smallmouth bass harvest (32,816 +/-32.4%) was a 41.6% decrease relative to the 2000-2004 average.
- Data on smallmouth bass fishing in Lake Ontario collected from the 1985-2005 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 1991-2004, smallmouth bass harvest rates at Henderson Harbor, adjacent to the Little Gallo Island cormorant colony, were all below the lake-wide average. The Henderson Harbor site continues to be the only localized bass fishery that has experienced a decline in harvest rate (see also "Diets of double-crested cormorants and impacts on sportfish populations").
- For the first time since 1984, a comprehensive survey of Lake Ontario tributary fisheries was conducted in 2005/2006. Interim results for the period September to the end of November, 2005, are reported (Section 10), with highlights below.

- The total estimated effort for all tributaries was 805,419 angler hours (Section 10). The Salmon River accounted for 60% of the total with 483,792 angler hours.
- Twenty-three of 28 tributaries surveyed had reported catches of Chinook salmon. The estimated catch and harvest of Chinook salmon on all tributaries surveyed in 2005 was 156,257 and 48,828, respectively. Overall, tributary anglers harvested 31% of Chinooks caught. The Salmon River accounted for 57% (89,448) of the catch and 53% (25,998) of the harvest.
- Coho salmon were a minor component of the tributary fishery and were only caught in eight of the 28 tributaries surveyed. The estimated catch of coho salmon for all the Lake Ontario tributaries was only 5,914 fish, with a harvest of 2,355. The Salmon River accounted for 96% of the catch (5,659) and 92% of the harvest (2,177).
- Sixteen of the 28 tributaries surveyed had reported catches of steelhead. For all tributaries surveyed, the total estimated catch and harvest was 27,245 and 3,572, respectively. The Salmon River had the highest estimated catch (7,738 - 28% of total) and harvest (1,441 - 40% of total). The release rate for steelhead on all tributaries combined was 87%, and 81% on the Salmon River.
- Fifteen of the 28 waters surveyed had reported catches of brown trout. For all tributaries surveyed, estimated brown trout catch and harvest were 46,877 and 5,518, respectively. Catch (26,266) and harvest (1,284) on Eighteenmile Creek were markedly higher than for any other tributary. The Salmon River catch and harvest of brown trout was second to Eighteenmile Creek at 5,517 and 542, respectively.

Diets of Double-crested Cormorants and Impacts on Sportfish Populations

- For the seventh 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 also employed in 2005. Nest destruction and culling of adult birds were utilized to discourage nesting on Bass and Gull Islands. A total of 281 cormorants were culled by shooting at Bass Island, and 686 at Little Galloo Island (Section 13).
- Exotic round gobies were first documented in Snake and Pigeon Island cormorant diets in 2002, and constituted 87% of cormorant diets from these colonies in 2005 (Section 16).
- Estimated consumption of smallmouth bass by cormorant colony (Lake Ontario only) in 2005 was as follows: Little Galloo Island - 240,000 and Pigeon Island - 50,000 (Sections 14 & 16).
- Estimated consumption of yellow perch by colony (Lake Ontario only) in 2005 was as follows: Little Galloo Island - 4.02 million, Pigeon Island - 590,000, and Snake Island - 720,000 (Sections 14 & 16).
- Egg oiling on Little Galloo Island reduced cormorant chick production by approximately 99%, thereby reducing the number of cormorant feeding days by 540,000. The resulting reduction in fish consumption was estimated at 97,000 smallmouth bass and 1.36 million yellow perch (Section 15).
- Smallmouth bass abundance in the Eastern Basin as measured in index gill nets increased in 2005 (Section 4), possibly indicating a population response to a reduced cormorant predation. Smallmouth bass harvest rates in the Eastern Basin, however, remain below the lake-wide average (Section 2).

- Estimated fish consumption by cormorants from three upper St. Lawrence River colonies (Ontario waters) in 2005 (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 6.21 million fish. Total, combined consumption in 2005 included 2.9 million yellow perch, 1.3 million round gobies, 1.2 million rock bass, 830,000 pumpkinseeds, and 60,000 smallmouth bass (Section 17).

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