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) in 2002 to 2004 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 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. 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 and 2004. While gobies have not yet been detected in the diets of Eastern Basin smallmouth bass, they were first detected in Little Gallo Island cormorant diets in 2004. The effects of these ecosystem changes on the Lake Ontario fish community have not been manifested completely, nor are they fully understood.

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 2004 bottom trawling, adult alewife abundance was similar to that measured in 2003 and well below long-term averages. Below average abundance of the 2003 year class suggests that adult abundance will not increase in 2005. Record-high body condition of alewives in the fall of 2004 suggests that alewife numbers were low relative to their zooplankton food supply, as 2004 zooplankton surveys indicate zooplankton biomass was not markedly higher in 2004 relative to previous years, and that populations of adult and juvenile alewife were not sufficiently abundant to suppress larger zooplankters. The emergence of the large, exotic zooplankter *Bythotrephes* in 2004 also indicates a relative lack of alewife predation on zooplankton. Mean length and weight of age-3 Chinook salmon increased slightly from record low levels observed in 2003 (means weights of age-2 Chinook fell to record-low levels in 2004), while Chinook salmon fishing success (catch per hour) reached a second consecutive record high level. These observations point to high predator abundance relative to forage fish abundance.

This report summarizes research and monitoring activities conducted by the New York State Department of Environmental Conservation and its cooperating agencies and universities on Lake Ontario and the St. Lawrence River in 2004.

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 density was more than two times greater than nearshore density and more than four times greater than offshore density. 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 2004, *C. pengoi* was detected in 45.3% of samples in from May through October, as compared to 31.8% in 2003 and 31.6% in 2002. In 2004, 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.

Prey Fish Assessments

- Adult (age-2 and older) alewife abundance in 2004 bottom trawl surveys increased slightly relative to 2003. Catches of age-1 alewife in 2004 were approximately 35% below the long-term average, suggesting no population expansion in 2005(Section 12). Condition of adult alewife in the fall of

2004 reached the highest level since 1980.

- Hydroacoustic data collected in summer 2004 have yet to be analyzed, however, mid-water trawl collections of alewife suggest relatively low abundance of age-1 and 2 fish (Section 3).
- Following record lows in 2003, number and biomass indices of age-1 and older rainbow smelt in 2004 were the highest since 1997 and 1998, respectively (Section12). Increased abundance was driven by a strong 2003 year class, and not by increased survival of fish in earlier year classes (abundance of age-2 and older smelt remains extremely low).
- Slimy sculpin abundance can no longer be assessed with traditional 12 m (39.4 ft) bottom trawls due to dreissenid mussel fouling (Section 12). Attempts to use the 3-in-1 bottom trawl (used in alewife surveys) resulted in the capture of few slimy sculpin in 2004. Strong bottom currents resulting from fall storms may have caused poor trawl contact with the bottom.

Coldwater Fisheries Management

- Fish stocking in the New York waters of Lake Ontario in 2004 included 1.84 million chinook salmon (14.8% increase over 1997-2003 levels), 250,000 coho salmon, 621,546 rainbow trout, 456,800 lake trout, 396,970 brown trout, and 57,127 Atlantic salmon. (Section 1).
- In 2004, 456,800 lake trout and 170,400 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 relative performance of shore-stocked vs. barge-stocked brown trout reared at Salmon River and Caledonia Hatcheries and stocked at Sodus Bay and Oak Orchard is being evaluated. Results to date suggest that shore-stocked brown trout returned 1.81 times better than barge-stocked fish, and that Caledonia-reared brown trout outperformed Salmon River fish. Hatchery origin evaluations will continue, however, it is not cost effective to continue barge stocking of brown trout at the Oak Orchard and Sodus sites (Section 23).
- The relationship between the number of Chinook salmon fingerling equivalents stocked and relative harvest at age-1 is not statistically significant ($P=0.348$, $R^2=0.049$). While the relationship between number of Chinooks stocked and relative harvest at age-3 was marginally significant in 2003 and 2004, the relationship returned to insignificance with the inclusion of 2004 data ($P=0.064$, $R^2=0.178$) (Section 2).
- Reductions in Chinook salmon growth in 2003 and 2004, as measured in the open lake fishery, were most evident in age-3 fish. Mean lengths of age-3 fish in 2003 and 2004 were record lows, however, growth improved slightly in 2004 relative to 2003 (Section 2).
- Mean weights of age-2 and age-3 Chinook salmon returning to the Salmon River hatchery in 2004 were at or near record low levels, as was mean weight of age-1 males (jacks) (Section 9). The predicted weight of a 900 mm (34.5 in) total length Chinook (15.5 lbs) also reached a record low level in 2004. Mean weights of age-2 coho remained low in 2004. Growth of steelhead was generally good, however, they are surveyed in the spring of the year and therefore do not reflect growth during 2004.

- 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 2004 were the highest observed over the six year history of the survey (Section 8).
- A three year tagging study was initiated in the spring of 1999 to address the effects of stocking method on the recent, relatively poor survival of Salmon River stocked Washington steelhead. Fish returns from four stocking methods have been variable with no one method clearly providing improved survival over the others (Section 9).
- 323,100 pre-smolt Chinook salmon and 56,800 rainbow trout were reared by cooperating sportsmen in net pens within Lake Ontario tributaries (Section 18).
- Evaluations of the performance of steelhead pen-reared at Oswego Harbor are complete and very favorable. Pen reared steelhead returned better than direct stocked by a margin of nearly 7:1 (Section 19).
- 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. Evaluations will continue on the Niagara River through 2005.
- Due to poor performance of pen-reared Chinook salmon in the Lower Niagara River, an evaluation of pen-reared Washington strain steelhead was initiated in 2004 (Section 18).

Lake Trout Restoration

- Catch of age-2 lake trout in 2004 (2002 year class) increased markedly from that in 2003, but was only 32% of the average catch for the 1983-1989 year classes (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 685 adult lake trout were captured in the September 2004 gill net survey. 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 2004 was down by 43% and 36%, respectively.
- Sea lamprey wounding rates on lake trout remain much lower than pre-1985 levels, but have been above the planned target level of 2 wounds per 100 fish for six of the last eight years. The length of A1 marked fish in 2003 ranged from 467 to 877 mm (mean = 712 mm or 28.1 in)(Section 5).

Numbers of lampreys observed attached to fish caught by boat anglers participating in the 2003 boat census increased by 98% relative to 2002, and declined slightly (6.6%) in 2004 (Section 2).

- Survival of Seneca strain lake trout has been about 30% to 50 % greater than that of Superior strain for the 1984-1995 year-classes. Lower survival of Superior vs. Seneca strain lake trout was likely due to higher susceptibility to and mortality from sea lampreys.

- In 2004, a total of 4 naturally produced yearling lake trout (85 to 151 mm or 3.4 to 5.9 in total length) were caught with bottom trawls. 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.
- The estimated annual harvest of lake trout from U.S. waters of Lake Ontario since the slot limit (635 - 762 mm or 25 to 30 in) was re-instated in 1992 has been more than 4 times lower than previous years when no size limits were in effect. Harvest in 2004 declined to a second consecutive record low level (4,250 lake trout harvested). Low lake trout harvest in 2003 and 2004 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, but fell to 22.5% in 2004 (Section 2).
- Condition of adult lake trout (weight of a 700 mm (27.6 in) total length fish) in 2004 was the lowest recorded for the last 13 years, and may be indicative of a limited food supply.
- 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-5 returns from Olcott favor offshore stocking over shore stocking in either May or June by a 2.0 : 1.0 : 1.2 margin. In addition, lake trout stocked at Olcott yielded catches 6.6 fold higher than those stocked at Sodus (Section 11).

Warmwater Fisheries

- 70,800 fingerling walleye were stocked into Lake Ontario embayments and the Lower Niagara River. In addition, 1,000 lake sturgeon fingerlings were experimentally planted in the lower Genesee River (Section 1).
- Total catch of warmwater fish in the 2003 Eastern Basin index gill netting program increased slightly for the second year since the record low levels observed in 2001, as did smallmouth bass abundance (Section 4). Three year moving average catches for yellow perch, pumpkinseed, northern pike and freshwater drum are increasing, whereas the same for walleye and smallmouth bass are relatively stable. Growth of smallmouth bass has increased in recent years. Lake sturgeon have been collected in eight of the last ten years, suggesting improvement in population status.
- Index gill netting in the Thousand Islands region of the St. Lawrence River revealed continued low

abundance of smallmouth bass and northern pike (Section 6).

- Yellow perch abundance in Lake St. Lawrence index gill netting declined precipitously to a record low level in 2004, likely due to predation by a local colony of Double-crested cormorants (Sections 7 and 17). Smallmouth bass abundance in 2004 increased to near the long-term average, while walleye abundance decreased and fell below the long-term average.

Sport Fishery Assessment

- Chinook salmon fishing success (catch/angler hour) in 2004 reached a second consecutive record high level, while total trout and salmon fishing success was only 6.6% below the 2003 record high (Section 2).
- 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 and the 1991-92 seasons, before reductions in the Lake Ontario stocking program were discussed.
- In 2004, total effort was estimated at 79,958 fishing boat trips [95% confidence interval ± 14.5%], a 5.9% increased over the 2003 record low. Total fishing boat effort in 2004 was down 8.3% compared to the 1999-2003 boat trip average (previous five years), and down 61.1% compared to the 1990 peak. The largest reductions in yearly percent contributions have occurred in the months of April and May, and in the west and west/central areas.
- An estimated 57,872 boat trips [± 17.5%] targeted trout and salmon in 2004 (68.3% of fishing boat trips). Trout and salmon fishing effort in 2004 increased 20.9% compared to the 2003 record low, and was nearly equal to the 1999-2003 average.
- The number of lampreys observed per 1,000 trout and salmon caught was estimated at 20.2 in 2004, a 45.5% increase compared to the 1999-2003 average.
- Trips targeting smallmouth bass during the open season declined to 22,340 fishing boat trips in 2004, however long-term smallmouth bass effort shows a variable but statistically significant upward trend, averaging 625 trips per year. Smallmouth bass was the most commonly harvested species in the census from 1995-2003, however, Chinook harvest increased dramatically in 2004 while smallmouth bass harvest declined. The 2004 smallmouth bass harvest was the lowest observed since 1996, a 47.6% decrease relative to 2003, and a 49.3% decrease relative to the 1999-2003 average.
- Data on smallmouth bass fishing in Lake Ontario collected from the 1985-2004 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").

- A creel census directed at characterizing Chinook salmon and steelhead angler effort and success in the Salmon River estimated 90,825± 6,075 angler days in 2004 (Section 10). An estimated 85,251 Chinook salmon were caught during the survey period, with 24,360 harvested. An estimated 6,924 steelhead were caught, with 1,314 harvested.

Diets of Double-crested Cormorants and Impacts on Sportfish Populations

- For the sixth consecutive year, cormorant population control was continued through oiling of eggs with food grade vegetable oil at the Little Galloo Island colony. Nest destruction and culling of adult birds were utilized to discourage nesting on Bass and Gull Islands (Section 13).
- Exotic round gobies were first documented in the diets of cormorants from Snake and Pigeon Islands in 2002, and gobies dominated the diets of Snake Island cormorants in 2003 (29.2%) and 2004 (84%) (Section 16).
- Estimated consumption of smallmouth bass by cormorant colony (Lake Ontario only) in 2004 was as follows: Little Galloo Island - 420,000, Pigeon Island - 40,000, and Snake Island - 60,000 (Sections 14 & 16).
- Estimated consumption of yellow perch by colony (Lake Ontario only) in 2004 was as follows: Little Galloo Island - 4.91 million, Pigeon Island - 190,000, and Snake Island - 500,000 (Sections 14 & 16).
- Egg oiling on Little Galloo Island reduced cormorant chick production by approximately 97%, thereby reducing the number of cormorant feeding days by 638,600. The resulting reduction in fish consumption was estimated at 296,000 smallmouth bass and 1.62 million yellow perch (Section 15).
- Smallmouth bass abundance in the Eastern Basin as measured in index gill nets remains low (Section 4). In addition, harvest rates of smallmouth bass in the Eastern Basin remain below the lake-wide average (Section 2).
- Modeling suggests that an overall reduction in cormorant numbers within the eastern basin can be expected as a result of egg oiling on Little Galloo Island. To reach the objective of 1,500 nesting pairs of cormorants, oiling of all nests on Little Galloo Island would need to occur through 2008. A less intensive maintenance program would begin in 2009. Residual effects would carry into the year 2010, at which time the target population of 1,500 pairs would be achieved. From 2010 on, the eastern basin cormorant population would be predicted to again increase slowly if Canadian colonies continued to grow. Cormorant populations have continued to grow on Lake Ontario over the past several years with the exception of 2003, but less predictably than in the 1980s and early 1990s (Section 13).
- Estimated fish consumption by cormorants from three upper St. Lawrence River colonies (Ontario waters) in 2004 (6.26 million fish) was within the range (4.79 to 6.64 million) reported for the four previous years. Average annual fish consumption by cormorants from Griswold, McNair, and Strachan Islands since 1999 is 6.02 million fish. Total, combined consumption in 2004 included

3.16 million yellow perch, 1.07 million rock bass, 610,000 pumpkinseeds, and 60,000 smallmouth bass (Section 17).

- An evaluation was conducted in 2004 to assess potential differences in characterization of Double-crested cormorant (DCC) diets using stomach contents and pellets. DCC stomach contents (n=515) and pellets (n=257) were collected at High Bluff Island, Presqu'ile Provincial Park, Ontario. DCC pellets on average contained of 18.4 more fish per sample than stomachs. In addition, fish size estimated by otolith length to fish length relationships was higher for otoliths recovered from stomach contents as compared to those recovered from pellets (Section 24).

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