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Lake Ontario Unit
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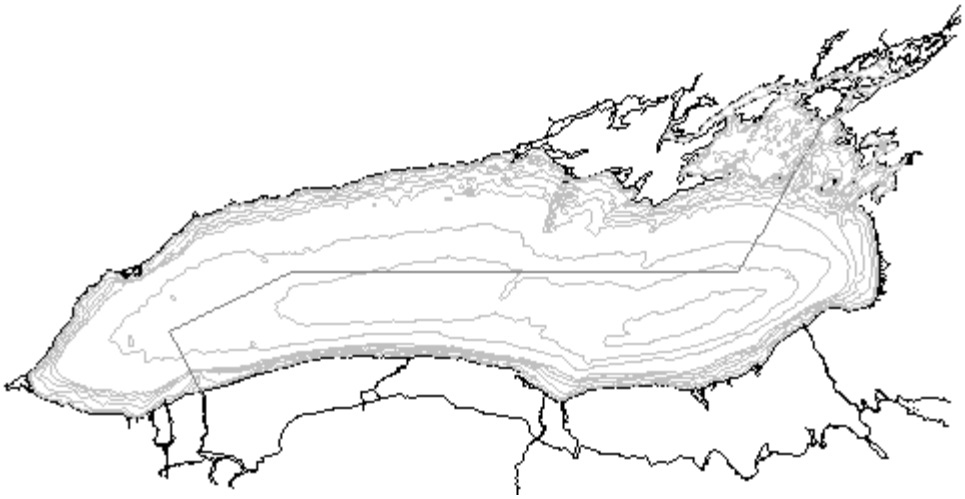
St. Lawrence River Unit
to the
Great Lakes Fishery Commission's
Lake Ontario Committee



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THE FOLLOWING STUDIES REPORTED IN THIS DOCUMENT ARE SUPPORTED IN WHOLE OR IN PART BY THE FEDERAL AID IN SPORT FISH RESTORATION PROGRAM

SECTIONS 1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 14, 15, 16, 19, 22, 23, AND 24

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SECTION	TITLE – AUTHORS	COOPERATING AGENCIES
1	**New York Lake Ontario and Upper St. Lawrence River Stocking Program 2012** *(Connerton)*	NYSDEC
2	**2012 Lake Ontario Fishing Boat Survey** *(Lantry J., Eckert)*	NYSDEC
3	**2012 Mass Marking of Chinook Salmon in Lake Ontario** *(Connerton, Balk, Prindle, Lantry J., Daniels, Bowlby, Bronte, Holey)*	NYSDEC OMNR USFWS
4	**Eastern Basin of Lake Ontario Warmwater Fisheries Assessment, 1976-2012** *(Lantry J.)*	NYSDEC
5	**Lake Trout Rehabilitation in Lake Ontario, 2012** *(Lantry B., Lantry J.)*	USGS NYDEC
6	**Thousand Islands Warmwater Fish Stock Assessment** *(McCullough, Gordon)*	NYSDEC
7	**2012 Lake St. Lawrence Warmwater Fisheries Assessment** *(Klindt, Gordon)*	NYSDEC
8	**2012 Salmon River Wild Young-of-Year Chinook Salmon Seining Program** *(Bishop, Prindle, Johnson)*	NYSDEC USGS
9	**Population Characteristics of Pacific Salmonines Collected at the Salmon River Hatchery 2012** *(Prindle, Bishop)*	NYSDEC
10	**2012 New York Cooperative Trout and Salmon Pen-Rearing Projects** *(Wilkinson, Sanderson, Prindle)*	NYSDEC
11	**Lake Ontario Tributary Angler Survey Fall 2011 – Spring 2012** *(Prindle, Bishop)*	NYSDEC
12	**Status of Important Prey Fishes in the U.S. Waters of Lake Ontario, 2012: Introduction and Methods, Alewife, Rainbow Smelt, Sculpins, Round Goby, and Estimating Area Swept** *(Walsh, Weidel, Connerton)*	USGS NYSDEC
13	**Cormorant Management Activities in Lake Ontario's Eastern Basin** *(McCullough, Mazzocchi)*	NYSDEC
14	**Double-Crested Cormorant Studies at Little Galloo Island, Lake Ontario in 2012: Diet Composition, Fish Consumption and the Efficacy of Management Activities in Reducing Fish Predation** *(Johnson, McCullough, Mazzocchi)*	USGS NYSDEC

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17	**Progress Report for the Sportfishing Restoration and Spending Plan for the Lake Ontario System** (*Balk)*	NYSDEC
18	**Lake Sturgeon Tagging Study 2012** (*Klindt, Gordon)*	NYSDEC
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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 1995; 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 2007, anglers fishing Lake Ontario and its tributaries contributed over $114 million to the New York State economy (Connelly and Brown 2009).

In recent decades, the Lake Ontario ecosystem has undergone dramatic changes resulting primarily from the introduction of exotic zebra and quagga mussels. 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. Epilimnetic zooplankton biomass in Lake Ontario's offshore epilimnion declined by 99% over the last 30 years, and populations of the exotic zooplankters *Bythotrephes* and *Cercopagis* were discovered in Lake Ontario in 1985 and 1998, respectively. The abundance and distribution of the deepwater amphipod, *Diporeia* has deteriorated markedly, likely due 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 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 grew exponentially, and it is now found throughout Lake Ontario and the St. Lawrence River. Round gobies are 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, northern pike, brown trout, and lake trout, and are apparently responsible for markedly increased growth rates for some sportfish species including smallmouth bass and yellow perch.

Viral Hemorrhagic Septicemia virus (VHSv) was first documented in the New York waters of Lake Ontario and the St. Lawrence River in 2006. Substantial freshwater drum and round goby mortality events were observed, as well as numbers of dead muskellunge, smallmouth bass, and a moribund burbot. VHSv 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.

Maintaining balance between predators and prey, primarily salmonids (predominately Chinook salmon) and alewife, remains a substantive challenge in the face of lower trophic level disturbances and ongoing

ecosystem changes resulting from invasive species. This report summarizes cooperative research and monitoring activities conducted on Lake Ontario and the Niagara and St. Lawrence rivers by the New York State Department of Environmental Conservation, U.S. Geological Survey, Ontario Ministry of Natural Resources, the US Fish and Wildlife Service, Fisheries and Oceans Canada, the SUNY College of Environmental Science and Forestry and Cornell University in 2012.

Lower Trophic Level Monitoring

- From 1995-2012, the biomonitoring program in Lake Ontario has measured indicators of lower food web status at embayments, nearshore and offshore sites. The primary objectives are to evaluate temporal and spatial patterns in total phosphorus, soluble reactive phosphorus, chlorophyll *a*, Secchi depth, and crustacean zooplankton density, biomass, and size structure (Section 16). Embayments were the most productive habitat sampled through 2010 with the highest zooplankton density and biomass, chlorophyll *a*, total phosphorus, and soluble reactive phosphorus, as well as the lowest water clarity. Beginning in 2011, analysis will focus on nearshore and offshore sampling.
- Lower trophic level indicators were similar in the nearshore and offshore habitats and indicative of oligotrophic conditions. In 2012, low total phosphorus, low summer chlorophyll *a* and high water clarity were similar to measurements from the last decade, indicating continued low productivity in Lake Ontario's nearshore and offshore waters (Section 16).
- Spring total phosphorus has declined in the longer data series (since 1981), but not since the inception of the Biomonitoring Program in 1995. In 2012, average spring total phosphorus concentrations in the nearshore and offshore waters were substantially lower than 10 μg/L (the goal of the Great Lakes Water Quality Agreement of 1978; nearshore average = 6.9 μg/L; offshore average = 4.9 μg/L).
- Summer epilimnetic nearshore and offshore zooplankton density and biomass have declined significantly since 1995 (i.e. at rates of 11-12% per year). Density also declined significantly in the long-term (since 1981) but has remained at a lower stable level since 2005. Beginning in 2010 and in addition to epilimnetic zooplankton samples, meta- and hypolimnetic samples were collected. Zooplankton biomass was concentrated in the metalimnion and hypolimnion in 2012, and with the exception of one date in April, between 65 and 99% of zooplankton biomass was found below the thermocline throughout the year. Total water column abundance of zooplankton in the offshore may not have declined to the levels suggested by epilimnetic samples (Section 16).
- Changes in the zooplankton community structure are consistent with a decline in fish predation and an increase in invertebrate predation. Bosminid and cyclopoid copepod biomass have declined significantly in offshore and nearshore waters. Daphnid biomass has also declined significantly in the nearshore. The predatory cladoceran *Cercopagis* continued to be abundant in the summer and also became abundant again in the fall at the same time *Bythotrephes* peaked (Oct); at that time the biomass of *Cercopagis* was approximately twice that of *Bythotrephes* (Section 16).

Prey Fish Assessments

- In April – May 2012, both the abundance (number) and weight (pounds) indices for adult alewife (age-2 and older) in U.S. waters of Lake Ontario increased from 2011 values. The age-1 alewife abundance index in spring 2012 was well above the long term mean and represents the largest year class observed since the 1998 year class collected in 1999. The index of adult alewife condition (wet weight of a 6.5-in alewife predicted from annual length-weight regressions) in spring and fall 2012 remained high and similar range to recent years (Section 12).
- In 2012, the abundance index for age-1 and older rainbow smelt increased slightly relative to 2011. The abundance index was 77% higher and the weight index was 35% higher than

respective 10-year averages. The percentage of large rainbow smelt (6 inches and larger) in the 2012 population (0.6%) was the lowest in the data series (Section 12).

- Low slimy sculpin density observed in 2012 was similar to that of 2011, providing additional evidence that Lake Ontario sculpin abundance likely declined by two orders of magnitude over the past 34 years (Section 12).
- Deepwater sculpin, once considered extirpated from Lake Ontario, have increased substantially over the past seven years. The 2012 catch of deepwater sculpin was the highest recorded since the reappearance of this species in 2005 (Section 12).
- Round gobies were first detected in Lake Ontario in 2002. Goby abundance and biomass expanded exponentially until 2008, and then declined dramatically in 2009. In 2010, the abundance index was unchanged while the biomass index decreased slightly indicating a shift toward smaller individuals in the population. In 2012, round goby abundance decreased approximately four fold from 2011estimates (Section 12).
- The 2012 hydroacoustic survey of Lake Ontario preyfish populations consisted of five cross-lake transects and an Eastern Basin transect. The estimate of yearling and older alewife abundance was 191 million fish, similar to 2011. The rainbow smelt population estimate was 63 million yearling and older fish (Figure 3), the lowest estimate in the history of the survey (Section 24).

Coldwater Fisheries Management

- Fish stocking in the New York waters of Lake Ontario in 2012 included 1.51 million Chinook salmon, 120,190 coho salmon, 972,970 rainbow trout, 122,830 lake trout, 419,410 brown trout, and 146,745 Atlantic salmon. Over 129,000 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 in the eastern portion of the lake (Section 1).
- The relationships between the number of Chinook salmon fingerling equivalents stocked and relative harvest at age 1 ($P=0.82$, $R^2=0.002$), age 2 ($P=0.401$, $R^2=0.027$), and age 3 ($P=0.594$, $R^2=0.011$) are not statistically significant, indicating that there was no relationship between stocking number and future fishing quality. Based on relative harvest, the 2009 and 2010 year classes appear to be two of the strongest produced, yet were stocked at intermediate levels (i.e., nearly 2 million fingerling equivalents each)(Section 2).
- The 2012 mean length (37.7 in) of age-3 Chinook salmon in August, as measured from the open lake boat fishery, was the 2nd highest observed. Additionally, Chinook salmon condition in 2012, as determined from predicted weights of given length fish, declined from 2011; however, predicted weights for all length groups examined were comparable to respective long-term averages (Section 2).
- At the Salmon River Hatchery, the mean weight of age-1 Chinook males (jacks) sampled in 2012 was very near the long term average. Age-2 males were 0.4 pounds above average (13.9 lbs) and females were less than 0.1 pound below average (14.8 lbs). Age-3 males were 3.9 lbs below average (19.2 lbs) and 5.5 pounds lighter than in 2011, while females were approximately 2 pounds below average (19.3 lbs). A possible explanation for the smaller fish in 2012 is the low water levels experienced during the salmon run, which allowed anglers to selectively target larger fish that would have otherwise completed their migration to the hatchery. Disproportionate harvest of larger individuals may have biased the age/size distribution of fish reaching the hatchery (Section 9).
- The condition or relative “plumpness” of Chinook salmon at the Salmon River Hatchery (based on the predicted weight of a 36 inch long Chinook salmon) in fall 2012 was 16.7 pounds, which is also the historical average (Section 9).
- Steelhead are sampled in the spring and, unlike Chinook and coho salmon, do not reflect growth during the 2012 growing season. Weights reported here reflect conditions prior to and including

2011. The mean weights of age-3 males and females were 4.7 and 6.2 lbs, respectively, which were approximately 1.0 and 0.1 pound less than their respective, long-term averages. The mean weights of age-4 males and females were 7.9 lbs and 8.2 lbs, respectively; with males 0.9 pounds lighter than and females equal to their long-term averages.

- Since the institution of seasonal base flows in the Salmon River in 1996, natural reproduction of Chinook salmon continues to be documented by an annual seining index conducted weekly during May and June at four sites (Section 8). Prior surveys suggested that high flows in October generally resulted in relatively high numbers of Chinook reaching the upper river to spawn, thereby increasing the numbers of young-of-the-year (YOY) Chinook caught the following spring. High flows in May tended to increase YOY outmigration, or decreased their vulnerability to our seine, resulting in lower catches. In 2012 we anticipated moderate catches based upon relatively low flow conditions in the fall of 2011 (mean = 324 cfs) and near average flows in May (614 cfs). We observed, however, a record high mean peak catch of 872 fish per haul during the last three weeks of May. These results strongly suggest that there are variables other than October and May flows influencing YOY production and/or survey catches.
- The fifteenth year of pen-rearing steelhead and Chinook salmon along the New York shoreline of Lake Ontario was very successful due to low fish mortality at most sites, and a relatively high percentage of fish reaching target weights (Section 10). A total of 83,300 Washington strain steelhead were raised at nine pen sites, comprising 15% of NYSDEC's Lake Ontario rainbow trout/steelhead stocking allotment in 2012. Eight pen-rearing sites raised a total of 497,970 Chinook salmon, representing 33% of NYSDEC's 2012 Chinook salmon stocking allotment. In 2010-2011, NYSDEC began tagging Chinook salmon at all pen sites and corresponding shore stocking sites to evaluate the relative performance of fish from the two stocking strategies.
- In 2008, the NYSDEC purchased an automated fish marking trailer (AutoFish) capable of adipose clipping and/or applying coded wire tags to salmon and trout automatically at a high rate of speed and accuracy. From 2008-2011, NYSDEC and the Ontario Ministry of Natural Resources "mass-marked" all stocked Chinook salmon with an adipose fin clip in Lake Ontario to determine the relative contributions of wild and hatchery stocked Chinook salmon to the fishery. The proportions of wild Chinook salmon in Lake Ontario varied among regions in 2012 with a significantly higher percentage of wild age-1 fish observed in Ontario waters (34.5%) compared to the NY east (17.0%) region but not the NY west region (24.3%); a significantly higher percentage of wild age-2 fish were observed in the New York east region (64.1%) compared to the Ontario (59.9%) and NY west (52.9%) regions; and a significantly lower percentage of wild age-3 fish observed in the NY west region (44.3%) compared with Ontario and NY east regions (59.3% and 56.9%, respectively) (Section 3).
- The proportion of wild Chinook salmon observed in tributaries varied among regions, but was generally low in most tributaries except the Salmon River, where significantly higher proportions of wild Chinook salmon were observed (i.e., 70.8%, 60.4%, and 87.5% of ages 2-4 respectively) compared with other regions. In NY western region tributaries, 5.9%, 5.7%, 4.2% and 0% of age 1-4 Chinook salmon were wild, respectively. The proportions of wild Chinook salmon in NY eastern region tributaries were significantly higher than the west region, with 7.1%, 23.2%, 20.9% and 30.8% of ages 1-4, respectively, of wild origin (Section 3).

Lake Trout Restoration

- The adjusted catch of age-2 lake trout in bottom trawls during the 2012 juvenile lake trout survey was the highest recorded since the 1990 year class was sampled in 1992 (Section 5).
- Adult lake trout catch per unit effort from the gill net survey recovered from historic lows observed during 2005-2007, and appear to have stabilized during 2010-2012 at a level near the 1999-2004 mean.

- The rate of wounding by sea lamprey on lake trout caught in gill nets was 2.41 fresh (A1) wounds per 100 lake trout, slightly above the target of 2 wounds per 100 lake trout (Section 5).
- In 2012, one age-1 and four age-2 naturally produced lake trout were collected from trawl survey catches, providing the first evidence of a 2011 year class and continued evidence of a 2010 year class (Section 5).
- Condition of adult lake trout (indexed from annual length–weight regressions) in 2007-2009 increased from relatively low values observed during 2000-2006, and remained nearly constant during 2010-2012 at the highest values observed for the 30 year time-series (Section 5).
- Estimates from the NYSDEC fishing boat survey indicated 2012 angler catch, harvest, and catch and harvest rates remained at levels comparable to 2011, which were the highest estimated since 2002 (Section 2).

Status of Sea Lamprey Control

- In 2012, 14 Lake Ontario tributaries (nine Canada, five New York) were treated with lampricides (Section 25). Treatments in New York included the Black River, Orwell Brook, Little Salmon River, Catfish Creek, and Sterling Creek.
- Orwell Brook was treated for the sixth consecutive year to address residual populations in numerous beaver impoundments. Construction of a sea lamprey barrier was completed in the fall of 2012 and the stream is scheduled to be re-treated in 2013 to target residual larvae that remain upstream of the barrier (Section 25).
- A total of 7,835 sea lampreys were trapped at 11 sites on 10 tributaries.
- The estimated population of adult sea lampreys was 57,270 (95% CI; 51,290-65,314), greater than the fish-community objective target range of 31,000 ± 4,000 (Section 25).
- Larval assessments determined that larval sea lamprey distibution on Farewell Creek (Ontario) had expanded upstream for the first time since 1977. As a result, an additional 7.2 miles of this tributary required treatment (Section 25).
- Larval assessments were conducted on a total of 49 tributaries (24 Canada, 25 NY). Surveys to estimate abundance of larval sea lampreys were conducted in nine tributaries (four Canada, five NY). Surveys to detect the presence of new larval sea lamprey populations were conducted in six Canadian tributaries. No new populations were detected (Section 25).
- The rate of wounding by sea lamprey on lake trout caught in gill nets was 2.41 fresh (A1) wounds per 100 lake trout and was slightly above the target of 2 wounds per 100 lake trout (Section 5). There were an estimated 3,441 (±29.6%) lampreys observed in the Lake Ontario fishing boat survey during 2012 (Section 2). In 2012, 60.0% of lamprey attacks were on Chinook salmon, 22.1% on brown trout, 8.6% on rainbow trout, 4.3% on lake trout, 2.9% on coho salmon, and 2.1% on Atlantic salmon.

Warmwater Fisheries

- A total of 20,200 fingerling walleye were stocked in the lower Niagara River (Section 1).
- Catch-per-unit-effort (CPUE) of warmwater fish in the 2012 Eastern Basin index gill netting survey was 32.0 fish/gill net, comparable (-5.8%) to the previous 5-year average. Smallmouth bass (25.4%) and yellow perch (46.8%) remained the most common species captured in 2012 (Section 4).
- In 2012, smallmouth bass abundance in the Eastern Basin as measured by index gill nets was comparable to the previous 5-year average and well above low levels observed in 2000-2004 (Section 4).
- Walleye CPUE has remained relatively stable for several years. The 2012 abundance estimate was 22% above the previous10-year average (Section 4).

- 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 from 2005-2010. In 2012, gobies were present in 78.8% of the 170 non-empty smallmouth bass stomachs processed. Gobies were present in walleye diets each year from 2006-2010 and have been found in northern pike, brown trout, lake trout, and lake whitefish caught in this survey (Section 4).
- In 2008, Eastern Basin white perch abundance reached its highest level since 1991. Each year from 2008-2011 white perch was the third most common species in the assessment, representing 9.6%-17.5% of the total warm water fish catch. The 2012 abundance estimate was a 79.8% decrease compared to the 2008-2011 time period (Section 4).
- At least one lake sturgeon has been collected in the Eastern Basin in fourteen of the last eighteen years suggesting improvements in population status (Section 4).
- Thousand Islands smallmouth bass abundance increased from low 1996-2006 levels, and has varied at relatively high levels since. Bass abundance reached its highest level since 1988. The trend in smallmouth bass abundance is complicated by a disproportionate representation of younger fish since 2006. Abundance of age-5 and older fish, which have historically constituted the bulk of the catch, has generally declined in recent years. Smallmouth bass growth rates have increased, which likely explains increased catches of younger bass relative to earlier surveys. Yellow perch abundance increased substantially in 2006, remained high in 2007 and 2008, and then declined. Perch abundance fell to a record-low level in 2012. Perch growth rates have generally increased since 1994. Increased smallmouth bass and yellow perch growth rates may be related to available round goby prey. From 1996 to 2012, northern pike abundance has remained relatively low. Ongoing poor recruitment is likely related to degraded spawning habitat resulting from water level regulation, and possibly predation by double-crested cormorants (Section 6).
- St. Lawrence River (Thousand Islands) yellow perch indices of abundance, growth, survival, and other parameters were evaluated. Yellow perch abundance declined early in the late 1970s/early 1980s and has since fluctuated at a lower level as annual survival declined. Growth, however, has generally increased, especially since 2005. As a result, despite generally reduced abundance, fishing quality may have actually improved as quality, preferred size yellow perch became more available (Section 21).
- In spite of increasing Double-crested cormorant (DCC) abundance, yellow perch abundance remains relatively high in the 2012 Lake St. Lawrence index gill net survey (Section 7). This is likely explained by a strong shift in DCC diet dominance from yellow perch to round goby (Section 15). Smallmouth bass abundance has been variable since 2005, and was above the long-term average in 2012. The 2005 year class continues to be well represented as age-7 fish in the 17-20 inch range. Walleye abundance remained above the long-term average for the 5th consecutive year. (Section 7).
- Abundance of spawning adult and young-of-the-year northern pike in the Thousand Islands region of the St. Lawrence River continues to be suppressed. Overall, natural reproduction at natural and managed spawning marshes remains poor, likely due to habitat degradation resulting from long-term management of Lake Ontario/St. Lawrence River water levels (Section 23).
- Muskellunge population indices in the Thousand Islands region of the St. Lawrence River continue to show signs of stress. Spring trap net surveys, summer seining surveys and an angler diary index all indicate reduced adult and young-of-the-year abundance. It is plausible that adult muskellunge mortality events attributed to outbreaks of the invasive viral hemorrhagic septicemia virus are contributing to lower adult muskellunge numbers and reduced natural reproduction (Section 19).
- Targeted gill net sampling for lake sturgeon in the Black River and the St. Lawrence River below the Moses-Saunders Power Dam in 2012 produced a total catch of 228 fish ranging from 28.3-63

inches (4.2-69.4 pounds). PIT tags were implanted in 199 fish to monitor fish growth, movements, and to manage brood stock genetics in restoration stocking efforts (Section 18).

- The US Fish and Wildlife Service continued a lake sturgeon research program in the Lower Niagara River from 2010 through 2012. A total of 28, 193, and 140 lake sturgeon were captured and PIT tagged in 2010, 2011, and 2012, respectively. Sturgeon ranged from 12.2 to 62 inches total length, and 1 to 28 years of age. Radiotelemetry tracking of 28 sturgeon suggests the presence of both migratory and resident fish. Increases in catch rates of sub-adult fish in 2010-2012 from 1998-2003 levels may indicate a positive trend in the abundance of mature lake sturgeon in the lower Niagara River (Section 26).

Sport Fishery Assessment

- Total trout and salmon fishing success (charter catch per angler hour=0.25) was the second highest in the 28-year data series. Total trout and salmon catch (196,625 fish) and harvest (107,456 fish) were dominated by Chinook salmon (45.2% and 51.3%, respectively), brown trout (20.1% and 21.7%, respectively), and rainbow trout (16.8% and 11.7%, respectively).
- The ten highest Chinook salmon catch rates among charter boats occurred each year 2003-2012. Fishing quality among charter boats in 2012 was the second highest in the 28-year data series for Chinook salmon.
- Charter boat catch rate of coho salmon was lower than rates observed in recent years; however, was 32.4.7% higher than the long-term average.
- Overall catch rate for rainbow trout was near record high levels, making 2012 the fourth consecutive year of very high quality fishing. Unlike all anglers combined and non-charter fisherman, catch per angler hour among charter boats was comparable to long term averages. This discrepancy between non-charter and charter boats is likely attributable to the fact that charter operators on the western half of the lake, where the majority of rainbow trout are caught, target rainbow trout in July and August if Chinook salmon fishing is poor. Due to excellent Chinook fishing quality in 2012, it appears that charter boats primarily targeted Chinooks (Section 2).
- The charter boat catch rate for brown trout in 2012 was 65.9% above the long-term mean, and the third highest on record.
- In 2012 catch rate of lake trout in the east/central region of the lake was the highest estimated since 1996, the period before significant declines in the population.
- In 2012, total fishing effort was estimated at 56,182 fishing boat trips (848,905 angler hours), the lowest estimated and primarily attributed to a decrease in effort targeting smallmouth bass since 2001**.** Effort targeting trout and salmon, however, has remained relatively stable with no declining trend for more than a decade. An estimated 46,059 boat trips targeted trout and salmon in 2012 (82% of fishing boat trips), a slight decrease compared to the previous 5-year average (Section 2).
- Smallmouth bass was the most commonly caught species in the survey each year 1985-2006. In 2012, smallmouth bass was the 6th most commonly caught species (Section 2).
- Fishing quality for smallmouth bass along the south shore peaked in 2002 and declined to record low levels. 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 6,203 in 2012, comparable to 2011 and a 35.5% decrease compared to the previous 5 year average. Bass catch rates were relatively stable from 1985 through the early 1990s (mean=1.03 bass per angler hour), then increased to the highest level in 2002 (2.02 bass per angler hour). Subsequently, fishing quality declined, with the eight lowest smallmouth bass catch rates occurring in the last eight years (2005-2012). Several factors may have contributed to poor fishing quality, including

expansion of round goby populations and the discovery of Viral Hemorrhagic Septicemia virus in smallmouth bass. (Section 2).

- A Lake Ontario black bass angler diary program was initiated in 2010, however, the number of participants needed to detect statistically significant changes in the bass fishery has yet to be achieved. The 2012 catch rate among anglers targeting smallmouth bass in the lake's main basin during the traditional open season was 0.70 smallmouth bass per angler hour, higher than the estimate from the 2012 NYSDEC Lake Ontario Fishing Boat Survey (0.49 smallmouth bass per angler hour) (Section 22).
- A creel survey was conducted on 21 major Lake Ontario tributaries from 15 September 2011 through 29 April 2012 (1 Sept. 2011 through 16 May 2012 on the Salmon River). The total estimated effort for all tributaries was 1,582,428 angler hours. The Salmon River accounted for 1,077,613 angler hours, 68% of the total. Total estimated angler trips for all 21 tributaries in 2011-12 was 409,211, up from 216,811 and 244,836 in 2005-06 and 2006-07, respectively (Section 11).
- Seventeen of 21 tributaries surveyed had reported catches of Chinook salmon. The estimated catch and harvest of Chinook salmon on all tributaries surveyed in 2011 was 125,180 and 45,214, respectively. The catch of Chinooks declined from 2005 and 2006 estimates of 170,441 and 152,155, respectively. Harvest also decreased from 49,363 and 55,634 estimated in 2005 and 2006, respectively. Overall, tributary anglers harvested 36% of Chinooks caught. The Salmon River accounted for 68% (86,184) of the catch and 70% (31,915) of the harvest (Section 11).
- Eleven of the 21 tributaries surveyed had reported catches of coho salmon totaling 30,857 fish. The estimated catch increased markedly from the 2005 and 2006 results with 18,163 and 5,804 fish caught, respectively. The Salmon River accounted for 95% of the catch (29,295) and 97% of the harvest (10,218). Eighteenmile Creek was the only other tributary to have a substantial coho catch in 2011 (1,041).
- Eighteen of the 21 tributaries surveyed had reported catches of steelhead. For all tributaries surveyed, total estimated catch and harvest was 170,642 and 15,142, respectively. The Salmon River had the highest estimated catch (96,398 - 56% of total) and harvest (8,608 - 75% of total). The release rate for steelhead on all tributaries combined was 91%, and was 91.1% on the Salmon River.
- Sixteen of the 21 waters surveyed had reported catches of brown trout. For all tributaries surveyed, estimated brown trout catch and harvest were 52,897 and 8,342, respectively. The brown trout catch from Maxwell Creek (10,330) was higher than any other tributary, and was >3X greater than the number caught in the previous two surveys (Section 11).

Diets of Double-crested Cormorants and Impacts on Sportfish Populations

- Egg oiling on Little Galloo Island in 2012 reduced both cormorant chick production and chick feeding days by approximately 83%. The resulting reduction in total fish consumption by chicks was 10.8 million fish (Section 14).
- In 2012, smallmouth bass abundance in the Eastern Basin as measured by index gill nets was comparable to the previous 5 year average and well above low levels observed in 2000-2004 (Section 4). Yellow perch abundance increased in 2008 to the highest level since 1984, and in 2012 was comparable to highs observed in recent years (i.e. +7.3% compared to the previous 5-year average). Increased smallmouth bass and yellow perch abundance may be due, in part, to cormorant population management and a shift in cormorant diets to round goby.
- Estimated total fish consumption by cormorants from the Little Galloo Island colony in 2012 was 21.16 million fish, including 20.58 million round goby, 0.5 million alewife, 1.26 million yellow perch, 0.28 million rock bass, 0.58 million pumpkinseed, and 0.05 million sportfish, including smallmouth bass and northern pike (Section 14).

- Round goby dominated cormorant diets at the three St. Lawrence River colonies surveyed in 2012 (Griswold, McNair, and Strachan islands). The contribution of game fish in cormorant diets in 2012 was the lowest observed since diet studies began in 1999. The 2012 fish consumption estimates for Griswold, McNair and Bergin island colonies were 3.5 million, 7.4 and 2.4 million fish, respectively. Since 1999, cormorants at three St. Lawrence River colonies have consumed an estimated 129.1 million fish, including 37.5 million yellow perch, 17.4 million rock bass, 50.4 million round goby, 10.6 million pumpkinseed, 1.5 million ictalurids (bullhead/catfish) and 1.0 million smallmouth bass (Section 15).
- For the 13th 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 (n=362) was employed again in 2012. Nest destruction was employed to discourage nesting on Gull Island (n=711), but was not necessary on Calf and Bass Islands. After dropping below target for the first time in 2010, the number of cormorant feeding days rebounded to 999,000 in 2011. In 2012, cormorant feeding days were estimated at 817,972, above the management target of 780,000, as measured by the Weseloh and Casselman feeding day model (Section 13).
- Since 1999, the cormorant reproductive suppression program on Little Galloo Island has cumulatively reduced fish consumption by chicks at the colony by 96.6 million fish including approximately 9.9 million yellow perch and 2.6 million smallmouth bass (Section 14).

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New York Lake Ontario and Upper St. Lawrence River Stocking Program 2012

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The New York stocking report is prepared annually to summarize information on fish stocked in the most recent calendar year. This report includes all fish stocked into New York waters of Lake Ontario and its tributaries, and the St. Lawrence River upstream of Alexandria Bay. Fish stocked into tributaries of Lake Ontario which are not expected to contribute to the Lake Ontario open water or associated tributary fisheries (e.g., brook trout, domestic rainbow trout, and brown trout stocked above barriers or in headwaters) are not reported here. Additional information on fish stocked in all New York waters can be found on the Internet at:www.dec.ny.gov/outdoor/7739.html

The report consists of three tables, and a description of stocking terminology and abbreviations. Table 1 provides totals for fish stocked in 2012 by species, strain, and life stage, and compares those totals with the 2012 New York Department of Environmental Conservation (NYSDEC) stocking policy. Table 2 provides totals by species and life stage, summarizing the New York stocking history from 1991-2012. New York stocking history from 1968-1990 is reported in Eckert (2000). Table 3 provides specific information for each group of fish stocked in 2012. If needed, more detailed information on fish stocked can be obtained from the agencies and/or hatcheries which conducted the work.

TERMINOLOGY AND ABBREVIATIONS

Species: Names follow those in the American Fisheries Society's sixth edition of *Common and Scientific Names of Fishes from the United States, Canada, and Mexico* (Nelson 2004).

Location and **GD/KY** (Grid/Key): Location information for fish stocked in New York waters. Fish stocked in tributaries of Lake Ontario are designated using the name of the water in the location column, and the official NY stream key in the GD/KY column (key = capital O, period, 2 or 3 digit number, plus in some cases, a dash followed by a pond/embayment designation and one or more tributary numbers). Stream keys which are too long to fit within the GD/KY column are completed in the comments column. More specific information about stream stocking sites is not included in Table 3, but is part of the NYSDEC stocking database. Fish stocked directly into Lake Ontario, Lower Niagara and the St. Lawrence Rivers are designated using a shore area description in the location column, and a 3 digit grid number in the GD/KY column (standard grids based primarily on 10 minute blocks of longitude and latitude).

Stk Date (stocked): Date the fish were stocked. For pen reared fish, refers to the date the fish were released from their rearing pen.

Htch (Hatchery): Last hatchery at which the fish were raised for a significant period of time. Hatcheries in Table 3 are designated using the abbreviations shown below.

Abbreviations for New York NYSDEC hatcheries:

AD	Adirondack
BA	Bath
CA	Catskill
CD	Caledonia
CQ	Chautauqua
CH	Chateaugay
CS	Cedar Springs
RA	Randolph
RM	Rome
SR	Salmon River
SO	South Otselic
VH	Van Hornesville

Abbreviations for other county, state or federal hatcheries, and sportsmen clubs:

CV	Cape Vincent Fisheries Station, Jefferson Co.
NAA	Niagara River Anglers Association
PMP	Powder Mill Park Hatchery, Monroe Co.
TUN	Tunison Laboratory of Aquatic Sciences, NY

U.S. Fish and Wildlife Service Hatcheries:

AL	Allegheny National Fish Hatchery, PA
IR	Iron River National Fish Hatchery, WI
PT	Pittsford National Fish Hatchery, VT
SC	Sullivan Creek National Fish Hatchery, MI
WR	White River National Hatchery, VT

YCL (Year Class): Year class of the fish stocked. Year class is defined as the first year spawned for a group of fish, or the first year in which they grew significantly. For spring or summer spawning fish, year class and year spawned will be the same. For fall spawning fish, year class will be one year later than the year spawned (e.g., coho salmon from eggs spawned in October 2004 would be 2005 year class).

Strain: Strain of the fish stocked. Fish stocked in New York waters are shown with strain abbreviations that are defined below. Information is included to determine whether or not terms such as steelhead or landlocked could be applied to a group of fish.

FL (Finger Lakes): Strain of rainbow trout or lake trout from the Finger Lakes, NY. Lake trout descended from a native Seneca Lake population (see SEN). Rainbow trout from a naturalized population in Cayuga Lake, and maintained by collecting eggs from fish in Cayuga L. inlet.

LC (Little Clear): Landlocked strain of Atlantic salmon. Includes both a feral broodstock maintained in Little Clear Lake, NY, as well as a captive broodstock held at the NYSDEC Adirondack Hatchery and derived from eggs taken from Little Clear Lake. Originally includes Swedish Gull Spang strain, as well as West Grand Lake (outlet spawners) and Sebago (inlet spawners) strains from Maine.

LO (Lake Ontario): Wild, self-sustaining population from Lake Ontario. Cisco eggs were collected in Chaumont Bay, Jefferson County and reared at U.S. Geological Survey (USGS) Tunison Laboratory of Aquatic Sciences (TUN) in 2011-2012. Walleye eggs were collected from adults netted in Mud Bay, Jefferson County, NY and incubated and reared at the NYSDEC Cape Vincent Fisheries Station in partnership with the Lake Ontario Fisheries Coalition and the Village of Cape Vincent. In 2009-2012, however, no walleye production occurred.

LM (Lake Michigan): wild, self-sustaining population of bloater from Lake Michigan. Eggs were collected from waters of Lake Michigan near Dorr County, WI and Milwaukee, WI and were incubated and reared at TUN.

ONL (Oneida Lake): wild, self-sustaining, population of walleye from Oneida Lake, NY.

RA (Randolph): a fall spawning strain of domestic rainbow trout maintained at the NYSDEC Randolph Hatchery.

RL (Rome Lab): Domesticated, furunculosis resistant, strain of brown trout originated and maintained at the NYSDEC Rome Hatchery with production broodstocks at Randolph and Catskill Hatcheries.

SAL (Salmon River): Lake Ontario populations of coho salmon and Chinook salmon which return to Salmon River for spawning. These populations were originally derived from eggs obtained mainly from Lake Michigan sources, through 1983 for coho salmon, and through 1986 for Chinook salmon. The spawning runs consist of feral fish from Salmon River Hatchery stockings, but may contain some strays from Ontario hatcheries or wild fish.

SEB (Sebago): Landlocked strain of Atlantic salmon derived from Maine. SEB were stocked in 2011-2012 by USGS TUN from eggs originating from Ed Weed Fish Culture Station, VT (2011-2012) and Casco Fish Hatchery, ME (2012).

SEN (Seneca Lake strain): Lake trout descended from a native population that coexisted with sea lamprey in Seneca Lake, NY. Until 2005, a captive broodstock was maintained at the U.S. Fish and Wildlife Service (USFWS) Alleghany National Fish Hatchery (AL), which began rearing lake trout for stocking in Lakes Erie and Ontario beginning with the 1978 year class. Through 1997, eggs were collected from fish in Seneca Lake and used to supplement broodstocks held at the AL and the USFWS Sullivan Creek National Fish Hatchery (SC). Beginning in 1998, SEN strain broodstocks were supplemented using eggs collected from both Seneca and Cayuga Lakes. Since 2003, eggs were collected exclusively from Cayuga Lake. After the 2005 stocking of the 2004 year class, an outbreak of Infectious Pancreatic Necrosis (IPN) required that all fish, including broodstock be destroyed and AL was closed for disinfection and renovation. The 2005 year class originated from eggs collected from Cayuga Lake and fish were reared at the NYSDEC Bath Fish Hatchery. The 2006 year class originated from both the NYSDEC Bath Hatchery egg take in Cayuga Lake and broodstock held at SC, and these fish were raised at the USFWS White River National Fish Hatchery (WR) and USFWS Dwight D. Eisenhower National Fish Hatchery (DE), formerly named the Pittsford National Fish Hatchery. Concerns of potential viral hemorrhagic septicemia virus (VHSv) introduction to WR prevented transfer of eggs from Cayuga Lake to WR following the fall 2005 egg take. SC provided eggs for the 2007 and 2008 year classes stocked in 2008 (reared at WR and DE) and 2009

(reared at WR only). The 2009 year class (stocked as Ylg in 2010) originated from the fall 2008 Cayuga Lake egg take, and was reared at the NYSDEC Bath Hatchery. This strain has been abbreviated as FL and FLW in the NYSDEC stocking database; SLW in the USFWS stocking database; and as SEN and SLW in the NYSDEC Lake Ontario Unit annual reports.

LCH (Lake Champlain strain): Lake trout descended from a feral population in Lake Champlain. The broodstock (Lake Champlain Domestic; LCH-D) is maintained at the Vermont State Salisbury Fish Hatchery and is supplemented with eggs collected from feral Lake Champlain fish. Broodstock eggs were supplied to WR for rearing of the 2008-2010 year classes stocked into Lake Ontario as spring yearlings in 2009-2011, and as fall fingerlings in October 2010 (2010 year class). A portion of the 2009 year class stocked in 2010 was reared at WR from eggs taken directly from feral Lake Champlain fish (Lake Champlain Wild; LCH-W). In 2011, flooding from Hurricane Irene inundated WR, severely damaging the hatchery and potentially contaminating the raceways with *Dydimo* an invasive algae. USFWS determined that lake trout slated to be stocked in 2012 (2011 year class) could not be stocked without posing a risk of spreading *Dydimo* to other waters so these fish were destroyed. Production at AL resumed in 2011, and the hatchery produced surplus fall fingerling LCH-D lake trout (2012 year class; eggs from Salisbury Fish Culture Station, VT) which were stocked in October 2012. This strain has been abbreviated as FL-HYB and LC in the NYSDEC stocking database; LC and SLWVT in the USFWS stocking database; and as LCH and SNVT in the NYSDEC Lake Ontario Unit annual reports.

SUP (Lake Superior strains): Captive lake trout broodstock initially developed at the USFWS Marquette Hatchery and derived from "lean" Lake Superior lake trout. Broodstock for the Lake Ontario stockings of the Marquette strain was maintained at AL until 2005. After the 2005 stocking of the 2004 year class, an outbreak of Infectious Pancreatic Necrosis (IPN) at AL required that all fish, including broodstock, be destroyed and the hatchery was closed for disinfection and renovation. The Superior – Marquette strain was no longer available for Lake Ontario stockings. Lake Ontario stockings of "lean" strains of Superior lake trout resumed in 2007 with Traverse Island strain fish (SUP-STW; 2006-2008 year classes) and Apostle Island strain fish (SUP-SAW; 2008 year class). The SUP-STW broodstock was phased out of production at USFWS Iron River National Fish Hatchery (IR) and will no longer be available as a source of eggs for future Great Lakes stockings. The Apostle Island strain broodstock was maintained at IR until after the fall 2011 egg take when production ceased. Disease concerns prevented transfer of eggs from IR to WR in fall 2008. These strains have been referred to as Trav Isl and Apostle Isl in the NYSDEC stocking database; and abbreviated as SMD, SAW, and STW in the USFWS stocking database; and as SUP, STW and SAW in the NYSDEC Lake Ontario Unit reports.

SKW (Klondike Reef): Captive lake trout broodstock held at SC and IR. This strain originated from a native, deep spawning "humper" morphotype of Lake Superior lake trout that are intermediate in fat content to lean and fat (Siscowet) morphotypes. Eggs for the 2008 year class raised at WR were obtained from the broodstock held at SC. Disease concerns prevented transfer of eggs from SC to WR in fall 2008 (2009 year class). This strain has been referred to as Klondike in the NYSDEC stocking database, and abbreviated SKW in the USFWS stocking database and in the NYSDEC Lake Ontario Unit annual reports.

SKA (Skamania): Summer run, anadromous strain of rainbow (steelhead) trout derived from eggs imported from Lake Michigan to New York. Feral Lake Ontario broodstock maintained since 1996 through collection of eggs from spawning runs of fin-clipped adults at NYSDEC Salmon River Hatchery.

WAS (Washington): Winter run, anadromous, strain of rainbow (steelhead) trout derived from eggs imported from Washington (Chambers Crk. strain) to New York through 1980. Feral Lake Ontario broodstock maintained through collection of eggs from spawning runs of fin-clipped adults at Salmon River from 1981-2006. Spawning of only fin-clipped Washington strain was discontinued in 2007 and since then, both clipped and unclipped steelhead are spawned, but clipping and selection of fin-clipped Skamania strain was continued to maintain separate steelhead strains.

W (Wild): Broodstock which spends a significant amount of time and achieves most growth in a lake or river, including both fish from natural reproduction as well as feral fish stocked at an earlier life stage. Adult fish may be held in captivity for several weeks or months until eggs are ready to be stripped.

D (Domestic): A captive broodstock which reaches maturity in a hatchery, regardless of the source of the eggs that they were derived from.

Mos (Months): Age of the fish to the nearest half month from the time the lot initiated feeding to the time they were stocked.

Stage: Life stage at which the fish was stocked, based on the convention that the birth date of fish from any particular year class is assumed to be January 1. Fingerlings (fing) are fish in their first year of life (age 0 or young-of-year), and year stocked will equal year class. The terms fry, spring fingerlings (SF), advanced fingerlings (AF), and fall fingerlings (FF), are simply additional designations for portions of the fingerling life stage. The term pond fingerling (PF) is used for fingerling walleye reared outside in ponds, usually without any supplemental food. Yearling fish (Ylg) are fish in their second year of life (age 1), and year stocked will be one more than year class. Yearling fish are most often stocked in the spring, and the term spring yearling (SY) is applied to such fish. The term adult (Ad) is applied to fish stocked in their third or later year of life (age 2 or more), even though these fish have often not reached sexual maturity.

Wt (g) [Weight]: Average weight of the fish in grams. For pen reared fish, refers to their size at the time they were released from their rearing pen.

Mark: Fin clips, tags, or other identifying marks applied to all members of a group before stocking. If more than one mark is applied (i.e. two clips or a clip plus a tag), all will be listed. Standard abbreviations for the various marks and tags are listed below. Tag colors, and numbers or codes, are included under "Comments" in Table 3.

AD	adipose fin clip
LV	left ventral fin clip
LP	left pectoral fin clip
CWT	coded-wire-tag
OTC	oxytetracycline - 6 hour immersion
VIE	visible implant elastomer

Number (stocked): Number of fish stocked at the particular site.

Comments: Significant comments and additional information relating to the rearing, marking, or stocking of the fish. If left blank, it can be assumed that the particular group of fish was released in a direct shore-line or stream-side stocking during daylight hours, without incident or undue mortality. Further descriptions for some of the comments listed in Table 3 are given below.

Barge: Fish transferred to a barge, ship, or other water craft, and transported some distance offshore before being released (LCM=military landing craft).

Boat Stocked: Fish transferred to a smaller boat or water craft and stocked nearshore.

Controls: Marked fish to act as controls in the evaluation of another marked experimental group.
CWT (2- or 6-digit number): Number for the coded wire tag used with each lot of Chinook salmon (2- or 6-digit), or lake trout or rainbow trout (both 6-digit).

Pen Reared (date, size): Fish held and reared in a pen at the release site for a period of time, usually one to four weeks. The date the fish were placed in their pen, and their average size at that time, are shown in the Comments column.

PMP release pond: Outdoor raceway at Powder Mill Park Hatchery (owned by Monroe County) which drains directly into a tributary of Irondequoit Creek. This hatchery raised WAS strain steelhead/rainbow trout until 2005, when concerns about spreading viral hemorrhagic septicemia (VHS) prevented transfer of WAS strain from Salmon River Hatchery. Since then, Bath Hatchery supplied PMP with rainbow trout from a wild Finger Lakes strain (in 2007, 2009, and 2011), or a Randolph (RA) domestic/wild Finger Lakes hybrid (in 2008 and 2010).

Smolt Release Pond (date): Fish released through the smolt release pond at the NYSDEC Salmon River Hatchery (currently only coho salmon). The fish are regularly monitored and fed. Downstream gates on the pond were removed, allowing the fish to voluntarily migrate into Beaverdam Brook at any time. The date the fish were stocked into the pond is shown in parentheses in the comments section. Date stocked corresponds to the date the smolt release pond was drained, forcing all remaining fish into Beaverdam Brook.

References

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Table 1. Summary of stocking in New York waters of Lake Ontario, the lower Niagara River, and the upper St. Lawrence River during 2012, and comparisons with the NYSDEC 2012 stocking policy.

Species	Stage		Strain	NYSDEC Stocking Policy*	Actual Number Stocked
Atlantic Salmon	AF	[1]	LC-D	-	13,800
	Ylg		LC-D	50,000	50,000
	FF	[2]	SEB	-	73,237
	Ylg	[2]	SEB	-	9,708
Atlantic salmon Total				50,000	146,745
Bloater Total	FF	[2]	LM	-	1,200
Brown Trout Total	Ylg		RL-D	455,000	419,410
Chinook Salmon Total	SF		SAL-W	1,761,600	1,511,080
Cisco Total	FF	[2]	LO	-	9,282
Coho Salmon	FF	[3]	SAL-W	155,000	0
	Ylg		SAL-W	90,000	120,190
Coho Salmon Total				245,000	120,190
Lake Trout	FF	[1]	LCH-D	-	122,830
	Ylg	[4]	LCH-D	500,000	0
Lake Trout Total				500,000	122,830
Rainbow Trout	Ylg	[5]	FL-W	7,500	7,300
	Ylg		RA-D	75,000	75,000
	Ylg	[6]	SKA-W	43,000	43,900
	FF	[1]	WAS-W	-	337,020
	Ylg	[6]	WAS-W	497,700	509,750
Rainbow Trout Total				623,200	972,970
Walleye Total	PF	[7]	ONL-W	97,200	23,200
Grand Total				3,732,000	3,326,907

[1] Surplus stocking
[2] Stocked by U.S. Geological Survey-Tunison for research project.
[3] No coho salmon fall fingerlings were stocked in 2012 due to unusually poor eye-up (survival) of eggs at SR in fall, 2011.
[4] Lake trout yearlings slated to be stocked in 2012 were destroyed after flooding from Hurricane Irene inundated White River National Fish Hatchery, severely damaging the hatchery and potentially contaminating the raceways with *Dydimo*.
[5] Domestic strain rainbow trout were stocked by Powdermill Hatchery from 2006-2009 because transfer of Washington strain steelhead from Salmon River Hatchery was restricted due to VHS concerns. Finger Lakes domestic/wild hybrid strain was stocked in 2010. The new policy in 2011 called for FL-W strain, which were stocked in 2011-2012.
[6] Due to shortage of Skamania strain eggs during 2011 egg take, Little Salmon River received Washington strain steelhead in 2012 in place of Skamania.
[7] Walleye stocking depends on annual hatchery production, and not all sites planned for 2012 received fish.

* Stocking policy as of Mar 1, 2012

Table 2. Approximate numbers (1000s) of trout, salmon, and other species stocked in New York waters of Lake Ontario, the lower Niagara River, and the upper St. Lawrence River from 1991 to 2012. Numbers of salmon, trout, and other species stocked in New York water of Lake Ontario and the St. Lawrence River from 1968-1990 can be found in Eckert (2000).

Species & Life Stage	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Co Ylg	97	94	96	92	119	98	95	90	90	99	101	105	95	95	99	110	90	124	95	114	141	120
Co FF	132	155	100	223	172	196	155	155	137	155	155	155	155	155	155	155	155	104	155	155	155	0
Co AF	0	290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Co f	0	0	0	0	0	0	0	0	0	0	0	4	7	0	0	0	0	0	0	0	0	0
Ck f	2835	2798	1603	1000	1150	1300	1605	1596	1596	1654	1629	1633	1622	1836	1809	1827	1813	799	1757	1531	1769	1511
Ck FF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LT Ylg	818	508	501	507	500	350	500	426	476	490	500	500	500	457	224	118	453	501	511	332	488	0
LT FF	160	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	122	0	123
LT Ad	0	0	0	0	0	0	0	<1	0	<1	0	0	0	0	0	0	0	0	0	0	0	0
BT Ylg	382	415	445	402	382	361	426	426	429	421	405	382	414	367	391	391	385	370	418	409	424	419
BT FF	0	0	0	0	0	0	0	0	25	0	0	136	39	0	66	0	0	0	70	57	6	0
BT AF	0	0	0	0	0	0	0	0	0	0	114	0	0	0	10	0	0	50	6	116	0	0
BT f	0	0	0	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	46	0	0	0
RT Ylg	82	85	88	92	24	70	93	92	97	75	60	71	75	64	75	72	68	74	78	80	82	82
RT FF	0	0	0	0	0	0	0	14	0	0	20	10	0	0	0	0	0	0	15	0	27	0
RT f	29	0	0	0	0	0	0	0	0	0	0	14	40	0	0	0	0	0	0	0	30	0
RT Ad	0	0	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0
Sthd Ad	0	0	0	0	0	0	0	<1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sthd Ylg	551	515	454	487	534	543	555	528	521	533	583	535	560	558	570	572	538	570	561	702	615	554
Sthd FF	40	0	0	0	50	60	110	0	107	0	0	15	0	0	0	0	0	0	80	188	0	337
Sthd f	175	0	0	0	0	0	0	0	0	0	0	1	6	0	0	0	0	0	0	0	0	0
ST FF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ST SF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	54	0	0	0
AS Ad	0	0	0	0	2	2	1	4	6	1	<1	<1	<1	1	0	0	0	0	0	0	0	0
AS Ylg	178	169	135	151	130	97	76	73	84	78	75	75	50	51	50	29	52	49	50	50	50	60
AS FF	0	0	30	38	34	34	25	25	25	25	25	0	0	0	0	0	0	0	24	37	66	73
AS AF	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	14
AS f	0	0	0	0	60	171	73	0	156	84	62	17	32	0	0	0	0	0	0	0	0	0
Sal Total	5479	5029	3453	2997	3158	3282	3715	3430	3749	3615	3729	3655	3594	3619	3450	3263	3554	2641	3920	3891	3854	3171
Wal AF	122	52	202	100	104	264	250	194	155	129	10	10	211	71	104	123	31	50	118	12	118	23
Wal FF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
Stur FF	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Bloat FF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Cisco FF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
TOTAL	5601	5081	3655	3097	3262	3546	3964	3623	3904	3745	3739	3665	3807	3691	3555	3382	3585	2696	4037	3903	3972	3327

Abbreviations:
Ad: Fish age 2 or older (adults)
Ylg: Yearlings, normally stocked between January and June
FF: Fall fingerlings, stocked between September and December
AF: Advanced fingerlings, stocked between mid-June and Sept
f: fry and spring fingerlings, stocked before mid-June
Co: coho salmon
Ck: Chinook salmon
LT: lake trout
BT: brown trout
RT: rainbow trout-domestic strains
Sthd: steelhead-anadromous rainbow trout
ST: brook trout
AS: Atlantic salmon
Sal: all salmonine species
Wal: walleye
Stur: lake sturgeon
Bloat: Bloater

* Surplus fingerling brook trout stockings were previously unreported in LOC annual reports 1991-2008

Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2012.

SPECIES	LOCATION	GD/KY	STK_DATE	HTCH	YCL	STRAIN	MOS	STAGE	WT(g)	MARK	NUMBERS	REMARKS
Atlantic Salmon	Beaverdam Brook	O.53-8	23-May-12	AD	2011	LC-D	14.9	Ylg	45.4	none	30,000	
Atlantic Salmon	Beaverdam Brook	O.53-8	28-Jun-12	AD	2012	LC-D	4.3	AF	3.3	none	13,800	Surplus
Atlantic Salmon	Beaverdam Brook	O.53-8	25-Apr-12	TUN	2011	SEB	14.5	Ylg	45.9	VIE	7,046	Yellow visible implant elastomer below right eye, stocked in 2 trips 4/25 and 4/30.
Atlantic Salmon	Beaverdam Brook	O.53-8	25-Apr-12	TUN	2011	SEB	14.5	Ylg	45.9	AD-VIE	2,662	Yellow visible implant elastomer below right eye, stocked in 2 trips 4/25 and 4/30.
Atlantic Salmon	Beaverdam Brook	O.53-8	2-Oct-12	TUN	2012	SEB	7.5	FF	13.3	AD	28,139	Done in 3 stockings 9/26, 9/27, 10/2/2012
Atlantic Salmon	Salmon River	O.53-8	4-Oct-12	TUN	2012	SEB	7.5	FF	12.9	AD	22,462	Source of eggs-Ed Weed Fish Culture Station, VT. Done in 3 stockings 9/27, 9/28 and 10/4/2012 behind SR hatchery
Atlantic Salmon	Salmon River	O.53-8	9-Oct-12	TUN	2012	SEB	5.8	FF	10.2	AD	13,492	Source of eggs-Casco Hatchery, ME. Done in 2 stockings 10/5 and 10/9/2012 behind SR hatchery
Atlantic Salmon	Orwell Brook	O.53-6	3-Oct-12	TUN	2012	SEB	5.6	FF	8.1	AD	4,572	Source of eggs-Casco Hatchery
Atlantic Salmon	Trout Brook	O.53-5	3-Oct-12	TUN	2012	SEB	5.6	FF	8.1	AD	4,572	Source of eggs-Casco Hatchery
Atlantic Salmon	Point Breeze	713	17-May-12	AD	2011	LC-D	14.7	Ylg	44.0	none	20,000	Stocked by boat
Atlantic Salmon Advanced Fingerlings									3.3		13,800	
Atlantic Salmon Fall Fingerlings Total									12.0		73,237	
Atlantic Salmon Yearling Total									45.0		59,708	
Atlantic Salmon Total									**24.6**		**146,745**	
Brown Trout	Black River	O.19	2-Apr-12	SR	2011	RL-D	15.7	Ylg	77.8	none	4,440	
Brown Trout	Stony Point	423	15-May-12	SR	2011	RL-D	17.1	Ylg	92.6	none	33,710	Barge/LCM
Brown Trout	Stony Crk.	O.40	2-Apr-12	SR	2011	RL-D	15.7	Ylg	77.8	none	2,660	
Brown Trout	Henderson Bay	424	27-Apr-12	SR	2011	RL-D	16.5	Ylg	86.6	none	15,080	
Brown Trout	Association Island	424	19-Jun-12	RM	2011	RL-D	18.8	Ylg	113.4	none	7,900	Surplus
Brown Trout	Selkirk Shores	623	15-May-12	SR	2011	RL-D	17.1	Ylg	92.6	none	31,930	Barge/LCM
Brown Trout	Oswego	622	16-May-12	SR	2011	RL-D	17.2	Ylg	92.6	none	31,930	Barge/LCM
Brown Trout	Fair Haven	720	16-May-12	SR	2011	RL-D	17.2	Ylg	92.6	none	31,930	Barge/LCM
Brown Trout	Sodus Point	819	1-May-12	SR	2011	RL-D	16.7	Ylg	94.5	none	28,380	Stocked off west pier
Brown Trout	Pultneyville	818	2-May-12	SR	2011	RL-D	16.7	Ylg	113.4	none	21,290	
Brown Trout	Webster	816	3-May-12	SR	2011	RL-D	16.7	Ylg	113.4	none	23,950	
Brown Trout	Irondequoit	815	30-May-12	CD	2011	RL-D	17.6	Ylg	114.8	none	23,950	
Brown Trout	Rochester	815	21-May-12	CD	2011	RL-D	17.3	Ylg	111.5	none	23,950	

Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2012.

SPECIES	LOCATION	GD/KY	STK_DATE	HTCH	YCL	STRAIN	MOS	STAGE	WT(g)	MARK	NUMBERS	REMARKS
Brown Trout	Braddocks Bay	815	14-May-12	CD	2011	RL-D	17.1	Ylg	103.6	none	23,950	
Brown Trout	Braddocks Bay	815	19-Jun-12	RM	2011	RL-D	18.8	Ylg	113.4	none	7,900	Surplus
Brown Trout	Hamlin	713	24-May-12	CD	2011	RL-D	17.4	Ylg	120.0	none	23,950	
Brown Trout	Point Breeze	711	17-May-12	CD	2011	RL-D	17.2	Ylg	106.2	none	18,750	New stocking site, a pull-off on the north side of the Parkway at Lakeshore Road
Brown Trout	Point Breeze	711	22-May-12	CD	2011	RL-D	17.4	Ylg	116.9	none	14,960	New stocking site
Brown Trout	Olcott	708	29-May-12	CD	2011	RL-D	17.6	Ylg	120.3	none	11,090	
Brown Trout	Olcott	708	4-Jun-12	CD	2011	RL-D	17.8	Ylg	121.9	none	11,090	LOTSA
Brown Trout	Wilson	707	15-May-12	CD	2011	RL-D	17.1	Ylg	90.0	none	22,180	
Brown Trout	Lower Niagara R	O.158	9-Apr-12	CD	2011	RL-D	16.0	Ylg	113.4	none	4,440	Stocked at Water St., Youngstown
Brown Trout Yearlings									102.9		419,410	
Brown Trout Total									**102.9**		**419,410**	
Chinook Salmon	Black River	OB-T0000	23-May-12	SR	2012	SAL-W	4.2	SF	5.3	none	129,270	
Chinook Salmon	South Sandy Crk.	LO-T0000	3-May-12	SR	2012	SAL-W	3.5	SF	5.3	none	81,300	
Chinook Salmon	Salmon River	LO-T0000	6-Jun-12	SR	2012	SAL-W	4.6	SF	9.0	none	360,000	
Chinook Salmon	Oswego River	O.65	22-May-12	SR	2012	SAL-W	4.1	SF	5.3	none	79,520	
Chinook Salmon	Oswego River	O.65	9-May-12	SR	2012	SAL-W	3.7	SF	4.3	none	34,060	In pens 4/26/12 @ 129/lb. 51 ^{o}F
Chinook Salmon	Little Sodus Bay	O.74	9-May-12	SR	2012	SAL-W	3.7	SF	5.4	none	25,000	In pens 4/18/12 @120/lb. 46 ^{o}F
Chinook Salmon	Sterling Crk.	O.73	10-May-12	SR	2012	SAL-W	3.7	SF	5.0	none	70,730	
Chinook Salmon	Sodus Bay	O.84-P96	21-May-12	SR	2012	SAL-W	4.1	SF	5.3	none	39,590	
Chinook Salmon	Sodus Bay	O.84-P96	14-May-12	SR	2012	SAL-W	3.9	SF	7.1	none	50,000	In pens 4/23/12 @ 130/lb. 43 ^{o}F
Chinook Salmon	Genesee River	O.117	11-May-12	SR	2012	SAL-W	3.8	SF	5.0	none	53,610	
Chinook Salmon	Genesee River	O.117	17-May-12	SR	2012	SAL-W	4.0	SF	6.3	none	85,250	In pens 4/20/12 @ 130/lb 57 ^{o}F
Chinook Salmon	Sandy Crk.	O.130	4-May-12	SR	2012	SAL-W	3.5	SF	4.0	none	55,000	In pens 4/20/12 @ 130/lb. 60 ^{o}F
Chinook Salmon	Sandy Crk.	O.130	17-May-12	SR	2012	SAL-W	4.0	SF	5.3	none	34,590	
Chinook Salmon	Oak Orchard Crk.	O.138	17-May-12	SR	2012	SAL-W	4.0	SF	5.3	none	32,300	Stocked at lighthouse
Chinook Salmon	Oak Orchard Crk.	O.138	15-May-12	SR	2012	SAL-W	3.9	SF	6.1	none	106,560	In pens 4/25/12 @ 129/lb. 48 ^{o}F
Chinook Salmon	Eighteenmile Crk.	O.148	18-May-12	SR	2012	SAL-W	4.0	SF	5.3	none	42,200	Stocked into Lake west of pier on beach due to warm harbor
Chinook Salmon	Eighteenmile Crk.	O.148	15-May-12	SR	2012	SAL-W	3.9	SF	7.0	none	67,100	In pens 4/26/12 @129/lb. 47 ^{o}F
Chinook Salmon	lower Niagara River	EN-T0000	24-May-12	SR	2012	SAL-W	4.2	SF	8.2	none	75,000	In pens 4/27/12 @129/lb. 42 ^{o}F
Chinook Salmon	lower Niagara River	EN-T0000	18-May-12	SR	2012	SAL-W	4.0	SF	5.3	none	90,000	
Chinook Salmon Spring Fingerling Total									**6.5**		**1,511,080**	

Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2012.

SPECIES	LOCATION	GD/KY	STK_DATE	HTCH	YCL	STRAIN	MOS	STAGE	WT(g)	MARK	NUMBERS	REMARKS
Coho Salmon	Beaverdam Brook	O.53-8	2-May-12	SR	2011	SAL-W	15.7	Ylg	29.6	none	120,190	
Coho Salmon Fall Fingerlings									0.0		0	No FF stocked due to poor egg eye-up in fall 2011
Coho Salmon Yearlings									29.6		120,190	
Coho Salmon Total									29.6		120,190	
Lake Trout	Point Breeze	711	15-Oct-12	AL	2012	LCH-D	8.3	FF	19.4	AD CWT	960	CWT# 640306, surplus
Lake Trout	Point Breeze	711	24-Oct-12	AL	2012	LCH-D	8.6	FF	19.5	AD CWT	39,420	CWT# 640306, surplus
Lake Trout	Point Breeze	711	15-Oct-12	AL	2012	LCH-D	8.3	FF	18.1	AD CWT	41,170	CWT# 640307, surplus
Lake Trout	Point Breeze	711	15-Oct-12	AL	2012	LCH-D	8.3	FF	18.0	AD CWT	41,280	CWT# 640305, surplus
Lake Trout Spring Yearlings									0.0		0	Yearlings were not stocked due to loss of fish from Hurricane Irene flooding of WR
Lake Trout Fall Fingerlings									18.6		122,830	
Lake Trout Total									**18.6**		**122,830**	
Rainbow Trout	Black River	424	6-Apr-12	SR	2011	WAS-W	9.1	Ylg	18.1	none	36,000	
Rainbow Trout	Black River	O.19	6-Apr-12	SR	2011	WAS-W	9.1	Ylg	18.1	none	36,000	
Rainbow Trout	Stony Crk.	O.40	9-Mar-12	SR	2011	WAS-W	8.2	Ylg	20.2	none	20,700	
Rainbow Trout	South Sandy Crk.	O.45	8-Mar-12	SR	2011	WAS-W	8.1	Ylg	20.2	none	28,750	
Rainbow Trout	Beaverdam Brook	O.53-8	14-May-12	SR	2011	WAS-W	10.3	Ylg	23.6	none	66,000	1 pond stocked on 5/14 and 1 on 5/18/12
Rainbow Trout	Beaverdam Brook	O.53-8	27-Apr-12	SR	2011	WAS-W	9.7	Ylg	23.1	none	66,000	1 pond 4/20 and 1 pond on 4/27/12
Rainbow Trout	Beaverdam Brook	O.53-8	26-Sep-12	SR	2012	WAS-W	2.8	FF	4.7	none	214,820	Surplus
Rainbow Trout	Beaverdam Brook	O.53-8	2-Nov-12	SR	2012	WAS-W	4.0	FF	5.2	none	122,200	Surplus
Rainbow Trout	Beaverdam Brook	O.53-8	2-May-12	SR	2011	SKA-W	10.4	Ylg	24.1	LV	43,900	
Rainbow Trout	Grindstone Crk.	O.54	14-Mar-12	SR	2011	WAS-W	8.3	Ylg	19.1	none	5,000	
Rainbow Trout	Little Salmon River	O.58	27-Apr-12	SR	2011	WAS-W	9.7	Ylg	33.7	none	5,000	In Pens 4/05/12 @26.3/lb 45 ^{o}F, Wash Sthd, No Skamania stocked due to shortfall at SRH
Rainbow Trout	Oswego River	O.66	5-May-12	SR	2011	WAS-W	10.0	Ylg	29.3	none	20,000	In pens 4/06/12 @ 26.3/lb 48°F
Rainbow Trout	Sterling Crk.	O.73	13-Mar-12	SR	2011	WAS-W	8.3	Ylg	19.5	none	4,600	
Rainbow Trout	Sterling Valley Ck	O.73-3	13-Mar-12	SR	2011	WAS-W	8.3	Ylg	19.5	none	4,600	
Rainbow Trout	Little Sodus Bay	O.74	26-Apr-12	SR	2011	WAS-W	9.7	Ylg	33.6	none	6,000	In pens 4/05/12 @ 26.3/lb 46 ^{o}F
Rainbow Trout	Maxwell Crk.	O.85	16-Mar-12	SR	2011	WAS-W	8.4	Ylg	20.0	none	20,000	
Rainbow Trout	Irondequoit Crk.	O.108	31-Mar-12	SR	2011	WAS-W	8.9	Ylg	23.8	none	27,500	
Rainbow Trout	Genesee River	O.117	9-Apr-12	SR	2011	WAS-W	9.2	Ylg	17.7	none	12,100	

Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2012.

SPECIES	LOCATION	GD/KY	STK_DATE	HTCH	YCL	STRAIN	MOS	STAGE	WT(g)	MARK	NUMBERS	REMARKS
Rainbow Trout	Genesee River	O.117	1-May-12	SR	2011	WAS-W	9.9	Ylg	24.5	none	10,000	In pens 4/9/12 @ 25.6/lb. 50 ^{o}F
Rainbow Trout	Salmon Crk.	O.125	9-Apr-12	SR	2011	WAS-W	9.2	Ylg	17.7	none	5,050	
Rainbow Trout	Sandy Crk.	O.130	9-Apr-12	SR	2011	WAS-W	9.2	Ylg	17.7	none	7,350	
Rainbow Trout	Sandy Crk.	O.130	1-May-12	SR	2011	WAS-W	9.9	Ylg	33.1	none	7,300	In pens4/9/12 @25.6/lb 56 ^{o}F
Rainbow Trout	Oak Orchard Crk.	O.138	10-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	7,000	
Rainbow Trout	Oak Orchard Crk.	O.138	24-Apr-12	SR	2011	WAS-W	9.6	Ylg	18.1	none	14,000	In pens 4/10/12 @ 25/lb. 52 ^{o}F.
Rainbow Trout	Marsh Crk.	O.138-1	10-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	7,100	
Rainbow Trout	Johnson Crk.	O.139	10-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	6,700	
Rainbow Trout	Keg Crk.	O.146	11-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	3,000	Stocked into Eighteen Mile Crk., Keg Ck. too low
Rainbow Trout	Eighteenmile Crk.	O.148	11-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	3,500	Stocked at Burt Dam
Rainbow Trout	Olcott	O.158	3-May-12	SR	2011	WAS-W	9.9	Ylg	26.8	none	3,500	In pens 4/11/12 @ 25/lb
Rainbow Trout	Twelvemile Crk. East Branch	O.152	11-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	7,500	Stocked at boat ramp Wilson-Tuscarora SP due to low water
Rainbow Trout	Twelvemile Crk.	O.152A	11-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	12,000	Stocked at Wilson Town Boat launch due to low water
Rainbow Trout	Twelvemile Crk.	O.152	2-May-12	SR	2011	WAS-W	9.9	Ylg	38.8	none	7,500	In Pens at Wilson on 4/11/12 @25/lb 52 ^{o}F
Rainbow Trout	Fourmile Crk.	O.156	11-Apr-12	SR	2011	WAS-W	9.2	Ylg	18.1	none	3,000	Stocked into lake @ 4 Mile State Park
Rainbow Trout	lower Niagara River	O.158	12-Apr-12	SR	2011	WAS-W	9.3	Ylg	20.6	none	37,000	Stocked 4/12 and 4/13
Rainbow Trout	lower Niagara River	O.158	9-May-12	SR	2011	WAS-W	10.1	Ylg	20.6	none	10,000	In pens on 4/12/2012 @22/lb 44 ^{o}F
Rainbow Trout	Sodus	819	31-May-12	CD	2011	RA-D	17.2	Ylg	116.6	none	20,000	
Rainbow Trout	Irondequoit Crk.	O.108	10-Apr-12	PMP	2011	FL-W	9.7	Ylg	30.2	none	7,300	Powder Mill Pond release, No WAS strain after 2006
Rainbow Trout	Webster	816	27-Apr-12	CD	2011	RA-D	16.1	Ylg	151.7	none	10,000	Due to lake roughness, fish were stocked in the Irondequoit channel.
Rainbow Trout	Hamlin	713	30-Apr-12	CD	2011	RA-D	16.2	Ylg	152.2	none	3,340	
Rainbow Trout	Hamlin	713	30-Apr-12	CD	2011	RA-D	16.2	Ylg	137.4	none	7,010	
Rainbow Trout	Hamlin	713	29-May-12	CD	2011	RA-D	17.1	Ylg	128.1	none	9,650	
Rainbow Trout	Olcott	708	26-Apr-12	CD	2011	RA-D	16.1	Ylg	142.6	none	12,500	
Rainbow Trout	Wilson	707	25-Apr-12	CD	2011	RA-D	16.0	Ylg	157.5	none	12,500	
Washington Steelhead Yearlings									21.8		509,750	
Skamania Steelhead Yearlings									24.1		43,900	
Washington Steelhead Fall Fingerlings									4.9		337,020	
Rainbow Trout Yearlings (Randolph strain)									137.5		75,000	
Rainbow Trout Yearlings (Finger Lakes W strain)									30.2		7,300	
Rainbow Trout Total									**27.9**		**972,970**	

Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2012.

SPECIES	LOCATION	GD/KY	STK_DATE	HTCH	YCL	STRAIN	MOS	STAGE	WT(g)	MARK	NUMBERS	REMARKS
Walleye	lower Niagara River	EN-P0000	7-Jun-12	CQ	2012	ONL-W	1.4	PF	0.3	none	23,200	
Walleye Fingerling Total									0.3		23,200	
Walleye Total											**23,200**	
Bloater	Oswego	621	14-Nov-12	TUN	2012	LM	6.4	FF	6.2	none	1,200	Stocked offshore at 100 m depth by RV Kaho
Cisco	Irondequoit Bay	815	20-Dec-12	TUN	2012	LO	10.0	FF	9.9	none	9,282	Stocked at Newport Yacht Club
Coregonine Total									**17.4**		**10,482**	
Salmonine Total											**3,293,225**	
Total All Species											**3,326,907**	

2012 Lake Ontario Fishing Boat Survey

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Each year from 1985-2012 the New York State Department of Environmental Conservation (NYSDEC) surveyed boats operating in New York waters of Lake Ontario's main basin. The data collected from boat counts and interviews of fishing boats are used for management of New York's Lake Ontario trout and salmon fishery and provide valuable information on other fish species (e.g. Eckert 1999). Each year from 1985-2009 the planned start of the survey was April 1 and the survey ended on September 30. Six-month estimates of creel survey results (1985-2009) were reported in previous annual reports (e.g., Eckert 1999, Eckert 2007, Lantry and Eckert 2010). The planned initiation of the survey was permanently changed to April 15 beginning with the 2010 season. To permit comparison of the 2010-2012 5½ month survey results (i.e. April 15- September 30) with previous years when the survey was conducted over six months (i.e. April 1- September 30), April 1985-2009 data were reanalyzed and half-month April (April 1-15) estimates were determined. Data presented and discussed in this report are 5½ month estimates for each survey year (1985-2012). This report focuses on 2012 results and on comparisons of 2012 with data collected during recent years. Appended tables and figures provide additional data (e.g. annual estimates of effort, catch, harvest and biological data) collected from 2003-2012 and an 18-year average for 1985-2002.

Methods

Sampling Design and Data Collection

Methods and procedures have changed little throughout the 28 years surveyed. For 20 of the 28 years the fishing boat survey covered the entire six-month period, April 1 to September 30. For 1995, 2002, 2003, 2008, and 2009 delays in hiring prevented an April 1 start, and sampling was initiated between April 8 and April 26. Beginning with 2010, the scheduled start of the survey was April 15. This angler survey does not include fishing activity from shore, in embayments and tributaries, in the eastern outlet basin (except for those which terminated their trip by returning through the Association Island Cut), boats fishing anywhere in Lake Ontario from October through April 14, or boats returning from the lake between one-half hour after sunset to two hours after sunrise (1.5 hours after sunrise during April and September only).

Boating access to Lake Ontario is limited and occurs mainly through channels associated with embayments and tributaries. Two crews of two agents each were used to survey access channels along approximately 190 shoreline miles from the Niagara River to the Association Island Cut near Henderson (Figure 1). The number of access channels surveyed varied between years from 28 to 30 (28 channels in 2012). Channels were divided each year into three or four sample strata based on estimates of expected fishing boat use (low-, medium-, high-, or super-use) and days were divided into two strata (low- and high-use). A stratified random design was used to proportionately allocate sampling effort among day and channel types for each month. Both crews were scheduled to work all of the designated high-use days (weekend days and holidays) and half of the crew/day combinations were scheduled on low-use week days.

During each time period surveyed, creel agents counted all boats returning from Lake Ontario and interviewed a random sample by anchoring and/or motoring small (18-20 ft) boats at the channel mouth. Time periods surveyed varied in length according to changes in sunrise and sunset, with each crew surveying opposite halves of the time

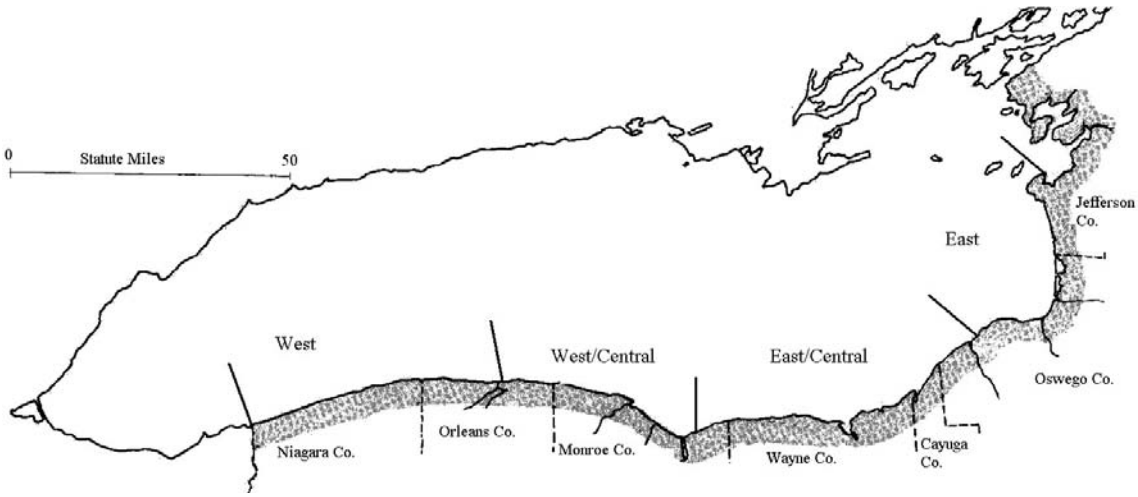

Figure 1. Lake Ontario's New York shoreline (shaded in gray), the seven New York counties that border the lake, and the four geographic areas used in analysis of the survey data.

period from two hours after sunrise (1.5 hours after sunrise during April and September only) and one-half hour after sunset. Interviews were conducted only among boat anglers who had completed their fishing trip, and all data and estimates presented in this report, unless clearly stated otherwise, are from completed fishing boat trips. A fishing boat trip was classified as completed if the anglers were not planning on returning to Lake Ontario within 1.5 hours or if some or all of the fish or fishermen were left onshore before returning. Under these criteria, any completed fishing boat trip could have consisted of more than one excursion to and from Lake Ontario, and the same boat or anglers could have participated in more than one completed fishing boat trip per day. The term harvest is used throughout this report for fish that were actually kept by the anglers, as well as any fish that were intentionally killed and discarded (e.g. round goby). The term catch is used for the sum of fish harvested plus fish intentionally released (intentionally unhooked and returned to the water alive).

Data Analysis

Estimated Effort, Catch and Harvest for 2010-2012

Estimates of fishing boat effort, catch and harvest were calculated for each channel and day surveyed by utilizing data from the sample of interviewed boats expanded by the total count of boats returning from the lake. These individual daily estimates were then multiplied by two to account for the "half day" census periods, and expanded by month using standard formulas for stratified random samples (Cochran 1977) to obtain monthly and seasonal estimates of effort, catch, harvest, and their respective variances. Variance estimates are conservative; therefore, the 95% confidence intervals are broad. To evaluate angling quality between years, species, areas, etc., we adjusted catch and harvest data per unit of fishing effort (e.g. catch and harvest per fishing boat trip). The basic unit sampled was an individual boat; therefore, effort is presented as estimated boat trips, and harvest rates and catch rates are presented per fishing boat trip. Effort in terms of angler trips and angler hours, and harvest and catch per angler trip and angler hour were also determined. Estimates of many variables such as angler residence and characteristics of fish harvested (length, age, etc.) were calculated directly from the interviewed boats assuming they were a random sample of the population. Data were also summarized for charter and noncharter boat trips.

Data Analysis and Calculation of Half-Month April and 5½ Month Estimates (1985-2009)

Beginning in 2010 and for the foreseeable future, the planned initiation of the Lake Ontario Fishing Boat Survey (hereafter "survey") will be April 15 rather than April 1 as was scheduled for the previous 25 years (1985-2009; Lantry and Eckert 2010). To allow for between year comparisons, we reanalyzed 1985-2009 April data to determine half-month (April 15-30) estimates. This report provides

5½ month estimates for 1985-2009 for all variables examined (e.g. effort, catch, harvest, and catch and harvest rates; regional estimates; and biological data analysis).

We considered survey sampling design, sample variability, heterogeneity and non-normal distribution of data throughout April, among other factors prior to calculation of half-month April estimates for 1985-2009 data. For each year 1985-1994, 1996-2001, and 2004-2007 (20 of the 25 years), data collected from the sample of interviewed boats at each channel and day surveyed were expanded by the total count of boats returning from the lake. These individual daily estimates were then multiplied by two to account for the "half day" census periods. Expanded data were summed for each parameter (fishing boat trips, charter fishing boat trips, coho harvested, coho caught, etc.) for the April 1-30 and April 15-30 periods. Parameter sums for the April 15-30 period divided by the respective sum for the April 1-30 period provided the percentage of the estimate that occurred during the second half of April. In some cases, the sum of adjusted parameters that were components (e.g. charter and noncharter brown trout catch estimates) of another parameter (e.g. total brown trout catch) did not equal the total adjusted estimate. Usually these differences were minor and were attributed to sample size and uneven distribution throughout the month. We proportionally adjusted the component estimates of each parameter so that they would sum to their respective totals (i.e. ratio of the sum of the component parts divided by the total). Summaries of residence data, regional data, and biological data were recalculated using only April 15 - September 30 data for each survey year (1985-2009).

Delays in implementing the 1995, 2002, 2003, 2008, and 2009 surveys resulted in too few samples collected within each of the survey strata (i.e. all channel-type and day-type combinations) to permit statistically valid and unbiased estimation of April effort, catch, and harvest. Expansions of April creel survey data for each of these years to full six-month estimates are described in Lantry and Eckert (2011). We reevaluated the methods used for those expansions prior to recalculating new half-month April and 5½ month estimates.

The 1995 and 2009 surveys were not initiated until late April (April 26 and April 22, respectively), and using the same methodology as was used to make April 1-30 estimates previously (Eckert 1996), we assumed that there was a relationship between what would have been observed April 15-30 and May-September and that the data from previous years could be used to approximate this relationship. For 1995, we used 1992-1994 data to estimate parameters for April 15-30, 1995. For 2009, we were unable to use the three previous years as was done for 1995 since the 2008 survey also started late; therefore, we used 2004-2007 data to estimate April 15-30, 2009. In cases where a given parameter included various component parts (e.g. total complete fishing boat trips included targeted trout and salmon trips, smallmouth bass trips, yellow perch trips, etc.; or total species-specific catch included harvest and catch by various boat types), the total calculated value was multiplied by the average April 1992-1994 or 2004-2007 contribution of each component part, respectively.

To recalculate the half-month April estimate for 2002 (initiated April 13), we used the data collected April 15-30, 2002. To maintain sufficient sample sizes within strata (i.e. a total of eight strata given the two day types and four channel types), we reduced the four channel types surveyed (super-, high-, medium- and low-use) to two channel types by combining data for super- and high-use channels into one channel type and medium- and low-use channels into the second channel type. These two channel type strata were each divided into the two day types (high and low-use days) for a total of four strata. Half-month April estimates were then determined using the same methods described previously for 2010-2012 (see section “Results: Data Analysis: *Estimated Effort, Catch and Harvest for 2010-2012*”).

Delayed survey initiation in 2003 and 2008 were relatively minor (initiated April 11 and April 8, respectively) and were accounted for by using the assumed values as described in Lantry and Eckert (2011) and half-month April estimates were determined using the same methods described above for the other years (i.e. calculated the percentage of

a parameter that occurred April 15-30 then reduced the full month estimate accordingly).

Regional comparisons were made by dividing the New York shoreline into four approximately equal areas (Figure 1, Table A1), and combining the daily estimates for access channels within each area for the entire season (i.e. months were eliminated as a strata classification). Boundaries of the four geographic areas and their designated names used throughout this report are: west area - Niagara River to Point Breeze; west/central area - Bald Eagle Creek to Irondequoit Bay; east/central area - Bear Creek to Oswego Marina; and east area - Sunset Bay (Nine Mile Point) to Association Island Cut (Table A1). Regional estimates were recalculated to a 5½ month time period for each year 1985-2009 using only April 15 - September 30 data. Given the survey design, estimating region-specific catch rate and harvest rate for each month was not possible. Lantry and Eckert (2011) did, however, evaluate relative harvest within specific regions and months as compared to previous 5-year averages and some general trends are reiterated here. For this report we were, however, able to compare 2012 5½ month regional results with general trends observed in previous years of the survey and reported in Lantry and Eckert (2011).

Statistical Analysis

For some parameters, regression analyses were used to examine for trends in the data series (SAS version 8.0, SAS Institute 1999, Lantry and Eckert 2011). Percentage data were arc sine transformed prior to statistical analysis (Kuele 1994). Analyses were statistically significant at $P<0.05$.

Results and Discussion

Fishing and Boating Effort

Fishing effort from April 15-September 30, 2012 was estimated at 56,182 ($\pm$12.5%) completed boat trips (Figure 2, Table A2), the lowest estimated and due primarily to a decrease in fishing effort targeting smallmouth bass in recent years. The total estimated number of fishing boat trips increased from 1985-1990, then decreased through 1996. The largest declines in fishing effort occurred shortly after the peak, with declines of 31,751 trips between 1990 and 1991, 42,112 trips between 1991 and 1992, and 12,740 trips between 1995 and 1996. Over the 10-year period from 2003-2012 total fishing effort, as measured by fishing boat trips, continued to show a downward trend; however, effort targeting trout and salmon has remained relatively stable with no declining trend for more than a decade (see "*Trout and Salmon Targeted Effort*" section; Figure 2). The decline in total fishing effort is attributed to a significantly declining trend in effort targeting smallmouth bass in recent years (P-value<0.0001; see "*Smallmouth Bass Targeted Effort*, Traditional Open Season:" section).

Total fishing effort in 2012, as measured by angler trips and angler hours, was 160,363 and 848,905, respectively. The average number of anglers per boat trip ranged from 2.5 (1985) to 2.9 (1991), and averaged 2.8 with an increasing trend during the last 10 years (Table A2). The increased number of anglers per boat trip may have been due to cost-saving efforts given the cost of gas and current status of the economy. In 2012, there was an average of 2.85 anglers per boat trip. The 2012 average trip length of 5.29 hours per boat trip was comparable to previous 5-year (+1.5%) and 10-year averages (+4.2%).

We evaluated the contribution to total seasonal fishing effort for each month April through September (Table A2). Since the early 1990s, the greatest amount of fishing effort occurred during the second half of the open lake fishing season (2003-2012 10-year averages: April 15-April 30: 4.2%, May: 14.4%, June: 12.0%, July: 21.1%, August: 29.8%, and September: 18.5%).

Geographic Area Fishing Effort

We evaluated the regional contribution to total seasonal fishing effort (Table A2). Typically, the greatest amount of fishing effort occurred in the east/central area, where the greatest amount of fishing effort occurred for 25 of the last 28 years (Lantry and Eckert 2012; Table A2). In 2012, there were an estimated 17,410 fishing boat trips in the east/central region (31.0% of all fishing effort).

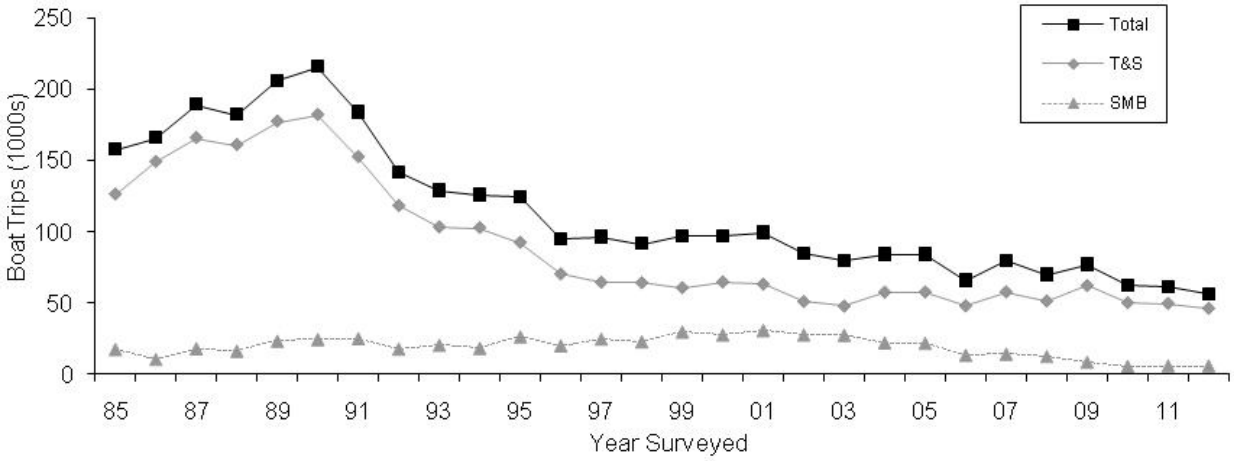

Figure 2. Seasonal (April 15-September 30) estimates of total fishing boat trips, trips targeting trout and salmon (T&S), and trips targeting smallmouth bass (SMB) during the traditional open season (3rd Saturday in June-September 30 when the survey ended), 1985-2012.

Effort in the east and west areas was estimated at 17,215 and 14,145 boat trips, respectively. For each of the 28 years surveyed, the lowest fishing effort occurred in the west/central area and, in 2012, there were an estimated 7,412 boat trips (13.2% of total fishing effort) in that portion of the lake.

Power Boat and Sailboat Excursions

This survey was specifically designed to count and interview fishing boat anglers, however, all recreational boats returning from Lake Ontario were also documented. Power boaters who spent at least a portion of their time fishing on Lake Ontario accounted for 56,979 vessel excursions and 38.2% of the total vessel traffic in 2012 (Table A2). Non-fishing power boats were estimated at 71,318 excursions in 2012 (47.9% of the total vessel traffic). Non-fishing power boat traffic peaked and declined similar to that described for fishing boats over the 28 survey period.

Sailboats, the smallest component of vessel traffic, showed a downward trend over the 28 years surveyed. In 2012, sailboats accounted for 20,703 excursions and represented 13.9% of the vessel traffic. This represented a 37.8% increase over the record lows observed from 2003-2007 (average = 15,022 sailboat trips; Table A2).

Trout and Salmon Targeted Effort

Trout and salmon, as a group, were the primary target of boat anglers interviewed each year since 1985 (1985-2012 range: 90.0% [1986] – 59.7% [2003]; 1985-2012 average = 75.9%; Figure 2, Table A2) and changes in fishing effort were due largely due to trout and salmon anglers (1985-late 1990s). Over the last 10 years, however, effort targeting trout and salmon remained relatively stable with no trend while total fishing effort declined over the same time period. That decline coincided with decreasing fishing effort directed at smallmouth bass. In 2012, trout and salmon anglers accounted for 82.0% of the total fishing boat trips, 86.5% of angler trips, and 92.5% of angler hours (Table A2).

In 2012, fishing effort targeting trout and salmon was estimated at 46,059 (±13.8%) boat trips, which was the lowest estimate for trout and salmon anglers but was a slight decrease (-14.9%) compared to the previous 5-year average (Table A2). In 2012, estimated monthly fishing effort targeting trout and salmon was below the previous 5-year average each month (range: -12.7% [May] to -30.0% [September]) with the exception of June when effort was comparable (+2.0%) to the previous 5-year average June estimate. Unlike most previous years when trout and salmon anglers stated they were targeting a mix of two or more species, the majority of those interviewed each year since 2005 were specifically targeting Chinook salmon (2005-2011 average=49.2%). During April 15-September 30

2012, 46.4% of salmonine anglers were specifically targeting Chinook salmon, 44.8% were targeting a mix of two or more species, and 8.4% were specifically targeting brown trout.

Smallmouth Bass Targeted Effort

Traditional Open Season:

The traditional open season for bass begins the third Saturday of June. Each year since 1985, smallmouth bass was the primary species targeted by anglers not seeking trout or salmon (Figure 2, Table A2). From 1985-2001 effort targeting smallmouth bass increased significantly (P=0.0004), averaging a gain of 797 boat trips per year. During 2001-2010, however, smallmouth bass effort declined significantly (P<0.0001), averaging a loss of 2,838 boat trips per year (Figure 2, Table A2). Effort directed at bass during the traditional open season declined 81.1% (31,035 boat trips) between the 2001 peak and the record low in 2010. Smallmouth bass fishing effort during the traditional open season in 2012 (June 18 to September 30) was an estimated 6,203 (±25.6%) boats trips, comparable to 2011 (6,257 boat trips; -0.9%) and a 35.5% decrease compared to the previous 5-year average (Figure 2, Table A2). Among all fishing boat trips (April 15 – September 30) on Lake Ontario, the percent contribution of smallmouth bass trips during the traditional season varied and ranged from a low of 6.5% of all fishing boat trips in 1986 to a high of 34.8% in 2003. In 2012, smallmouth bass anglers fishing during the traditional open season accounted for 11.0% of all fishing boat trips (April 15 – September 30), 8.4% of angler trips, and 4.9% of angler hours. In 2012, the average number of anglers per bass boat trip (2.2 anglers) and hours per boat trip (3.1 hours) were comparable to previous 10-year averages (-1.2% and +1.9%, respectively). In 2012, fishing effort for smallmouth bass was below previous 5-year averages for each month July through September (range: -53.1% [September] to 32.9% [July]) and for all four geographic areas (range: -46.3% [east/central] to -15.1% [west]; Table A2).

The decline in smallmouth bass effort may be due, in part, to the declining fishing quality experienced by many bass anglers in recent years. Many smallmouth bass anglers interviewed in recent years were dissatisfied with their fishing experiences because catches were dominated by round gobies (Table A3) and few bass were caught. Some anglers interviewed had changed their fishing strategies, successfully avoided gobies, and continued to catch bass. In 2007, a gillnetting assessment in Lake Ontario near Pultneyville (between Irondequoit Bay and Sodus Bay) indicated that smallmouth bass abundance in that area was high enough to produce a quality fishery (Sanderson 2008) as was experienced by some anglers interviewed. By 2009, however, some anglers who had experienced good bass fishing through 2008 were no longer experiencing satisfactory catch rates. Declining catch rates likely contributed to the declining fishing effort directed at smallmouth bass (see "Smallmouth Bass *Fishing Quality*" section).

Pre-Season Catch and Release Period:

For the sixth consecutive year, few anglers targeted bass during the pre-season catch and release period. Prior to October 1, 2006, NYSDEC fishing regulations established the open bass season in Lake Ontario from the third Saturday in June through November 30 and allowed anglers to harvest a daily limit of five smallmouth bass with a minimum length of 12 inches. The smallmouth bass regulation was changed effective October 1, 2006, establishing pre-season catch and release of bass from December 1 through the Friday preceding the third Saturday in June (except in Jefferson County waters of Lake Ontario's eastern basin). Prior to this regulation change some anglers admitted to targeting smallmouth bass before the traditional season opening (third Saturday in June) and, with the exception of 2006, accounted for nearly 1% of the April 15 - September 30 total smallmouth bass targeted fishing effort (Table A2). In 2006, before the new regulation permitting pre-season catch and release was in effect, 3.5% of total effort occurred pre-season (an estimated 500 boat trips). Since the regulation change, effort targeting bass during the pre-season catch and release period remained low (range: 2.8% [2008] – 7.7% [2012]) and a minor component of the total bass effort occurring April 15 - September 30. In 2012, effort remained low with an estimated 521 boat trips targeting smallmouth bass during the pre-season catch and release period. This represented 7.7% of the total

bass effort occurring April 15 - September 30, 2012 (Table A2).

Effort Targeting Other Species

Yellow perch and walleye were the third and fourth most commonly targeted species (preceded by salmonines and smallmouth bass) among open lake boat anglers in 2012, however, trips targeting these species only represented 3.2% of the total fishing boat trips (Table A2). The "all others" category, which comprised 2.8% of 2012 fishing boat trips, was primarily composed of anglers who stated that they were fishing for "anything" (Table A2).

Charter Boat Fishing Effort

Charter boats are an important, highly visible component of the Lake Ontario open lake fishery. Charter boats differ from noncharter boats in that charter boats have more anglers onboard (captain and mate included), fish for a longer period of time, are more likely to target trout and salmon, have higher catch rates, and harvest a higher percentage of the catch. In 2012, charter boats accounted for 13.6% of the total number of fishing boat trips (16.6% of trout and salmon fishing boat trips), but with more anglers on board and longer trips, charter boats accounted for 24.2% and 30.2% of the angler trips and angler hours, respectively (captains and mates counted as anglers; Table A2). Although charter boats accounted for only 13.6% of total fishing boat effort, they accounted for 33.3% of the total salmonine catch in 2012. Differences between charter and noncharter catch, harvest, and fishing quality are discussed in the "Total Salmonines: Catch, Harvest, and Fishing Quality" section of this report.

Charter fishing effort was at its highest levels during 1988-1991, then declined and has remained relatively stable over the last 10 years (2003-2012; Figure 3, Table A2). The 2012 estimated charter boat effort was 7,632 (±19.2%) trips, which was a slight decrease (-15.7%) compared to the previous 5-year average. Estimated monthly charter fishing effort in 2012 was above the previous 5-year average in April (+79.4%), was comparable to the previous 5-year average in July (-7.7%), and was below previous 5-year averages in May (-46.5%), June (-30.4%), August (-12.8%), and September (-17.0%; Table A2).

Angler Residency

Residency of anglers fishing Lake Ontario changed over the years surveyed, due in part to fishing interest and effort changes associated with the novelty of the trout and salmon fishery (i.e. in the 1980s) and trends in salmonid and smallmouth bass fishing quality. New York State (NYS) anglers consistently dominated the open lake boat fishery (Figure 4, Table A4). The most notable change in angler residency occurred during the first few years of the survey. In 1985 and 1986, NYS residents comprised 79.8% and 75.7% of all anglers

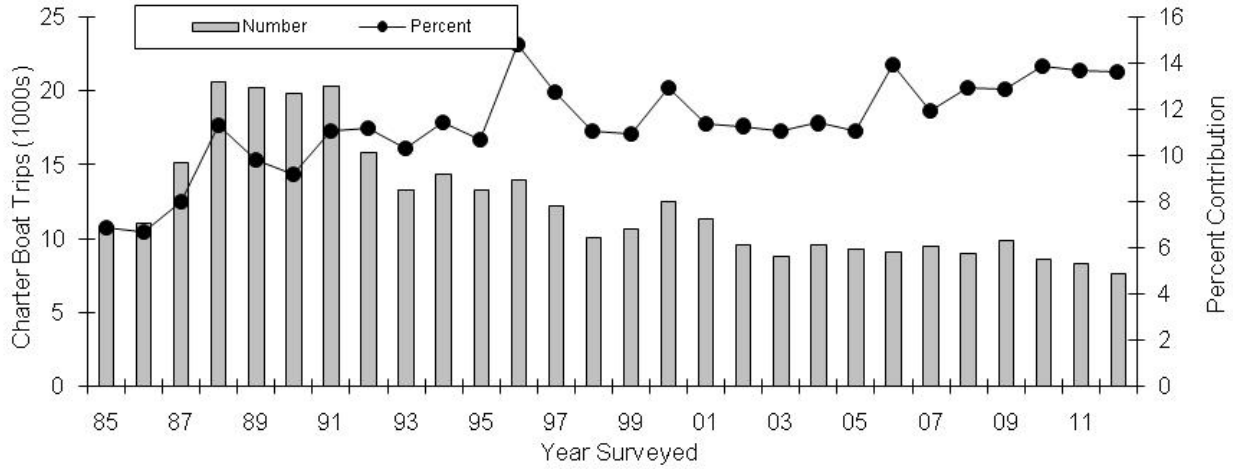

Figure 3. Seasonal estimates of charter fishing boat trips, and their percent contribution to total fishing boat trips, April 15- September 30, 1985-2012.

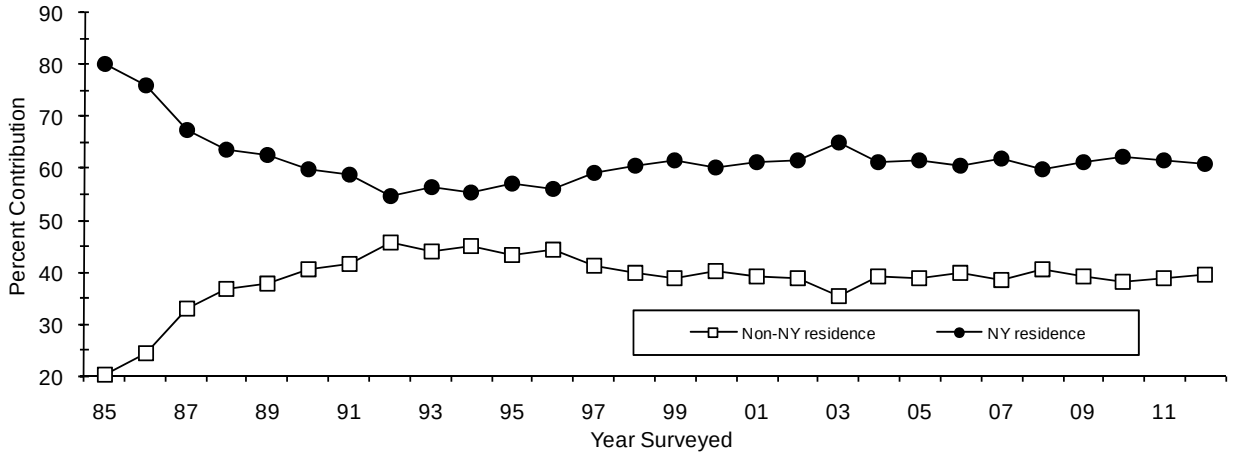

Figure 4. Percent contribution of anglers with and without New York state residency.

interviewed, respectively (Figure 4). There was no strong trend in the proportion of anglers residing in NYS for the period 1985-2012. Over the last 10 years, an average of 61.3% of Lake Ontario anglers resided in NYS (60.6% in 2012).

The proportion of nonresident anglers grew from 1985 through 1992, likely due to increasing awareness of the Lake Ontario trout and salmon sportfishery (Figure 4). In 2012, non-NYS residents comprised 39.4% of the boat anglers interviewed, comparable to previous 5-year and 10-year averages (1.1% and 1.9%, respectively; Figure 4; Table A2, Table A4). Pennsylvania represented the largest component of nonresident anglers for each of the 28 years surveyed (21.9% of the all anglers in 2012). The highest proportions of Pennsylvania anglers occurred each year 2010-2012 (the lowest [8.5%] occurred in 1985; Table A4), and increased significantly over the past 10 years (P=0.0211). Other major sources of non-NYS anglers in 2012 were Ohio (3.9%), New Jersey (2.6%), Massachusetts (2.6%), Vermont (2.5%) and Connecticut (1.5%; Table A4).

Throughout the 28-year data series, the majority of NYS anglers resided in the seven counties bordering Lake Ontario (Jefferson, Oswego, Cayuga, Wayne, Monroe, Orleans and Niagara counties; peaked at 66.9% in 2003; Table A4); however, in 2012 the percentage of NYS residents residing in the border counties had declined to the lowest level recorded (57.9% of anglers interviewed). As was observed each year of the survey, Monroe County remained the most important source of residents in the boat fishery, representing 16.2% of all NYS anglers interviewed in 2012 (Table A4). Other counties representing important components of the open lake boat fishery in 2012 were Oswego (12.5%), Wayne (10.3%), Niagara (9.4%), Onondaga (6.4%), Erie (5.2%), and Orleans (4.1%; Table A4).

Total Salmonines: Catch, Harvest and Fishing Quality

Catch and Harvest

Trout and salmon as a group (salmonines) are the most sought after fish in Lake Ontario. Total catch of all trout and salmon species was estimated at 196,625 (±16.3%) fish, which was comparable to (+5.9%) the previous 5-year average and a 22.0% increase compared to the previous 10-year average (Figure 5, Table 1, Table A5a). Each year since 2003, Chinook salmon dominated total trout and salmon catch (2003-2012 averages: 80,729 Chinook caught representing 47.6% of total catch) and harvest (2003-2012 averages: 46,833 Chinook harvested representing 48.9% of total harvest). For seven of those years, including 2012, brown trout was the second most commonly caught fish. From 2008 to 2010, rainbow trout was the second most commonly caught and harvested salmonine. Salmonine contributions in the 2012 catch were 45.2% Chinook salmon, 20.1% brown trout, 16.8% rainbow trout, 11.3% lake trout, 6.4% coho salmon, and 0.3% Atlantic salmon. In 2012, anglers harvested 54.7% of all trout and salmon caught,

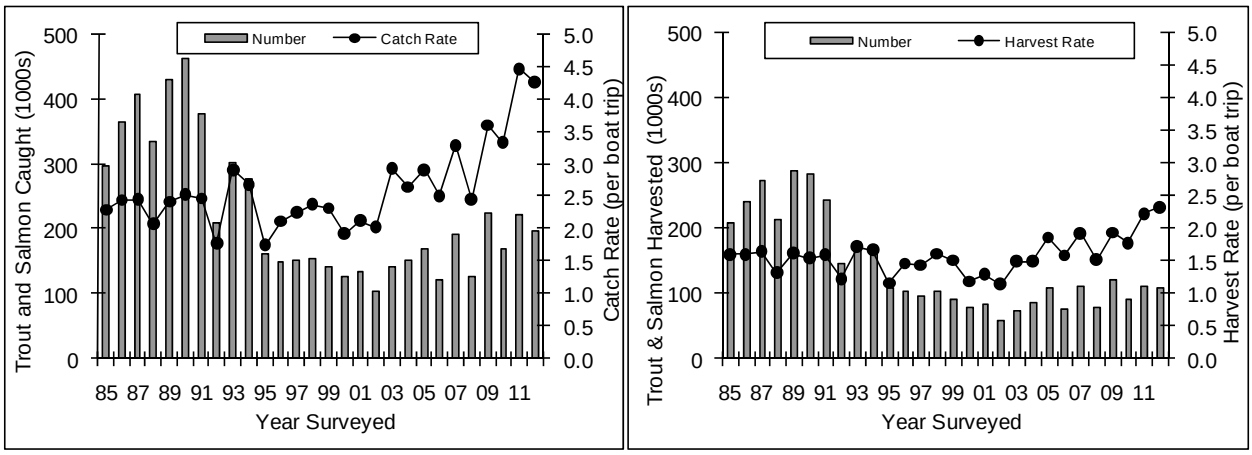

Figure 5. Total trout and salmon catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985 - 2012.

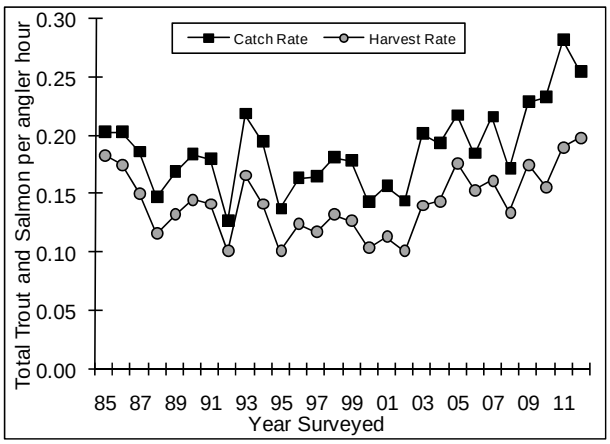

Figure 5b. Charter boat catch rate and harvest rate per angler hour for total trout and salmon, April 15 – September 30, 1985 - 2012.

which was comparable to (-1.5%) the previous 5-year average.

Estimated salmonine harvest was 107,456 (±17.5%) fish, and comparable to (+5.9%) the 2007-2011 average (Figure 5, Table 1, Table A5a). The 2012 percent contributions of each species to the total trout and salmon harvest were 51.3% Chinook salmon, 21.7% brown trout, 11.7% rainbow trout, 7.7% coho salmon, 7.3% lake trout and 0.3% Atlantic salmon (Table 1).

Fishing Quality

The quality of trout and salmon fishing in Lake Ontario, as measured by catch rate, was variable but relatively stable from 1985-2002; however, has increased substantially since 2002 (Figure 5). Catch rate for 2012 was the second highest estimated in the survey (4.3 fish caught per boat trip) and was 24.3% higher than the previous 5-year average (Figure 5, Table A5b). Seven of the eight highest catch rates occurred between 2003 and 2012. Four consecutive years of record high catch rates (2009-2012) for trout and salmon was due to high catch rates of Chinook salmon, coho salmon, rainbow trout and brown trout. The 2012 seasonal total trout and salmon harvest rate for all boats specifically targeting trout and salmon was 2.3 fish per boat trip and a 24.3% increase compared to the 2007-2011 average harvest rate (Figure 5, Table A5b). Catch rate and harvest rate data (fish per boat trip) were also evaluated by month. In 2012, rates were above previous 5-year and 10-year averages during each month April 15 - September 30. The greatest increase occurred during April and August when catch rates were +135.0% and +34.7% higher than previous 5-year averages, respectively (Table A5b).

In 2012, charter boats targeting trout and salmon accounted for 33.3% and 47.5% of all salmonines caught and harvested, respectively, but represented only 13.6% of trout and salmon fishing boat effort. Charter boat total trout and salmon catch rate (8.6 fish per boat trip; second highest observed) and harvest rate (6.7 fish per boat trip; highest recorded) were well above the long-term averages (+28.8% and +32.3%, respectively; Table A5b). Charter catch rate per angler hour was 0.25 salmonines, which was the second highest in the data series and

Table 1. Harvest and catch estimates for April 15 – September 30, 2012 from the NYSDEC Lake Ontario fishing boat survey.

	Number Harvested	*Number Caught*
Coho salmon	8,259	12,494
Chinook salmon	55,137	88,851
Rainbow trout	12,617	32,975
Atlantic salmon	310	592
Brown trout	23,305	39,507
Lake trout	7,829	22,206
Smallmouth bass (includes pre-season)	5,683	24,032
Yellow perch	16, 701	35,836
Walleye	130	130
Round goby	9,182	13,484
Other fish	1,284	6,315

12.5% and 22.8% increases compared to previous 5-year and 10-year averages, respectively (Figure 5b; Table A5b).

Noncharter fishing boats caught as average of 3.4 salmonine per boat trip (0.25 fish per angler hour) in 2012, the second highest observed and well above previous 5-year and 10-year averages (Table A5b). Among noncharter boats fishing for trout and salmon, the seasonal harvest rate was 1.5 salmonines per boat trip, which was a 30.0% increase compared to the 2007-2011 average (Table A5b).

We further evaluated angling quality in the Lake Ontario boat fishery using other parameters, including the percent of boats with zero harvest and catch (indicator of poor angling quality), and the percent of boats that harvested the maximum daily limit of trout or salmon (indicator of good angling quality). These parameters are listed in Table A6, and generally show that harvest and catch rates are inversely correlated with these parameters (e.g. when harvest or catch rates are higher [i.e. better fishing quality], a lower percentage of boats fail to harvest or catch at least one fish, and vice versa). Table A6 reports fishing quality parameters for the 5½ month period, April 15 - September 30, 1985-2012. From 1985-2012, the proportion of boats with zero catch of any salmonine species ranged from 24.3% (2012, indicating excellent fishing quality) to 49.7% (1992, indicating relatively poor fishing quality; Table A6). The seven years with the lowest proportions of boats with zero trout and salmon catch occurred since 2003, with the lowest proportion recorded in 2012.

Angler harvest is affected by angler catch rates, harvest regulations, and angler desire to keep or release fish. Inter-annual comparisons of boats that harvested the maximum daily limit were compromised by fishing regulation changes that occurred between the 1996 and 1997 seasons and the 2006 and 2007 seasons; however, they can provide another indication of angling quality (Table A6). From 1985-1996, anglers were allowed a daily limit of five trout and salmon per angler, with no more than three lake trout and no more than one Atlantic salmon. Beginning with the 1996 and 1997 seasons, the daily limit was changed to a maximum of seven trout or salmon, with no more than three lake trout, no more than one Atlantic salmon, and no more than three fish of coho salmon, Chinook salmon, rainbow trout or brown trout in combination (popularly known as the 3-3-1 limit). The most recent regulation changes affected harvest

of two trout species. Effective October 1, 2006, the rainbow trout size limit was increased to 21 inches and the lake trout daily limit was reduced to two fish per angler but allowing no more than one within the slot limit (25-30 inches).

In 2012, 22.1% of the charter boats targeting trout and salmon harvested the maximum daily limit of three coho salmon, Chinook salmon, rainbow trout, or brown trout in combination for their paying customers (Table A6). This was an 11.4% increase compared to the 2007-2011 average and was the third highest in the 16 years with comparable regulations (1997-2012). Of the charter boats that harvested the three in any combination limit for their customers, 50.8% went on to harvest additional fish permitted under the fishing licenses held by the boat's captain and mate(s), and 20.8% harvested the limit for all anglers (4.6% of all charter boat trips in 2012). Among noncharter boats fishing for trout and salmon in 2012, 3.7% harvested the maximum daily limit of three coho salmon, Chinook salmon, rainbow trout, or brown trout in combination which was the highest in the 16 years with comparable regulations (1997-2012) indicating excellent fishing quality. Limits of lake trout were consistently less common than aggregate limits for the other four species. In 2012, 5.3% of the charter boats interviewed harvested the legal limit of lake trout for their customers, which is the highest percentage since 2002. Among noncharter boats, none harvested the legal limit of lake trout. Of all the boats interviewed from 1997-2012, none had the maximum aggregate limit of lake trout, Atlantic salmon and the four fish species combination. This included all the charter boats interviewed, even when counting only the charter party as potential anglers (captains and mates excluded from the angler count). There were, however, 147 charter boat trips in 2012 with the limit of lake trout and the four fish species combination for each angler in the charter party.

Coho Salmon

Catch and Harvest

In 2012, coho salmon was the fifth most commonly caught and fourth most commonly harvested salmonine in the boat fishery (6.4% and 7.7% of total catch and harvest, respectively; Table 1, Table A7a). Estimated coho salmon catch (12,494 [±36.7%] fish) in 2012 was a 20.3% decrease compared to the previous 5-year average which includes two of the highest seasonal catch estimates in the survey (Figure 6). More than 66% of coho salmon caught were harvested, comparable (+1.8%) to the previous 5-year average. Coho salmon harvest in 2012 was an estimated 8,259 (±28.9%) fish and was a 15.7% decrease compared to the 2007-2011 average (Figure 6, Table A7a). During 2012, estimated catch of coho salmon was above the previous 5-year average in August (+80.6%); however, was below previous 5-year averages for the other months (range: -63.4% [April] to -15.9% [September]; Table A7a).

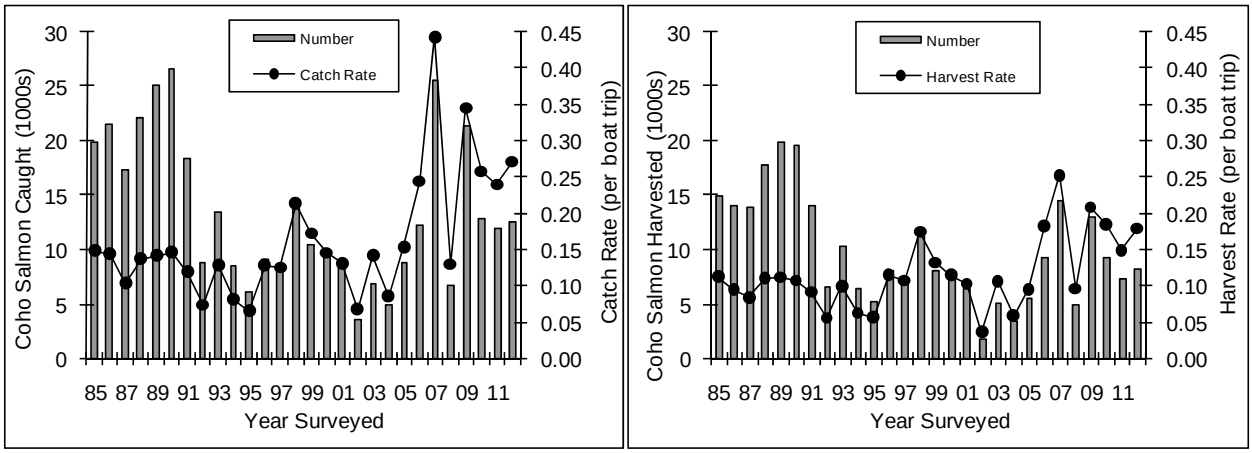

Figure 6. Total coho salmon catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985-2012.

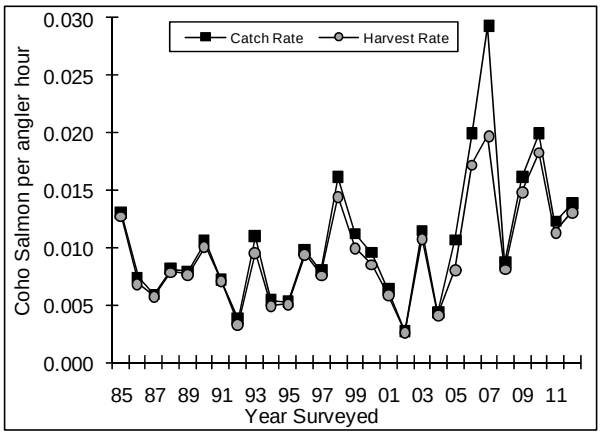

Figure 6b. Charter boat catch rate and harvest rate per angler hour for coho salmon, April 15 – September 30, 1985-2012.

Fishing Quality

Coho salmon catch rates and harvest rates were excellent during five of the past seven years (Table 7b, Figure 6, Figure 6b). In 2012, coho salmon catch rate (0.27 fish per boat trip) and harvest rate (0.18 fish per boat trip) were comparable to rates observed in recent years (-4.1% and +0.7% compared to previous 5-year averages, respectively); however, were above respective 10-year (2002-2011; +28.6% and +30.9%, respectively) and long-term (1985-2011; +69.5% and +56.2%, respectively) averages (Figure 6, Table A7b). Among charter boats, coho salmon catch rate (0.014 fish per angler hour) was 19.8% below the previous 5-year averages; however, was a 32.4% increase compared to long-term average (Figure 6b, Table A7b). Among noncharter boats, the 2012 catch rate and harvest rate were 0.017 and 0.009 coho salmon per angler hour, respectively (Table A7b).

Coho salmon catch and harvest rates are typically highest during April and May and in the western portion of the lake (Lantry and Eckert 2011; Table A7b). For the fifteenth consecutive year, the west region experienced the highest coho salmon catch rate (0.46 fish per boat trip). Catch rate was highest during May (0.48 per boat trip, and the fourth highest May catch rate) and August (0.30 per boat trip, and the highest August catch rate recorded). Coho salmon catch rates per boat trip were above respective 2007-2011 averages during August (+130.2%) and September (+18.7%), was comparable to the previous 5-year average in May (-9.1%), and were below 2007-2011 averages in April (-55.3%), June (-53.2%), and July (-39.9%). Similar trends were observed with harvest rate data (Table A7b).

Biological Data

Biological data analysis presented here includes fish processed during April 15 - September 30 for all survey years (1985-2012). Each year, the majority of coho salmon harvested in the open lake were age 2 (>73.8%; 28-year average=95.2%; Table A8). In 2012, 98.0% of the coho salmon sampled were age 2, comparable to previous 5-year and 10-year averages (+0.9% and +2.1%, respectively). There were no age-1 coho sampled during 2010-2012. This was the fourth occurrence of zero age-1s observed in the 28-year data series. The contribution of age-3 coho salmon in angler harvest is small and represented ≤2.0% of harvest for 26 out of 28 years surveyed. The age 3 contribution was ≤1.0% for 18 of those years. In 2012, 2.0% of the coho salmon sampled were age 3 (n=3).

Condition indices for coho salmon in 2012, as determined from predicted weights of standard length fish, were well within the range of values observed in previous years. Condition of the smallest coho salmon (18-in and 20-in length groups) was slightly above the respective long-term averages (Table A8). Condition of a 22-in coho was average. Predicted weights of large coho salmon (24-in to 30-in length groups) were below their respective 25-year long-term averages. The mean length of age-2 coho salmon in September was 28.2 inches. The average monthly gain in length in 2012 (1.6 inches per month) was the eighth lowest in the data series (Table A8).

Chinook Salmon

Catch and Harvest

Chinook salmon dominated the catch and harvest of trout and salmon in New York's Lake Ontario boat fishery annually since 2003, and was the most commonly captured salmonine in 17 of the 28 years surveyed. In 2012, Chinook salmon catch was estimated at 88,851 fish (±21.3%), representing 45.2% of the total 2012 salmonine catch. This was a

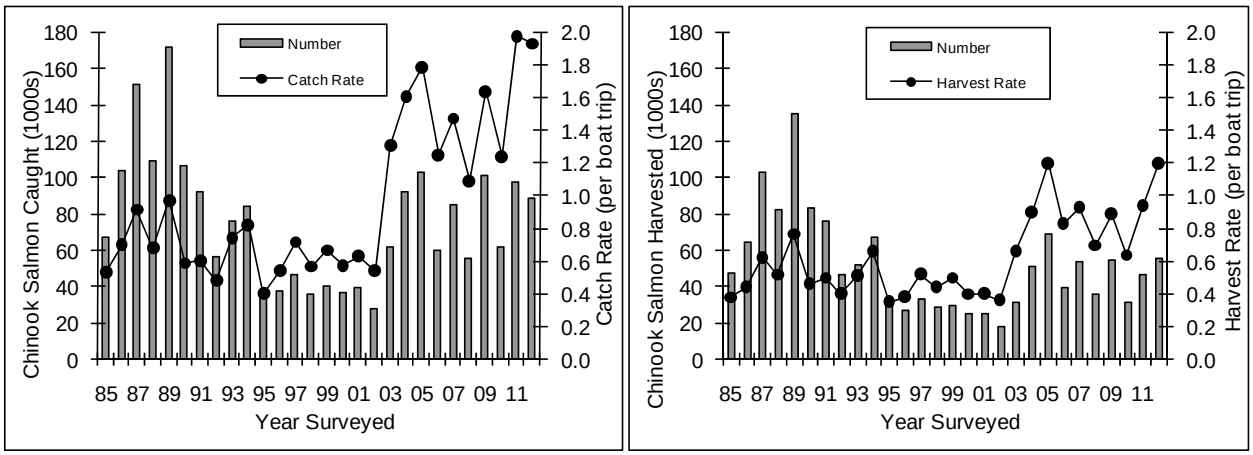

Figure 7. Total Chinook Salmon catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 - September 30, 1985-2012.

10.5% increase compared to 2007-2011 (Figure 7, Table 1, Table A9a). Sixty-two percent of Chinook salmon caught in 2012 were harvested (Table A9a). The highest percent harvest occurred in 1995 when 87.3% of all Chinook salmon caught were harvested. Since 2003, anglers have experienced the best Chinook salmon fishing on Lake Ontario and the percentage of Chinook salmon harvested (2003-2012 average percent harvest=58.1%) was 21.3% lower than during the 1985-2002 time period (average=73.9%). The recent decline in percent harvest is likely attributable to both improved catch rates (i.e. with increased catch rates the anglers can be more selective with the fish harvested and still harvest their limit of fish) and increasing numbers of anglers practicing catch and release. Harvest in 2012 was estimated at 55,137 Chinook salmon (±23.8%), which represented 51.3% of the total salmonine harvest (Figure 7, Table 1, Table A9a). The 2012 harvest estimate was a 24.3% increase compared to the 2007-2011 average.

As is typically observed, the majority of the Chinook salmon catch and harvest occurred during August 2012 (31,097 and 21,746, respectively; Table A9a). The highest regional contribution of Chinook salmon catch typically occurs in the west region (39.3% in 2012), followed by the east/central (25.13% in 2012) and east (25.2% in 2012) regions (Lantry and Eckert 2011; Table A9a).

Fishing Quality

The quality of Chinook salmon fishing in Lake Ontario was excellent each year from 2003-2012, with catch rates the highest estimated among the 28 years surveyed for ten consecutive years (Figure 7, Figure 7b, Table A9b). From 1985-2002 the catch rate per boat trip for all trout and salmon boats was variable and without trend, but beginning in 2003 seasonal catch rates averaged more than 2.3-fold higher than those observed in years prior to 2003. The 2012 seasonal catch rate among all boats fishing for trout and salmon was 1.9 Chinook salmon per boat trip, the second highest rate per boat trip observed in the survey (2011 was the highest) and a 136.6% increase compared to the 1985-2002 average (0.65 Chinook Salmon per boat trip; Figure 7, Table A9b). Among charter boats, the 2012 Chinook salmon catch rate was 3.8 fish per

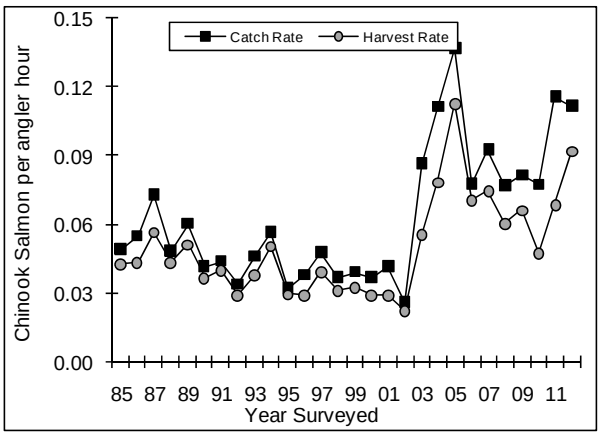

Figure 7b. Charter boat catch rate and harvest rate per angler hour for Chinook salmon, April 15 – September 30, 1985-2012.

boat trip, the second highest rate among years surveyed, a 22.4% increase compared to the previous 5-year average, and a 100.1% increase compared to the 1985-2002 average (1.7 Chinook salmon per charter boat trip; Table A9b). Charter catch rate per angler hour was 0.11 Chinook salmon, the second highest estimated in the data set and 2.1 times higher than during 1985-2002 (1985-2002 average=0.05; Figure 7b). Among noncharter boats, the 2012 catch rate was 1.6 Chinook salmon per boat trip and 0.11 per angler hour, which were among the highest rates experienced among noncharter anglers (Table A9b).

Chinook salmon harvest rates were at or near record highs in recent years, with the 2003-2012 estimates 86.4% higher, on average, than those prior to 2003 (1985-2002 average = 0.5 fish per boat trip, 2003-2012 average = 0.9; Figure 7, Figure 7b, Table A9b). The 2012 seasonal harvest rate among boats seeking trout and salmon was 1.2 Chinook salmon per boat trip (Figure 7, Table A9b). This was the second highest seasonal Chinook salmon harvest rate among the years surveyed and a 47.0% increase compared to the previous 5-year average. Among charter boats fishing for trout and salmon, the 2012 seasonal harvest rate was 3.1 Chinook salmon per boat trip which was well above previous 5-year and 10-year averages (+40.3% and +36.8%, respectively; Figure 7b, Table A9b). Charter boats harvested 0.09 Chinook salmon per angler hour in 2012 (Figure 7b). Among noncharter boats, the 2012 seasonal harvest rate was 0.8 Chinook salmon per boat trip, a 51.7% increase compared to the 2007-2011 average (Table A9b).

Spring Chinook salmon catch, harvest and fishing quality are typically highest in the west area and across all areas during the later half of the open lake fishing season (Lantry and Eckert 2011; Table A9a, Table A9b). In 2012, catch rates were highest in the west area (2.8 Chinook caught per boat trip, 1.4 harvested per boat trip). The other regions experienced seasonal catch rates at (east region: highest on record and 1.6 caught per boat trip) or near (west/central region: third best year and 1.7 caught per boat trip; east/central region: second best year and 1.6 caught per boat trip) record high levels. Unlike previous years, however, anglers were catching Chinook salmon across the entire NY shoreline as early as April, resulting in the highest April catch rate in the data series (1.6 Chinook salmon caught per boat trip and an average of 9-fold higher than previous Aprils). Catch rates for the other months were near record high and were above previous 5-year averages during May (+12.7%), June (+35.9%), August (+50.9%), and September (+42.2%).

Biological Data

Biological data analysis presented here includes fish processed during April 15 - September 30 for years 1985-2012. Each year age composition of Chinook salmon harvested is influenced by several factors, including catchability, year class strength, growth rates, and fishing quality for all salmonines. In 2012, the contribution of age-1 fish in angler harvest (5.0%) was the seventh lowest among years surveyed and an 82.3% decrease compared to the 2010-2011 record highs (Table A10). The 2012 contribution of age-2 Chinook salmon (70.8%) was highest in the data series (2011 was the second highest) and a 92.8% increase compared to the long-term average. Contributions of age-3 Chinook salmon varied without trend from 1985-2010. In 2011, age-3 Chinook salmon represented only 8.6% of angler harvest, the lowest value in the data series. Contribution of age 3s (2009 year class) improved in 2012 to only 24.1%, the third lowest contribution in the data series. This was unexpected, given that data suggest the 2009 year class was possibly the strongest on record. Age-4 Chinook salmon have represented between 0.0% (2000) and 14.0% (1996) of the harvest (1985-2011 average=3.4%). In 2012, 0.2% of the Chinook salmon harvested were age-4 fish (Table A10).

As an indicator of Chinook salmon condition, we evaluated predicted weights of seven standard lengths (16-in to 40-in length fish by 4-in size increments). The predicted weights were calculated from length-weight regressions of fish harvested in July and August 1988-2012 (Table A10) and showed no statistically significant trends over the 25-year data series. For each length group, predicted weights generally increased from the early 1990s to the late 1990s, then declined through the mid 2000s. Among the 28-in to 40-in standard

sizes, the lowest predicted weights all occurred in 2007 (Table A10). Salmon River Hatchery returns of Chinook salmon showed a similar decline in condition in 2007 (Bishop and Prindle 2009). Condition then improved through 2011 for the 28-in to 40-in length groups, when predicted weights were among the highest in the data series for the 28- and 32- inch groups and the highest in the data series for the 36- and 40- inch groups. Condition of Chinook salmon during 2012 declined; however, predicted weights for all length groups examined were comparable to respective long term averages.

To evaluate Chinook salmon growth, we determined mean length-at-age by month for samples collected July through September (data collected from 1991-2012; Figure A1, Table A11). There was no significant trend in August length of age-1 Chinook salmon over the 22-year data series, however, the 2012 average (21.5 in) was the second highest observed and was 1.7 inches longer than the 1991-2012 average. Of the ten longest age 1s sampled from 1991-2010, eight were collected in 2010, including the top three. No record length age-1 Chinook salmon were sampled in 2012. In 2012, the August mean length of age-2 Chinook salmon was 32.3 inches, the third consecutive year of the longest age-2 Chinooks among the 22 years evaluated. The longest age-2 Chinook salmon sampled in 2012 was 37.6 inches and the seventh longest measured in this data series (Figure A1, Table A11). The August mean length of age-3 Chinook salmon was 37.7 inches, the second longest in the data series, and 1.0 inches longer than the 22-year average. The largest Chinook salmon sampled in 2012 were all age-3 fish. The longest of those was 43.6 in and was tied with two other fish (collected in 1998 and 1999) for the second longest in the data series (longest age 3 was 43.9 inches in 1997).

The oldest Chinook salmon sampled in Lake Ontario are age-4 and they make up a small percentage of the total Chinook salmon sampled (0.2% of all Chinooks processed in 2012; Table A11). Only one age-4 Chinook salmon was processed in 2012 (40.0 in, 29.0 lbs). It was tied with two age-3 fish as the sixteenth longest Chinook, and was the tenth heaviest sampled in 2012. Scale growth patterns suggest that the fastest growing individuals of any year class are more likely to mature and spawn at an earlier age, thereby removing themselves from the lake population, and that many of the age-4 fish are among the slower growing members of their cohort.

Angler Returns of Clipped and Tagged Chinook

To determine the contribution of naturally produced Chinook salmon to the sportfishery and to evaluate stocking strategies, NYSDEC and Ontario Ministry of Natural Resources (OMNR) initiated a Chinook salmon mass marking program (Connerton et al. 2013). All Chinook salmon stocked into Lake Ontario (New York and Ontario waters) were adipose fin clipped (AD) and a portion of those fish also had a coded wire tag (CWT) injected into their snout for the 2008 through 2011 year classes. The AD clip permits identification of a hatchery stocked fish and, when present, the CWT permits the identification of year class, raceway of origin, and stocking method/location of the fish. Each Chinook salmon processed during the angler survey was checked for an AD clip and the presence of a CWT. To date four age classes of marked Chinook salmon have recruited into the sportfishery (2008, 2009, 2010 and 2011 year classes, ages 1 through 4 in 2012).

Each year Connerton et al. (2011, 2012, 2013) report the percentages of unmarked (i.e., wild) Chinook salmon determined from data collected during this survey (i.e., Lake Ontario Fishing Boat Survey) and additional sampling efforts conducted in New York waters. The percentage of wild Chinook salmon differed between the three regions Connerton et al. (2013) evaluated (i.e. Ontario waters, NY west region [includes Fishing Boat Survey sites in the west and west/central regions], and NY east region [includes Fishing Boat Survey sites in the east/central and east regions]; Table A1). Among 2012 samples processed in the NY east region, 17.0% of age 1, 64.1% of age 2, 56.9% of age 3 were wild. The age-specific contributions of wild fish among samples processed in the NY west region were 24.3% of age 1s, 52.9% of age 2s, and 44.3% of age 3s (Connerton et al. 2013). A more detailed discussion of the mass marking program, methods and 2010-2012 results of open lake and

tributary collections are reported in Connerton et al. (2011, 2012, 2013).

Stocking Level Verses Relative Harvest

To permit between year comparisons of harvest-at-age data, we calculated age-specific harvest rates (age-specific numbers of Chinook salmon harvested per 150,000 boat trips April 15 - September 30; Table A12; Eckert 2007), hereafter termed relative harvest. Age compositions of Chinook salmon harvested during 1985-1990 were estimated using monthly length-frequency distributions, and age compositions of Chinook salmon harvested during 1991-2012 were estimated using monthly length-age keys derived from fish aged by scales.

Chinook salmon relative harvest (harvest per 150,000 targeted fishing boat trips; Table A12) was variable and appeared most affected by year class strength. The year class-specific total relative harvest of age-1 through age-4 fish (1984-2008 year classes) varied from a high of 202,709 fish for the 2002 year class (harvested at ages 1 to 4 from 2003 to 2006, respectively) to a low of 20,497 fish for the 1994 year class (harvested at ages 1 to 4 from 1995 to 1998, respectively), a 9.9 fold difference (Table A12). By comparison, survey year-specific total relative harvest (1985-2012 survey years) varied from the high of 179,857 fish in 2005 to a low of 52,112 fish in 1995, only a 3.5 fold difference. Ten of the eleven highest total relative harvest estimates occurred during 2003-2012 (Table A9b, Table A12), and based on the age-specific relative harvest, were due to high numbers of returns from each year class 2002-2006 and 2009-2010. These year classes contributed to the seven highest relative harvests of age-2 and age-3 Chinook salmon among the years surveyed (highest age-2 returns for the 2010 year class), despite the intermediate stocking level of each of these year classes (1,700,374 [2003 year class] – 2,075,169 [2005 year class]; Table A12, Table A13). Stocking levels varied between 862,840 (1981 year class) and 3,368,296 (1987 year class) fingerling equivalents.

The 2012 total relative harvest (179,564 fish) was the second highest in the 28-year data series (Table A12). This is primarily attributed to the highest return of age-2 Chinook salmon for the second consecutive year. The contribution of age-2 fish (127,157 fish) from the 2010 year class was an average of 4-fold higher than age-2 returns from 1985-2009 (Table A12). The contribution of age-3 fish (43,212 fish from the 2009 year class) was within the relative harvest estimates determined for previous years. The contribution of Chinook salmon from the 2008 year class at age-4 (296 fish) was among the lowest for age-4 fish in the data series. The low return of age-4 fish was not unexpected given that each year the majority of Chinook salmon are mature and leave the lake by ages 2 or 3, and the 2008 year class experienced excellent growth (based on mean length at ages 2 and 3) and condition which likely contributed to a higher percentage maturing at younger ages. Additionally, poor reproductive conditions in the Salmon River during fall 2007 (i.e. warm temperatures and low flows during the spawning run) may have resulted in less wild production than typically occurs, and stocking level of the 2008 year class was approximately 41% below the stocking target (i.e. the second lowest fingerling equivalent stocked in the data series [1,038,844 fish]; Connerton 2009).

To control for changes in stocking levels and allow for between year comparisons, relative harvest data were adjusted to a common base of 2,000,000 fingerling equivalents stocked (Figure 8). Regression analysis of 1985-2012 data resulted in a statistically significant (P=0.0004) upward trend, indicating that in recent years returns to the fishery were higher than expected when both effort and stocking level were accounted for. This could be due, in part, to improved survival of stocked fish and/or increased relative contribution of wild fish. The age-specific relative harvest data per unit number of fingerling equivalents stocked (Figure A2) showed that this trend was due to increased relative harvest of age 1s (2009-2010 year classes), age 2s (2002-2003, 2005-2006, and 2009-2010 year classes), age 3s (2002-2004 and 2006 year classes) and age 4s (2002-2003 year classes).

We also evaluated number stocked versus age-specific relative harvest and found that there was no relationship between stocking number and future fishing quality. There was no relationship between numbers of fingerling equivalents stocked and

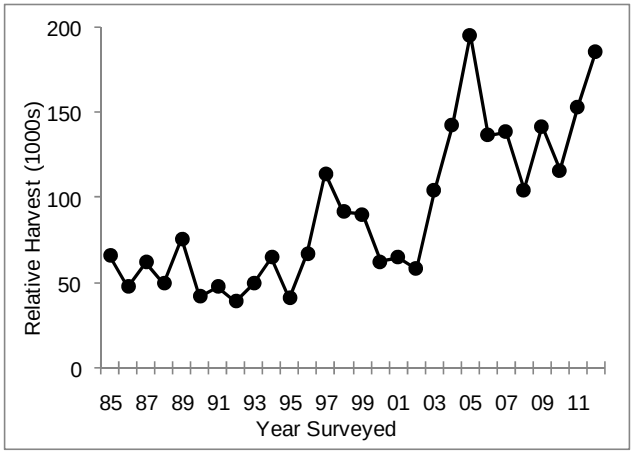

Figure 8. Relative harvest of Chinook salmon per 150,000 boat trips targeting trout and salmon, per 2,000,000 fingerling equivalents stocked.

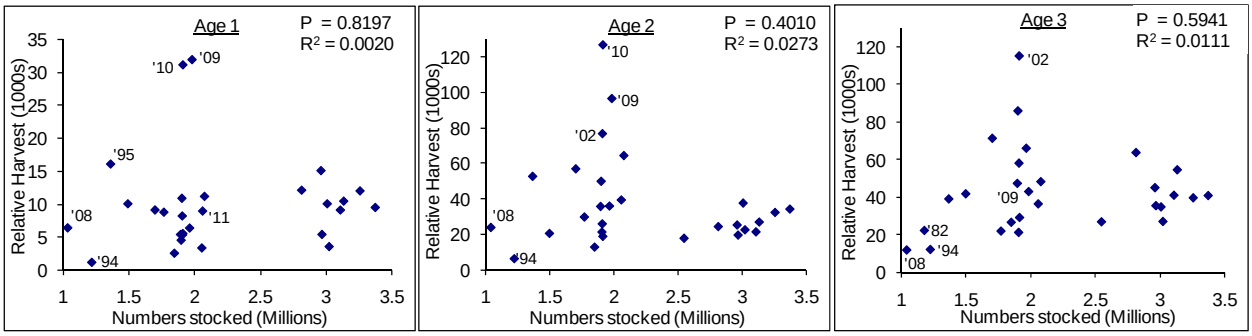

Figure 9. Number of fingerling equivalents stocked and relative harvest of age-1 (1984-2011 year classes), age-2 (1983-2010 year classes), and age-3 (1982-2009 year classes) Chinook salmon.

relative harvest at age 1 (P=0.8197 and R^2=0.0020), age 2 (P=0.4010 and R^2=0.0273), or age 3 (P=0.5941 and R^2=0.0111; Figure 9). Data patterned into two groups of vertical scatter separated by stocking levels for the 1984-1992 year classes (2.96-3.37 million fingerling equivalents stocked) and the 1993-2011 year classes (1.04-2.08 million fingerling equivalents stocked; Figure 9, Table A13). The lowest and highest age-1 (1994 and 2009 year classes, respectively), age-2 (1994 and 2010 year classes, respectively) and age-3(2008 and 2002 year classes, respectively) relative harvest estimates occurred after the 1993 stocking cuts. The 2008 year class was stocked at the lowest level (1,038,844 fingerling equivalents) since the 1981 year class (862,840 fingerling equivalents), yet relative harvests at age 1 and age 2 were well within the range of values determined for other year classes that were stocked at levels as high as approximately 3 million fish (Figure 9, Table A13). By age 3, however, relative harvest (12,123 fish) was the lowest in the data series. Relative harvest of the 2008 year class at age 4 (296 fish) was the third lowest in the data series.

Based on relative harvest, the 2009 and 2010 year classes were two of the strongest produced (Figure 9, Table A12). The 2009 year class contributed to the fishery in 2010 as age 1s and in 2011 as age 2s. Relative harvest estimates at those ages (32,062 and 96,706 fish, respectively) were the highest in the data series. Hatchery returns of the 2009 year class indicate that a majority may have matured at age 2, also consistent with growth and condition data. Relative harvest of the 2010 year class at age 1 was 31,194 fish at age 1, similar to the relative harvest of the 2009 year class in 2010 as age-1 fish. The Salmon River wild young-of-year Chinook salmon seining program also indicated possible production of a strong 2010 year class of wild Chinook

salmon; however, high river flow during May 2009 may have reduced sampling efficiency and hindered the ability to detect a strong 2009 year class (Bishop et al. 2011). The cause(s) of record high relative harvest of the 2009 and 2010 year classes is unclear, but may be partly attributable to improved survival of stocked fish (traditional and/or pen reared fish), improved production and/or survival of wild fish, or a combination of these factors.

Several variables were evaluated to determine which, if any, could predict subsequent age-specific harvest, including all reasonable combinations of stocking levels and age-specific relative harvests. Twenty relationships were tested and only eight were significant (p-values$\leq$0.0462). For all eight significant relationships, the R^2 values ranged between 0.2226 and 0.5847, indicating that although some of the variation could be accounted for, approximately 42%-78% of variation was unaccounted for (i.e. additional factors were contributing to data variability and determining age-specific relative harvest).

Factors contributing to the observed increased relative harvest and the lack of relationship between numbers stocked and fishing quality include: 1) improved survival of stocked fish, 2) increased production and contribution of wild fish in recent years, 3) increased catchability of Chinook salmon (e.g. due to changing preyfish populations, improved angling conditions or techniques, or increased numbers of fish available thereby allowing anglers to harvest more fish from a population of the same relative size), or 4) a combination of these factors. Clipping and tagging stocked Chinook salmon will allow us to estimate relative survival of stocked fish and the contribution of wild fish to the population and the fishery (see Connerton et al. 2013). This information is needed to better manage Lake Ontario's fishery.

Rainbow Trout

Catch and Harvest

Rainbow trout was the third most commonly caught and harvested salmonine in 2012, and represented 16.8% and 11.7% of the total trout and salmon catch and harvest, respectively (Figure 10, Table 1, Table A14a). Estimates peaked in 1989, declined to the lowest levels in 2002, and then showed an upward trend. Rainbow trout catch in 2012 was an estimated 32,975 ($\pm$31.8%) fish, which was a 16.4% decrease compared to the 2007-2011 average, but nearly 4-fold higher than the 2002 low. Anglers harvested 38.3% of the rainbow trout that they caught, the lowest percentage recorded. The increased release rate observed in recent years is partly due to a fishing regulation change effective October 1, 2006 which increased the minimum harvestable size from 15 in to 21 in (i.e., it was not legal to harvest rainbow trout less than 21 in). Prior to the regulation change (1985-2006) an average of 69.7% of all rainbow trout caught by anglers (all fishing boat trips) were harvested. In 2002, when catch and catch rate were the lowest estimated, 80.9% of all rainbow trout caught were harvested. Following the 2006 regulation change an average of 47.6% (2007-2012) rainbow trout caught were harvested.

In 2012, an estimated 12,617 ($\pm$30.3%) rainbow trout were harvested (Figure 10, Table 1, Table A14a). This was a 34.7% decrease compared to the2007-2011 average; however, was more than 1.8-fold higher than the 2002 low. For 27 consecutive years (1986-2012), the majority of rainbow trout caught and harvested were in the west area (Lantry and Eckert 2011). In 2012, 66.9% and 68.3% of all rainbow trout were caught and harvested in the west area, respectively. Typically the majority of rainbow trout were caught and harvested during August (2001-2010 averages: 37.1% and 39.5%, respectively). During 2011, however, the majority of rainbow trout were caught and harvested during July (50.5% of total catch and 45.3% of total harvest; Table A14a). Again in 2012, the majority of rainbow trout were caught in July (33.7%; Table A14a).

Fishing Quality

Over the past five years, Lake Ontario anglers have experienced four of the highest catch per boat trip rates in the history of the survey. The 2012 rainbow trout catch rate was the fourth highest observed (0.72 rainbow trout per boat trip; Figure 10, Table A14b), comparable to (-1.8%) the previous 5-year average. Among noncharter boats, the 2012 catch rate was near record highs (0.6

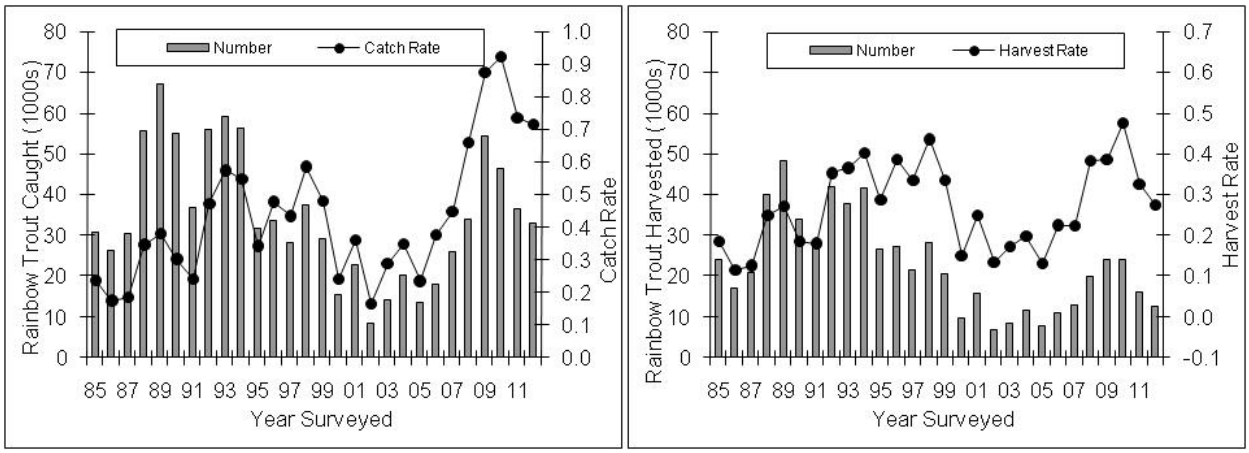

Figure 10. Total rainbow trout catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 - September 30, 1985-2012.

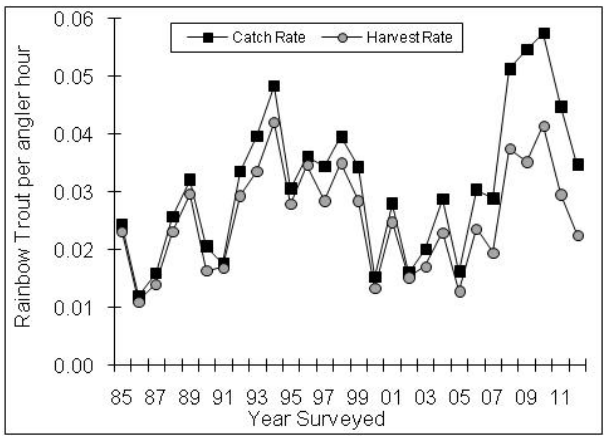

Figure 10b. Charter boat catch rate and harvest rate per angler hour for rainbow trout, April 15 – September 30, 1985-2012.

rainbow trout per boat trip and 0.05 fish per angler hour), making 2012 the fourth consecutive year of the best rainbow trout fishing for non-charters as well (Table A14b). Unlike all anglers combined and noncharter fisherman, catch per boat trip and catch per angler hour among charter boats were not near record high levels, rather were comparable to respective long term averages (+4.1% and +12.1%; Figure 10b, Table A14b). This discrepancy between noncharter and charter boats is likely attributable to the fact that charter operators on the western half of the lake, where the majority of rainbow trout are caught, tend to target rainbow trout in July and August when Chinook salmon fishing is poor. In 2012, anglers experienced one of the best Chinook salmon fishing years on record and specifically targeted rainbow trout less frequently. The 2012 seasonal harvest rate among all boats fishing for trout and salmon (0.27 rainbow trout per boat trip) was a 23.8% decrease compared to the previous 5-year average; however, was 47.7% higher than the lows observed during 2000-2007 (Figure 10, Table A14b). Among noncharter boats fishing for trout and salmon, the harvest rate was 0.2 rainbow trout per boat trip (0.01 fish per angler hour) which was 16.4% above the long-term average (Table A14b). Among charter boats fishing for trout and salmon, the harvest rate was 0.8 rainbow trout per boat trip (Table A14b). Charter boats harvested an average of 0.02 rainbow trout per angler hour (Figure 10b), an 11.4% decrease compared to the long-term average.

Rainbow trout monthly and geographical catch rate and harvest rate trends for most years show monthly rates highest during the summer and lower in April, and geographical rates highest in the west area, lower in the east/central and west/central areas (both similar), and lowest in the east area (Lantry and Eckert 2011; Table A14b). This was also observed in 2012 with catch and harvest rates highest in the west area (1.7 and 0.7 fish per boat trip, respectively) and during June-August (0.8-1.3 and 0.3-0.5 fish per boat trip, respectively; Table A14b). Rainbow trout catch rates were above previous 5-year monthly averages during June (+106.0%) and July (+20.6%), and rates were below the previous 5-year averages during the other months (range: -73.2% [September] to -14.1% [August]).

Biological Data

Biological data analysis presented here includes fish processed during April 15 - September 30 for years 1985-2012. Lengths of rainbow trout sampled from the open lake boat fishery were dependent on several factors including age and strain composition, stage of maturity, and fishing regulations (i.e. minimum size limit). The 2012 open lake season was the sixth affected by the regulation change that raised the minimum harvestable length of rainbow trout from 15 in to 21 in. During 2007-2009, 10.7%-14.5% of the rainbow trout harvested and measured by creel agents were less than the 21-in minimum size limit (i.e. illegally harvested; Table A15). These values should have been zero and were minimally expected to be the lowest among the years surveyed, however prior to 2010, 1998 (7.1%) and 1999 (10.1%) were the lowest. Further data analysis indicated that harvest of sub-legal length rainbow trout was likely due to measurement error in 2007 and 2009-2010, but not in 2008 (Lantry and Eckert 2010 and 2012; Table A15). During 2010 and 2011, 7.1% and 10.5%, respectively, of harvested rainbow trout were less than the 21-in minimum harvestable size. During 2012, 8.0% of harvested rainbow trout were shorter than the legal 21 in minimum harvestable size.

Weight data were collected each year from 1988-2012 and each year we evaluated rainbow trout condition by determining the predicted weights of standard length fish (Table A15). For each standard length group (18- to 32-in lengths, by 2-in size increments), predicted weights were variable but showed increasing trends from 1988 to about 2002-2003 (trends similar to those observed with Chinook and coho salmon) then declined through 2009 to record and near record lows. In 2010 and 2011, condition of rainbow trout improved for each length group examined. In 2012, however, condition declined for all length groups and returned to mid-2000 levels.

Atlantic Salmon

In 1990, New York's Lake Ontario Atlantic salmon program changed from a small scale experimental project with an annual stocking target of 50,000 yearlings, to a larger put-grow-take program for trophy fish (>25 in) with an annual stocking target of 200,000 yearlings and fall fingerlings. These stocking increases began in 1991 (1990 year class) with annual stockings ≥160,000 fish for most years up to 1996 (Eckert 2000). Given this increased stocking level, Atlantic salmon catch in the open lake was expected to increase beginning in 1992, however, both catch and harvest declined after 1994 (Figure 11, Table A16; Eckert 1998). In 1996, the objective of a put-grow-take program for trophy fish was maintained and the annual stocking target was reduced to 100,000 yearlings and fall fingerlings. Stocking policy was further reduced to an annual target of 50,000 yearlings effective with the 2002 year class (stocked in 2003) because of continued poor returns, and a NYSDEC and local stakeholders' decision to replace the Atlantic

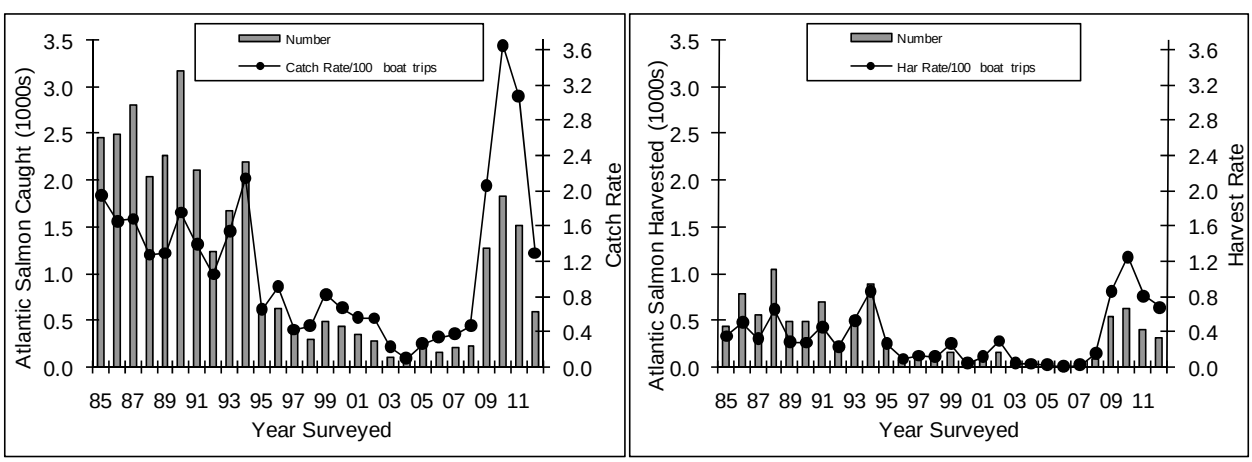

Figure 11. Total Atlantic salmon catch and catch rate, and harvest and harvest rate per 100 boat trips for boats seeking trout and salmon, April 15 – September 30, 1985-2012.

salmon stockings in the Black River with an equivalent number of brown trout. Each year 2009-2012, and in addition to the NYSDEC stockings, the USGS Tunison Lab reared and stocked Atlantic salmon (Connerton 2010, 2011, 2012, and 2013).

Each year from 2003 through 2008, few Atlantic salmon were reported in angler catch or harvest, and ≤1 was observed in the boat fishery by creel agents, resulting in harvest estimates of less than 20 fish per year and catch estimates of less than 300 fish per year (Table A16). In 2008, three Atlantic salmon were processed by creel agents and estimated catch and harvest estimates were 233 and 79, respectively (Figure 11, Table A16). Each year 2009-2011, before initiation of the creel survey, anecdotal reports indicated that anglers were catching Atlantic salmon in greater frequency than what occurred during the previous decade. Each year 2009-2011, creel agents sampled an Atlantic salmon on the first day of the survey (April 22 [2009] and April 15 [2010 and 2011]). Agents continued to document catch and harvest of Atlantic salmon throughout the open lake seasons. For three consecutive years, estimated seasonal lakewide catch and harvest were the highest since 1994 (Figure 11, Table A16).

During 2012, fewer Atlantic salmon were caught (592 [±43.4%]) and harvested (310 [±53.9%]) than during 2009-2011 (3-year averages of 1,539 caught and 518 harvested); however, 2012 estimates were well above 1995-2008 levels (+83.6% and +313.3%, respectively (Table 1). Atlantic salmon catch rate (1.3 fish per 100 boat trips seeking trout and salmon) was an average of nearly 8-fold higher than 1995-2008 rates (average = 0.16 per 100 boat trips). Harvest rate in 2012 (0.7 fish per 100 boat trips seeking trout and salmon) was more than 17 times higher than the 1995-2008 average (0.04 fish harvested per 100 boat trips).

Many factors may have contributed to the increased occurrence of Atlantic salmon in angler catches. Survival of stocked Atlantic salmon may have improved. Wild, subyearling Atlantic salmon were captured in the Salmon River each year 2009-2011 (J.H. Johnson, USGS Tunison Lab, Cortland, NY; personal communication); however, the contribution of naturally reproduced fish to the lake fishery is unknown. Additionally, recent efforts by Canada to restore a self-sustaining population of Atlantic salmon in Lake Ontario included increased stocking levels beginning in 2006. To date, the contribution of the enhanced stocking by Canada to the sport fishery is unknown. Genetic analysis of tissue samples collected during this survey (2009-2011) indicated that all of these fish had been stocked by NYSDEC.

Brown Trout

Catch and Harvest

Among trout and salmon species, brown trout was the second most commonly caught and harvested in 2012. Brown trout accounted for 20.1% and 21.7% of the total salmonine catch and harvest, respectively (Table 1, Table A17a). Both catch and harvest declined from the mid 1980s to the mid 1990s and varied without trend since 1995 (Figure 12, Table A17a). In 2012, seasonal catch and harvest estimates (39,507 [±27.0%] and 23,305 [±28.7%] fish, respectively) were comparable to the previous 5-year averages (+7.3% and -0.6%, respectively; Figure 12, Table 1, Table A17a). In 2012, 59.0% of brown trout caught were harvested, comparable to previous 5-year (-7.8%) and 10-year (-6.4%) averages. Each year, 1985-2007 and 2009-2011, the east/central area accounted for the highest proportions of brown trout catch and harvest (Lantry and Eckert 2012). In 2008 and 2012 the highest proportion of brown trout catch and harvest occurred in the east area where brown trout fishing was good throughout much of the open lake fishing season (Lantry and Eckert 2011). During 2012, anglers fishing along most of the New York shore experienced above average brown trout catch and harvest. As typically occurs, the majority of brown trout catch and harvest in 2012 occurred during April and May (50.6% of total catch and 48.2% of total harvest; Table A17a). Angler catches were above previous 5-year averages in April (+63.4%), August (+29.6%), and September (+89.0%). Estimated catch was comparable to the previous 5-year average in July (-1.1%) and estimates were below average in May (-19.4%) and June (-27.0%).

Fishing Quality

Brown trout catch rates (seasonal, charter and

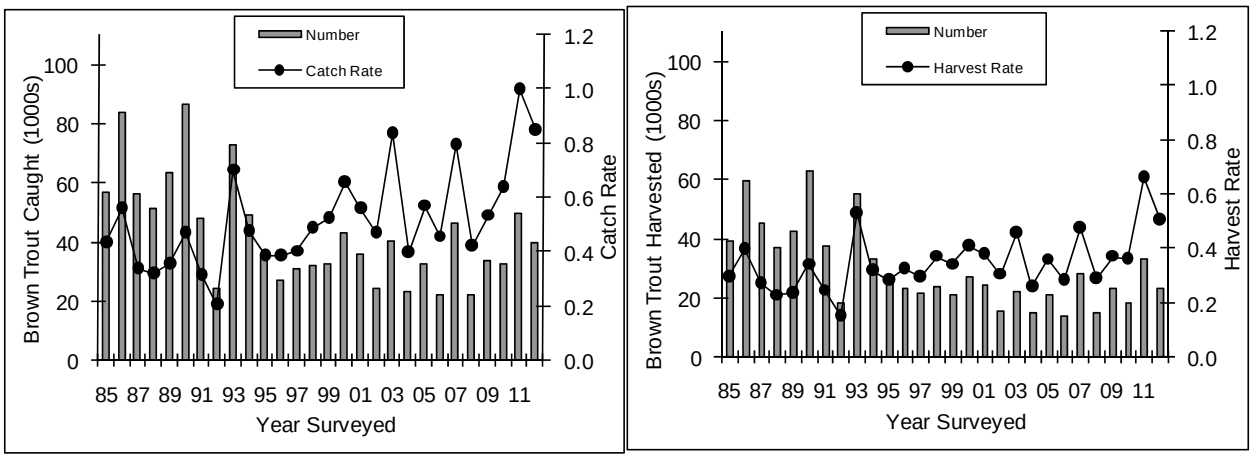

Figure 12. Total brown trout catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985-2012.

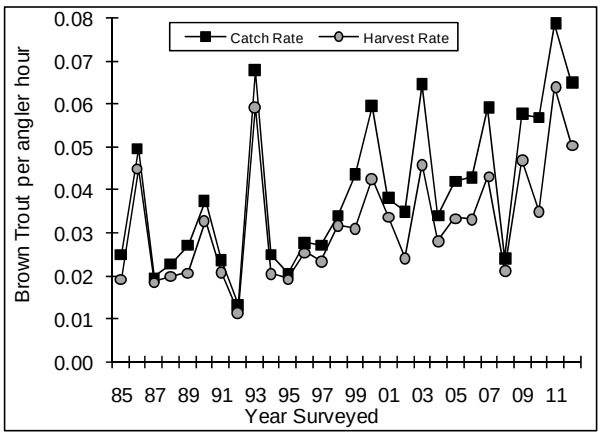

Figure 12b. Charter boat catch rate and harvest rate per angler hour for brown trout, April 15 – September 30, 1985-2012.

noncharter) were variable over the 28-year data series with no trend (Figure 12, Figure 12b, Table A17b). Among trout and salmon fishing boats, brown trout catch and harvest rates (0.8 and 0.5 fish per boat trip, respectively) were among highest in the 28-year data series. In 2012, charter boats targeting trout and salmon caught 42.3% of the brown trout caught by trout and salmon anglers. Catch rate among charter boats was 2.2 brown trout per boat trip in 2012 and the third highest in the 28-year data series (Figure 12b, Table A17b). The charter boat catch rate per angler hour was 0.07, a 65.9% increase compared to the longterm average and the third highest in the data series (Figure 12b). Among noncharter boats, the 2012 catch rate was 0.58 brown trout per boat trip and 0.04 fish per angler hour, which were the second and third highest, respectively (Table A17b).

Brown trout harvest rates (seasonal, charter and noncharter) were also variable, showed no trends over time. The 2012 rates were among the highest in the survey (Figure 12, Figure 12b, Table 17b). Among boats seeking trout and salmon, the 2012 seasonal harvest rate was 0.5 brown trout per boat trip, a 16.7% increase compared to the previous 5-year average (Figure 12, Table A17b). Among charter boats fishing for trout and salmon, the 2012 harvest rate was 1.7 brown trout per boat trip (0.05 fish per angler hour) and a 16.9% increase compared to the 2007-2011 average (Figure 12b, Table A17b). Among noncharter boats fishing for trout and salmon, the 2012 harvest rates were 0.27 brown trout per boat trip and 0.02 fish per angler hour.

Brown trout monthly and geographical harvest rate trends for most years showed monthly rates highest in April and May and declining from April through September, and highest in the east/central area (Lantry and Eckert 2012; Table A17b). During 2012, seasonal trends were typical, with brown trout catch and harvest rates highest in April and May. Fishing boats caught an average of 4.5 brown trout per boat trip in April, the highest April on record and more than 2.8 times higher than the long term average. Anglers fishing the east/central area experienced average fishing with catch rates similar to previous 10-year and long term averages (-6.2%

and +12.9%, respectively). Anglers fishing the other areas surveyed, however, experienced excellent brown trout fishing quality (east and west/central areas were second highest recorded, and west area was the third highest in the data series; Table A17b).

Biological Data

Biological data analysis presented here includes fish processed during April 15 - September 30 for all years 1985-2012 (previous reports, e.g. Lantry and Eckert 2012, presented results for fish processed beginning April 1 each year through 2009). Scales were collected from nearly all brown trout processed by creel agents during 1993-2012. For each of those years, the majority of brown trout were age-2 fish (66.0% to 88.8%; Table A18). In 2012, 74.6% of the brown trout were age-2 fish, comparable (-7.6%) to the previous 5-year average. Each year very few brown trout sampled are age 1 (0.0%-3.3%) because few are caught due to angling strategies (i.e. species targeted, lure type and their small size), and those caught are too small to be legally harvested (i.e. are less than 15 inches in length). In 2011 and 2012, none of the brown trout sampled were age-1. The 2012 contribution of age-3 fish (21.3%) was the highest age-3 contribution since 2006 and a 32.1% increase comparable to the previous 5-year average. In 2012, 3.3% of brown trout harvested were age-4, a 27.6% increase compared to the previous 5-year average. From 1993-2012, age-5 or older brown trout have comprised, on average, 0.6% of those sampled (0.7% of brown trout sampled in 2012 and the highest since 2004; Table A18). Few brown trout age 6 or older were observed, and in the 20 years that scale samples were aged, only nine age-6 and one age-7 brown trout were observed.

We evaluated brown trout condition by determining predicted weights of seven standard length groups (16-28 in, by 2-in length increments; Table A18). Predicted weights for each inch group were well below average, but within the range of values observed in previous years. Data were variable with no significant trend over the 25-year data series.

Lake Trout

Catch and Harvest

Lake trout fishing regulations for New York waters of Lake Ontario differ from the other salmonines. Since 1988, lake trout harvest has been limited by a slot size limit designed to increase the number and ages of spawning adults. In 1993, the slot limit was set at 25-30 inches total length. Until fall 2006, Lake Ontario anglers could harvest three lake trout outside of the 25-30 inch slot limit. Effective October 1, 2006, the lake trout creel limit was reduced to two fish per day per angler, one of which could be within the 25-30 inch slot. In 2012, lake trout was the fourth most commonly caught and fifth most commonly harvested trout or salmon species, contributing 11.3% and 7.3% of the total salmonine catch and harvest, respectively (Table 1, Table A19a). In 2012, estimated lake trout catch (22,206 [±34.3%] fish) and harvest (7,829 [±37.8%]) were comparable to 2011 estimates (-8.8% and +11.6%, respectively), which were the highest since 2002 (Figure 13, Table 1, Table A19a). Lake trout catch and harvest remains relatively low compared to historic levels. Declines in lake trout catch and harvest in recent years are attributable, in part, to both the excellent fishing quality for other salmonine species (i.e. possibly less effort specifically directed at lake trout) and the relatively low abundance of lake trout in Lake Ontario during the mid-2000s (Lantry and Lantry 2013).

Prior to 2001, the east area accounted for the highest proportion of lake trout catch and harvest for nearly every survey year (Lantry and Eckert 2011; Table A19a). During 2001-2008 the highest lake trout catch occurred in the west or west/central area; however, the highest harvest remained in the east area (five of the eight years) and west/central area (three of the eight years; Lantry and Eckert 2011). In 2010, lake trout catch was distributed across all four regions (range: 17.8% [west] - 28.5% [west/central]); however, again, the majority of harvest occurred in the eastern half of the lake. During 2011-2012, as was observed 2001-2008, the majority of lake trout catch occurred in the west area (29.2% of total catch in 2012), and the majority of harvest occurred in the east and east/central areas (62.8% of total harvest in 2012; Table A19a). The

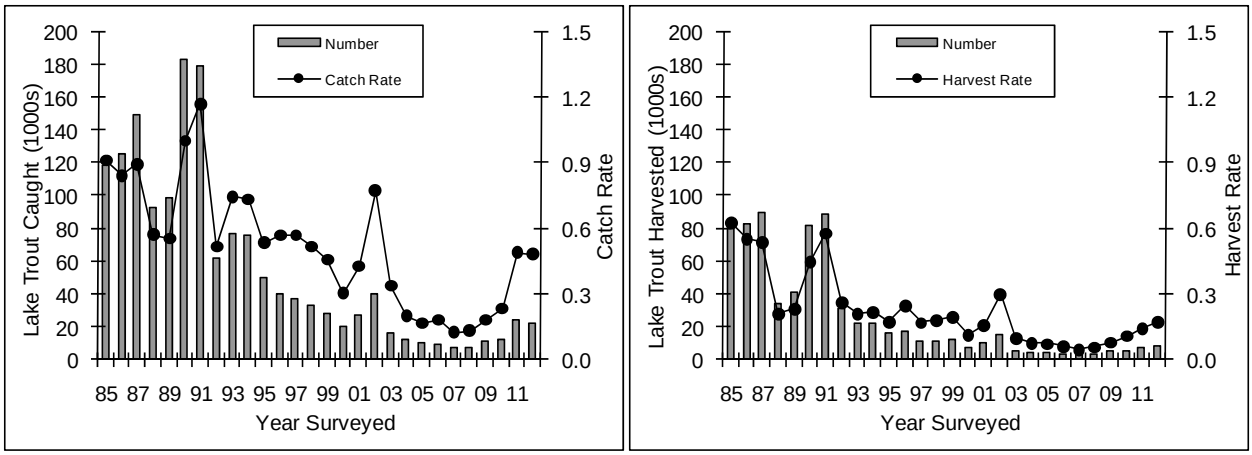

Figure 13. Total lake trout catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985-2012.

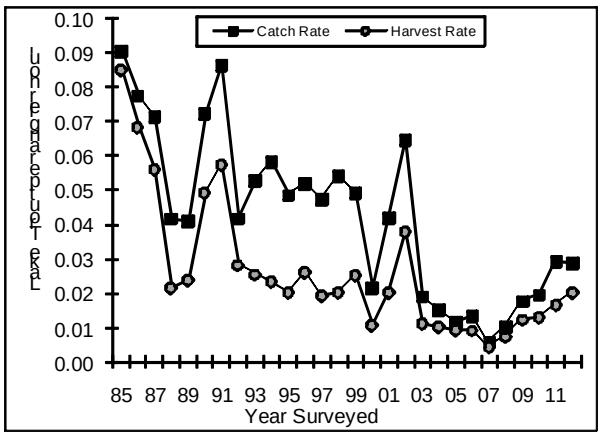

Figure 13b. Charter boat catch rate and harvest rate per angler hour for lake trout, April 15 – September 30, 1985-2012.

number of lake trout caught during April 2012 (3,823 fish) was the highest estimated for that month since 2003 and was well above previous 5-year and 10-year averages (+468.2% and 92.8%, respectively). The majority of lake trout were caught during May (37.8% of lake trout caught and a 93.4% increase compared to the previous 5-year average; Table A19a). Catch of lake trout remained above average for the remainder of the season with estimates higher than previous 5-year averages during June, August and September (range: +22.4% to +117.5%). July was comparable to (+0.9%) the previous 5-year average.

Fishing Quality

Low lake trout abundance during the mid 2000s (Lantry and Lantry 2013) and excellent fishing quality for other salmonine species beginning in 2003 contributed to declining lake trout catch rates and harvest rates in angler creel from 2003 to 2007 (Figures 13 and 13b, Table A19b). Since then, catch rates improved, increasing each year through 2011. That increase coincided with low but consecutive increases in the index of lake trout abundance as determined from the USGS/NYSDEC fall lake trout assessment (Lantry and Lantry 2013). The 2012 seasonal catch rate among all boats seeking trout and salmon was 0.48 lake trout per boat trip, comparable to 2011 (-1.8%; 0.49 per boat trip and the highest since 2002) and a 107.3% increase compared to the 2007-2011 average catch rate (Figure 13, Figure 13b, Table A19b). Among charter boats fishing for trout and salmon, the seasonal catch rate was 0.98 lake trout per boat trip which was also comparable to 2011 (-0.1%) and an increase (+71.5%) compared to the previous 5-year average (Table A19b). Charter catch rate per angler hour was 0.03 in 2011 and 2012, remaining at the highest level estimated since 2002 (Figure 13b). Catch rate among noncharter boats fishing for trout and salmon was 0.38 lake trout per boat trip and 0.03 fish per angler hour (Table A19b).

The 2012 seasonal harvest rate among boats seeking trout and salmon was 0.17 lake trout per boat (Figure 13, Table A19b). Among charter boats

fishing for trout and salmon, the 2012 seasonal harvest rate was 0.69 lake trout per boat trip (0.02 per angler hour; Figure 13b, Table A19b). Among noncharter boats fishing for trout and salmon, the seasonal harvest rate was 0.07 lake trout per boat trip (0.005 per angler hour; Table A19b).

In 2012 catch rate of lake trout in the east/central region of the lake was the highest estimated since 1996, the period before significant declines in the population (Lantry and Lantry 2013). Anglers fishing the east region of the lake in 2012 experienced the highest lake trout catch rates observed since 2002. Comparisons by month showed that catch rates were well above their respective 2007-2011 averages during each month (range: +9.7% [July] - +613.8% [April]; Table A19b). Harvest rate estimates were above their respective previous 5-year averages during April-July (range: +13.0 [July] - +546.8% [April]) and September (+276.1%; Table A19b).

Biological Data

Biological data analysis presented here includes fish processed during April 15 - September 30 for all survey years. Lantry and Eckert (2010) present biological data that include fish processed prior to April 15. The 2012 open lake fishing season was the sixth season affected by the October 2006 regulation change that now permits each angler to keep two lake trout per day with no more than one between 25 and 30 inches. From 1993-2006, 9.0% (2003) - 26.4% (1993) of the lake trout harvested were within the 25-30 inch slot, due in part to measurement errors and location of capture (fish harvested in Ontario waters are exempt from New York regulations, Table A20). Given the regulation change we expected to see increased harvest of slot limit sized fish. During the first five years after the regulation change (2007-2011), an average of 37.2% of lake trout harvested were within the 25-30 inch slot. As was expected, this was well above levels observed during 2002-2006 (17.0%; average increase of +118.5% compared to the most recent five years prior to the regulation change; Table A20). In 2012, 50.4% of all lake trout harvested were within the 25-30 inch slot, the highest observed since the regulation change. Nearly 30% of the lake trout harvested in 2012 were <25 inches (Table A20). Ages determined from fish with coded wire tags indicated that the majority (76.5%) of the tagged fish were from the 2006-2008 year classes, (i.e. age 4-6 fish) making 2012 the third consecutive year that these year classes dominated angler harvest (2011: 91.8% of tagged fish, 2010: 78.1% of tagged fish).

Smallmouth Bass

Catch and Harvest

Prior to October 1, 2006, NYSDEC fishing regulations established the smallmouth bass open season in Lake Ontario from the third Saturday in June through November 30 and allowed anglers to harvest a daily limit of five smallmouth bass with a minimum length of 12 inches. The regulation was changed effective October 1, 2006, establishing pre-season catch and release of smallmouth bass from December 1 through the Friday preceding the third Saturday in June (excluding Jefferson County's Lake Ontario waters). April 15 through June 15, 2012 was the sixth pre-season catch and release period covered by the NYSDEC fishing boat survey. During that period, there were an estimated 521 (±72.9%) fishing boat trips targeting smallmouth bass with all of the effort occurring in May and June (Table A2).

During the traditional open season covered by the survey and among all fish species, smallmouth bass was the most commonly caught and harvested species each year 1985-2006. In 2007, smallmouth bass became the third most commonly caught species in the open lake boat fishery, preceded by yellow perch and Chinook salmon (Table A21a). Since 2009, smallmouth bass was the fifth or sixth most commonly caught species (sixth in 2012). The 2012 catch estimate of 24,032 fish (±46.3%; April 15 - September 30) was a 16.2% increase compared to the record low estimated in 2010; however, was a 41.2% decrease compared to the previous 5-year average (Table 1, Table A21a). During the traditional open fishing season, 20,636 smallmouth bass were caught and 5,030 of those were harvested (24.4% caught were harvested; Figure 14, Table A21a).

Fishing Quality

Fishing quality was relatively stable from 1985

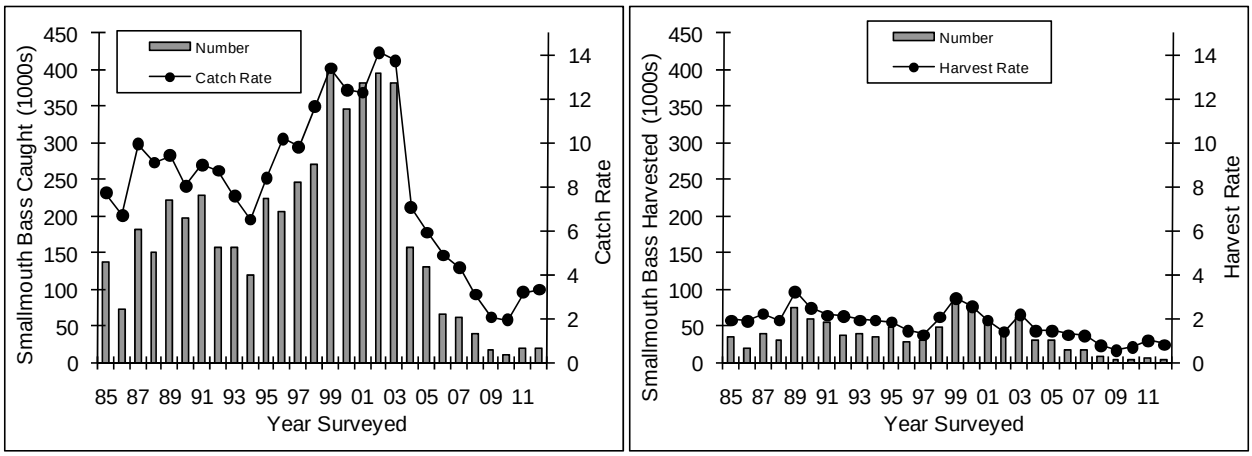

Figure 14. Total smallmouth bass catch and catch rate, and harvest and harvest rate per boat trip for boats seeking smallmouth bass during the traditional open season.

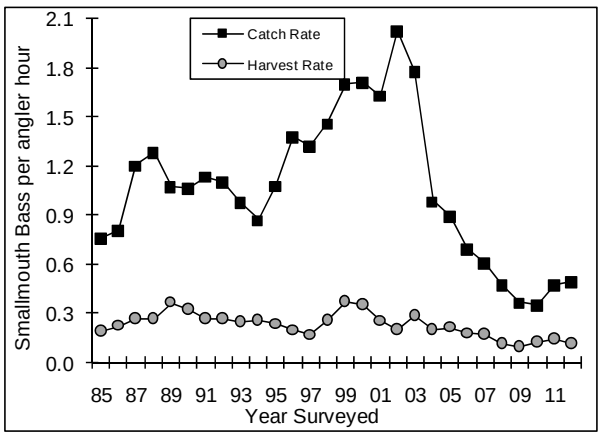

Figure 14b. Smallmouth bass catch rate and harvest rate per angler hour among anglers targeting bass during the traditional open season, 1985-2012.

through the early 1990s (1985-1994 average catch per boat trip = 8.3 bass; average catch per angler hour = 1.0 bass), then increased to its highest level in 2002 (2002 catch per boat trip = 14.1 bass; catch per angler hour = 2.0 bass; Figure 14, Table A21b). Since then, fishing quality declined. In 2010, both catch rate and harvest rate among boats targeting smallmouth bass during the traditional open season were the lowest recorded (1.9 and 0.7 caught and harvested per boat trip, respectively; Figure 14). Although remaining among the lowest in the data series, catch rate and harvest rate increased slightly in 2011 but remained near record lows (3.2 and 1.0 bass caught and harvested per boat trip, respectively; Figure 14, Table A21b). Catch and harvest rates in 2012 remained low (3.3 and 0.8, respectively) and similar to 2011. Over the 28-year data series the eight lowest smallmouth bass catch rates occurred during the last eight years (2005-2012). Smallmouth bass catch rate per angler hour in 2012 was 0.49, comparable to (+8.8%) the previous 5-year average (Figure 14b, Table A21b).

Comparisons of 2012 month- and region-specific catch and harvest rates with their respective 2007-2011 averages (Table A21b) showed above average fishing quality during July (+67.8%), and rates comparable to previous 5-year averages in June (-2.7%), August (-11.2%) and September (4.0%). The 2012 seasonal catch rate in the west geographical area was the highest since 2003 (5.4 bass per boat trip and a 132.4% increase compared to 2007-2011). Catch rates in the east/central and west/central areas were below their respective previous 5-year averages (-22.5% and -49.7%). Smallmouth bass catch rate in the east was only a slight increase (+11.4%) compared to the 2007-2011 average (Table A21b).

Other measures of fishing quality were evaluated and provided additional evidence of poor bass fishing in Lake Ontario's main basin in recent years. In 2012, 53.6% of boats specifically targeting smallmouth bass during the traditional open season failed to catch at least one bass, the third highest value among years surveyed (Table A6, Part B) and comparable to (+2.2%) the previous 5-year average. Additionally, among boats targeting smallmouth

bass during the traditional open season, 79.7% failed to harvest a single bass in 2012 (Table A6). Each year of the survey a relatively low percentage of boats harvest the daily creel limit of five bass per angler (1985-2003 average=6.3%). Since catch rates began decreasing after 2003, an even lower percentage of bass boats harvested their limit of bass (2004-2012 average=2.5%). In 2012, only 0.6% of bass fishing boats harvested the daily creel limit of five bass per angler, which was the second lowest percentage in the data series (Table A6). The reduced percentage of anglers harvesting their creel limit can be influenced by sizes of bass caught and a change in angler attitude toward catch and release (i.e. more anglers may favor release rather than harvest).

The decline in fishing quality coincides with an increase of round goby in angler catches (Table A3). Round goby abundance and distribution in Lake Ontario, as determined from prey fish bottom trawling assessments, also increased during that time period (Weidel et al. 2013). Round goby catches were first reported in the NYSDEC fishing boat survey in 2001 (965 fish caught), increased exponentially reaching the highest level in 2008 (63,407 fish caught in 2008), then estimated catches declined to 13,484 in 2012 (Table 1, Table A3). Round gobies negatively affect the quality of smallmouth bass fishing because they are frequently caught by bass anglers instead of bass, and they are an extremely abundant food for bass (i.e. bass are more likely to be satiated and less likely to be caught by anglers). Through the 2008 season, some anglers changed their fishing strategy to avoid catching gobies and maintained acceptable bass catch rates. Beginning in 2009, however, many of these anglers were experiencing poor quality bass angling.

The current status of the bass population along Lake Ontario's south shore is unclear, as we lack assessment data to determine if bass distribution and/or population structure has changed in recent years. Gill netting in Lake Ontario's main basin is problematic and presents challenges that we do not encounter in the eastern basin; primarily dramatic thermocline shifts that compromise our ability to interpret gillnet catch data (i.e. via changing bass density and inundating nets with cold water). This makes it unfeasible to conduct annual long-term gillnetting assessments in Lake Ontario's main basin, however, we have made several attempts to gill net bass on the south shore in recent years. The most recent netting indicated that the bass population is lower than levels observed in 2007 when gill net catches indicated that the bass population should be sufficient to provide a quality fishery (Sanderson 2012). A Black Bass Angler Diary Program was initiated in 2010 to gain information on fishing quality experienced by anglers targeting smallmouth and largemouth bass in Lake Ontario, its embayments, and tributaries to the first impassable barrier, as well as biological characteristics of bass caught (Sanderson and Lantry 2012 and 2013). The intent of this program is to gain insight into the recent declining trend in fishing effort and quality among Lake Ontario's bass anglers. Unfortunately participation to date has been lower than anticipated (Sanderson and Lantry 2013).

Recent, declining fishing quality appears limited to anglers targeting smallmouth bass in Lake Ontario's south shore. Many of the same factors affecting Lake Ontario's southern shore fish populations are also affecting Lake Ontario's Eastern Outlet Basin, the St. Lawrence River and Lake Erie bass populations, including, invasive species (round goby, Viral Hemorrhagic Septicemia virus [VHSv], zebra and quagga mussels, *Hemimysis*, etc.), *Cladaphora* (i.e. commonly called witch's hair), and nutrient and water clarity changes. Unlike the southern shore, however, these regions continue to provide quality bass angling and high quality bass. We will use data from our long-term assessment programs in Lake Erie, the eastern basin of Lake Ontario and the St. Lawrence River to evaluate changes in recruitment, adult survival, and other population parameters. The Lake Ontario Fishing Boat Survey will continue to monitor bass angling effort and success in areas outside of the eastern basin. We also plan to continue the angler diary program that was initiated in 2010; however, significantly more participation is needed.

<u>Yellow Perch</u>

Yellow perch catch and harvest estimates are highly

variable because few boats with perch in their creel are interviewed, anglers targeting perch in the lake can have very low to very high catches, and the probability of interviewing perch anglers is low. The 2012 estimated catch (35,836 [±56.7%] fish) and harvest (16,701 [±57.0%] fish) were well below previous 5-year estimates (-53.4% and -48.2%, respectively; Figure 15, Table 1, Table A22). Estimates were, however, well above levels observed during the late 1980s through the early 2000s (Figure 15, Table A22). Yellow perch are distributed along much of the Lake Ontario shoreline, however, each year 1996-2008 and 2010-2012 the greatest proportion of harvest occurred in the east/central area by relatively few fishing boats targeting perch (46.8% of total harvest in 2012; Lantry and Eckert 2011; Table A22). Coinciding with improved angler catch in recent years, fisheries assessments and anecdotal angler reports suggest that yellow perch populations were sufficient and producing quality fisheries in areas not covered or poorly sampled by the survey, including embayments and tributaries adjacent to the open lake fishery, and in Lake Ontario's eastern basin (e.g. Lantry 2013).

Walleye

Walleye have always been a minor component of the open lake boat survey, although angler interest in this species is high and, as part of management programs, fingerling stocking has occurred in many Lake Ontario embayments (e.g. Eckert 2005, Connerton 2013). Catch and harvest estimates for walleye are highly variable which is partly attributed to catch and harvest being greatest in locations and at times not included in, or poorly covered by, this survey (i.e. harvest in embayments or the eastern basin, and at night). Additionally, as with yellow perch, walleye catch and harvest estimates are influenced by only a few boats specifically targeting walleye and the probability of interviewing those boats is low. In 2012, there were an estimated 130 walleye caught and harvested in Lake Ontario (±155.4% and ±155.4%, respectively; Figure 15, Table A23). Fisheries assessment data (Lantry 2013) and anecdotal angler reports suggest that walleye populations and fisheries are greatly underestimated by this survey.

"Other Fish"

The "other fish" category includes a variety of species, including unidentified fish. In 2012, as in previous years, "other fish" was dominated by warm water species (Table 1, Table A3). Many of these are important components of the nearshore fish community, and although most open lake boat anglers do not actively target these species, the total numbers caught and harvested can be substantial. Game fish included in the "other fish" category in 2012 were: northern pike (204 caught, 132 harvested) and largemouth bass (516 caught, 132 harvested). For only the second year in the 28-year data series, lake sturgeon were reported as an angler caught species (27 caught). Gizzard shad were reported in angler catch (14 caught) for the first time since 1990, likely attributed to the warm 2011-2012

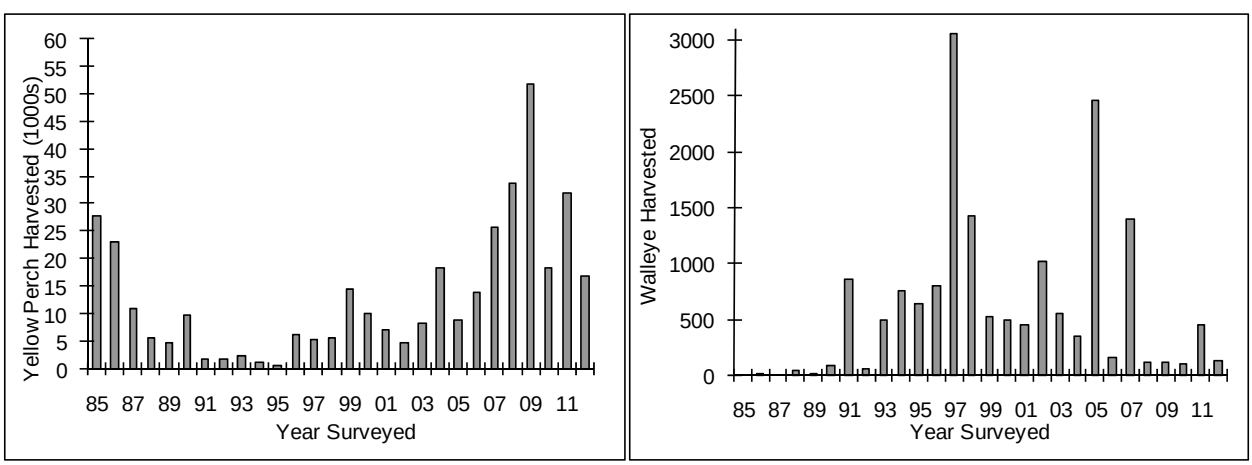

Figure 15. Total yellow perch and walleye harvested by all fishing boats, April 15-September 30 1985-2012.

winter and improved survival rate. Cisco (a.k.a lake herring; 375 caught, 247 harvested) were reported in angler creel for the third consecutive year since 1994. Prior to that Cisco were rare in this survey but were caught and harvested in low number for eight of ten years from 1985-1994. After 1994, none were reported caught or harvested in this survey until 2010.

From 1985 through 2002, there was a significant decline in the total number of "other fish", due largely to decreases in white perch and rock bass. No white perch were reported in angler creel in 2012; however, an estimated 1,840 rock bass were caught. Despite declines with these species, total harvest and catch of "other fish" increased from 2003 to 2009 as abundance of round goby increased (Walsh et al. 2007). The round goby population has since declined in abundance (Weidel et al. 2013) and angler catch (Table A3).

As round goby increased in abundance and distribution in Lake Ontario, its occurrence in angler creel increased dramatically. Goby was first reported and observed in this survey in 2001 at the Niagara River (Table A3). By 2002, round goby was the most commonly harvested "other species" (most are killed and discarded), and by 2004 it became the most commonly caught "other species" (54.9% of the 2004 "other species" total). In 2009, round goby was the third most commonly caught (58,310 fish) species in Lake Ontario and comprised 89.8% and 98.0% of "other fish" catch and harvest, respectively. In 2011, round goby catch and harvest decreased making it the sixth most commonly caught fish in the lake (Table 1). In 2012, round goby was the seventh most commonly caught species (13,484 [±51.5%] caught, 9,182 [±47.0%] harvested).

Lamprey Observations

Since 1986, all boat anglers were specifically asked if they observed lampreys attached to any of the fish they caught. Follow-up questions confirmed that the anglers observed an actual parasitic phase lamprey (as opposed to a lamprey mark), and determined what species of fish the lamprey was attached to. When saved by anglers, the lampreys were examined and a length measurement taken.

In 2012, there were an estimated 3,441 (±29.6%) lampreys observed in the fishing boat survey (Figure 16, Table A24). The number of lampreys observed by anglers per 1,000 trout and salmon caught (hereafter referred to as attack rate) was relatively stable during 1986-1995 and averaged 5.9. After 1995, the attack rate increased, reaching a peak in 2007 when an average of 44.4 lampreys were observed per 1,000 trout and salmon caught. This increase coincides with a decline in abundance of lake trout >17 in, the preferred prey of sea lamprey prey (Lantry and Lantry 2013). Lamprey attack rate decreased from the 2007 peak and, in 2012, there were an estimated 17.5 lamprey per 1,000 trout or salmon caught (Figure 16, Table A24).

For ten of the last twelve years (2001-2012) the majority of lamprey observations occurred on Chinook salmon (2001-2012 average=57.0%), which was due in part to the large number of Chinook salmon caught by anglers (e.g. 2001-2012 average=44.4% of total trout and salmon catch; Table A5a, Table A9a). In 2012, 60.0% of lamprey attacks were on Chinook salmon (Table A5a, Table A17a, Table A24). Other host salmonines in 2012 were brown trout (22.1% of attacks), rainbow trout (8.6% of attacks), lake trout (4.3% of attacks), coho salmon (2.9% of attacks), and Atlantic salmon (2.1% of attacks; Table A24). Three lamprey were observed on fishing gear in 2012. Among the 27years of lamprey observation data, there were a total of 32 lampreys reported on fishing gear.

We further examined the data by determining host-specific attack rate (e.g. the seasonal proportion of brown trout caught by anglers with a lamprey attached; Table A24). Prior to 1996, lamprey attack rate on other salmonines (i.e. excluding lake trout) was low and, on average, fewer than 1% of each species caught by anglers was observed with a lamprey attached (range of 1986-1995 averages: 0.02% [coho salmon] – 0.63% [Chinook salmon]). By 1996, the percentage of angler caught salmonines with an attached lamprey increased for all species examined. On average, during 1996-2012, lampreys were observed on 1.1% of coho salmon, 2.7% of Chinook salmon, 1.2% of rainbow

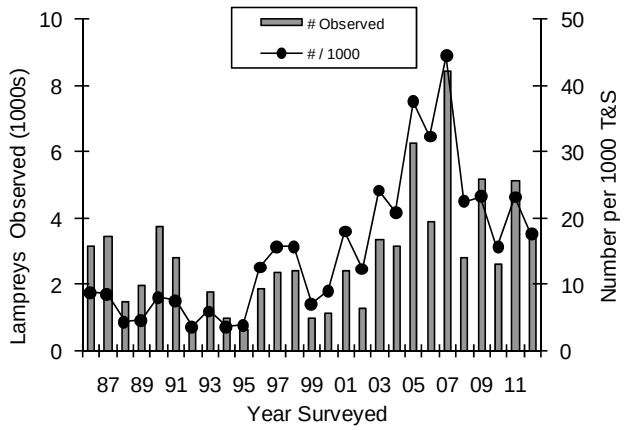

Figure 16. Total lamprey observed, and lampreys observed per 1,000 trout and salmon caught, April 15-September 30, 1985-2012.

trout, 7.1% of Atlantic salmon, and 2.4% of brown trout caught in Lake Ontario. The increase in attack rate on these salmonine species coincided with a decrease in abundance of the preferred lamprey prey (i.e. lake trout ≥17 inches; Lantry and Lantry 2013). Since 2007, the decrease in attack rate (Figure 16) coincides with a reduced lake trout wounding rate as determined from September gill netting, fewer lampreys observed attached to lake trout in the creel survey, and five consecutive years of increased lake trout catches in gill nets (Lantry and Lantry 2013).

Acknowledgments

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2012 Lake Ontario Fishing Boat Survey

Appendix Tables and Figures

Table A1. The four geographic areas (Roman numerals) used in analysis of the 1985-2012 NYSDEC Lake Ontario fishing boat survey data.

I. West geographic area: Niagara River to Point Breeze. Access locations include Williams Marina, Niagara State Park launch ramps (Youngstown), Roosevelt Beach, Wilson, Olcott, Green Harbor Marina, Golden Hills State Park, Johnson Creek, and Point Breeze.

II. West/Central geographic area: Eagle Creek Marina, Sandy Creek, Braddock Bay, Long Pond outlet, Genesee River, Irondequoit Bay.

III. East/Central geographic area: Bear Creek, Pultneyville, Hughes Marina, Sodus Bay, East Bay, Port Bay, Blind Sodus Bay, Little Sodus Bay (Fair Haven), Sterling Creek, Wrights Landing at Oswego, Oswego Marina.

IV. East geographic area: Sunset Bay, Catfish Creek, Dowie Dale Marina, Little Salmon River, Salmon River, Sandy Pond, Lakeview (North and South Sandy), Stony Creek, Association Island Cut.

Table A2. Effort and use statistics collected April 15 - September 30 during the 1985-2012 NYSDEC fishing boat surveys.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Part A: Effort for all fishing boats.											
Seasonal (5½ month) estimates of fishing effort for all fishing boats:											
Fishing Boat Trips	137,679	79,707	84,122	84,045	65,495	79,167	69,687	76,838	62,104	60,943	56,182
Boat Angler Trips	381,330	205,377	225,098	225,593	182,153	219,647	194,658	221,925	175,820	171,519	160,363
Boat Angler Hours	2,084,744	1,002,100	1,089,608	1,101,896	930,174	1,113,767	985,898	1,229,977	905,357	898,339	848,905
Anglers/Boat Trip	2.76	2.58	2.68	2.68	2.78	2.77	2.79	2.89	2.83	2.81	2.85
Hours/ Boat Trip	5.41	4.88	4.84	4.88	5.11	5.07	5.06	5.54	5.15	5.24	5.29
Monthly estimates of boat trips for all fishing boats:											
April	12,629	2,851	3,204	2,524	4,058	3,014	3,131	3,230	2,680	2,529	2,409
May	21,211	7,244	9,279	13,581	8,558	11,796	7,784	15,360	11,111	8,605	9,540
June	16,558	11,300	8,709	11,670	6,941	11,174	8,650	8,351	5,489	6,183	8,128
July	24,350	15,946	15,613	19,512	15,265	16,316	15,507	12,735	12,703	15,024	12,024
August	37,785	28,411	28,151	20,826	18,602	23,131	21,147	19,815	21,764	17,315	15,096
September	25,146	13,955	19,167	15,932	12,071	13,736	13,468	17,346	8,356	11,286	8,986
Seasonal estimates of boat trips among four geographic areas for all fishing boats:											
West	32,938	15,730	13,031	16,734	13,068	18,543	14,276	20,404	16,269	16,248	14,145
West/Central	20,351	11,124	10,327	11,592	9,358	11,461	7,722	10,746	7,011	6,890	7,412
East/Central	44,049	34,936	31,010	31,161	25,153	25,300	25,094	25,448	22,318	19,926	17,410
East	40,341	17,917	29,753	24,558	17,916	23,863	22,594	20,239	16,506	17,879	17,215
Part B: Seasonal estimates of total boat excursions (traffic).											
Power Boats:											
Fishing Boats	142,123	80,705	85,374	85,292	66,243	80,405	70,525	77,410	62,435	61,383	56,979
Nonfishing Boats	119,317	87,713	76,659	86,487	57,544	76,672	80,479	86,372	84,587	69,943	71,318
Sail Boats	31,926	17,854	14,026	12,918	12,186	18,126	19,750	22,224	23,914	23,782	20,703
Part C: Seasonal estimates of boat angler trips by residence.											
NY Resident	236,134	132,994	136,982	138,117	109,629	135,400	115,936	134,954	108,712	105,145	97,153
Nonresident	145,197	72,383	88,116	87,476	72,524	84,247	78,722	86,971	67,108	66,374	63,210
% NY Resident	61.5%	64.8%	60.9%	61.2%	60.2%	61.6%	59.6%	60.8%	61.8%	61.3%	60.6%
Part D: Effort for boats seeking trout and salmon.											
Seasonal (5½ month) estimates of fishing effort for boats seeking trout and salmon:											
Fishing Boat Trips	109,270	47,622	57,397	57,510	47,812	57,620	51,229	62,028	50,059	49,548	46,059
Boat Angler Trips	315,750	134,327	165,299	169,125	142,264	172,001	152,905	189,796	151,747	147,775	138,687
Boat Angler Hours	1,861,199	760,555	902,544	928,097	806,572	968,752	868,237	1,143,095	843,037	831,675	785,271
Anglers/Boat Trip	2.90	2.82	2.88	2.94	2.98	2.99	2.98	3.06	3.03	2.98	3.01
Hours/ Boat Trip	5.89	5.66	5.46	5.49	5.67	5.63	5.68	6.02	5.56	5.63	5.66
Monthly estimates of boat trips for boats seeking trout and salmon:											
April	12,468	2,851	3,204	2,397	4,024	2,998	2,874	3,610	2,610	2,518	2,366
May	20,222	6,944	8,808	12,945	7,959	11,009	7,262	14,731	9,401	8,050	8,388
June	10,806	5,580	4,783	5,363	2,733	5,862	4,760	5,201	3,878	4,313	5,138
July	14,976	5,865	7,154	10,862	8,259	10,212	9,261	8,743	9,233	10,903	9,255
August	29,898	16,776	19,185	14,090	14,496	16,674	16,485	15,192	18,080	14,123	12,910
September	20,901	9,607	14,262	11,853	10,340	10,864	10,586	14,552	6,858	9,642	8,002
Seasonal estimates of boat trips among four geographic areas for boats seeking trout and salmon:											
West	28,645	11,928	11,155	14,363	11,029	16,119	12,440	18,562	14,258	14,715	12,671
West/Central	15,336	4,994	5,852	7,139	6,828	6,962	4,293	7,725	5,574	5,047	5,584
East/Central	32,136	17,603	17,746	17,434	16,768	16,507	17,094	19,173	16,740	15,137	13,596
East	33,152	13,097	22,644	18,574	13,187	18,031	17,403	16,568	13,487	14,649	14,208
Percent of total seasonal fishing effort by boats seeking trout and salmon:											
Fishing Boat Trips	76.9%	59.7%	68.2%	68.4%	73.0%	72.8%	73.5%	80.7%	80.6%	81.3%	82.0%
Boat Angler Trips	80.6%	65.4%	73.4%	75.0%	78.1%	78.3%	78.6%	85.5%	86.3%	86.2%	86.5%
Boat Angler Hours	87.6%	75.9%	82.8%	84.2%	86.7%	87.0%	88.1%	92.9%	93.1%	92.6%	92.5%

Table A2 (continued). Summary of effort statistics.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Part E: Boats seeking smallmouth bass during the open season.											
Seasonal estimates of fishing effort for boats seeking smallmouth bass during the traditional open season (3rd Saturday in June - September 30):											
Fishing Boat Trips	22,556	27,754	22,340	22,108	13,586	14,509	12,786	8,666	5,855	6,257	6,203
Boat Angler Trips	52,024	61,856	50,367	47,220	30,938	33,135	28,548	18,885	12,106	13,758	13,505
Boat Angler Hours	176,426	214,630	160,373	146,449	96,062	103,494	83,434	48,847	32,603	42,718	41,972
Anglers/Boat Trip	2.31	2.23	2.25	2.14	2.28	2.28	2.23	2.18	2.07	2.20	2.18
Hours/ Boat Trip	3.41	3.47	3.18	3.10	3.10	3.12	2.92	2.59	2.69	3.10	3.11
Monthly estimates of boat trips for boats seeking smallmouth bass during the traditional open season:											
April & May	-	-	-	-	-	-	-	-	-	-	-
June	4,066	3,752	2,312	4,626	2,915	2,879	2,325	1,284	634	935	1,525
July	7,984	9,125	7,413	7,736	5,881	4,738	4,979	2,517	2,212	2,704	2,303
August	6,919	10,922	8,191	6,115	3,743	4,778	3,579	2,878	2,139	1,724	1,646
September	3,587	3,954	4,423	3,631	1,048	2,114	1,903	1,987	870	894	728
Seasonal estimates of boat trips among four geographic areas for boats seeking smallmouth bass during the traditional open season:											
West	2,713	2,690	1,272	1,623	1,237	1,561	1,001	1,370	1,051	815	984
West/Central	3,716	4,899	3,710	3,574	1,512	2,621	2,426	1,453	642	784	1,006
East/Central	10,193	16,114	11,348	11,331	6,912	6,649	5,451	3,638	2,768	2,809	2,289
East	5,933	4,051	6,010	5,580	3,925	3,677	3,908	2,204	1,394	1,849	1,924
Percent of total seasonal fishing effort by boats seeking smallmouth bass during the traditional open season:											
Fishing Boat Trips	18.6%	34.8%	26.6%	26.3%	20.7%	18.3%	18.3%	11.3%	9.4%	10.3%	11.0%
Boat Angler Trips	15.6%	30.1%	22.4%	20.9%	17.0%	15.1%	14.7%	8.5%	6.9%	8.0%	8.4%
Boat Angler Hours	9.9%	21.4%	14.7%	13.3%	10.3%	9.3%	8.5%	4.0%	3.6%	4.8%	4.9%
Part F: Other species sought.											
Seasonal estimates of fishing boat trips by species sought for boats not seeking salmonids or smallmouth bass during the traditional open season:											
Northern Pike	103	40	53	0	73	224	0	0	78	46	29
SMB pre-opener	191	404	293	184	500	496	367	644	292	239	521
Largemouth Bass	31	0	0	0	0	52	16	0	0	13	13
Yellow Perch	915	485	955	717	769	1,203	1,914	1,800	1,901	1,794	1,556
Walleye	466	348	326	570	278	1,210	373	270	470	384	233
All Other	4,104	3,055	2,759	2,957	2,476	3,853	3,003	3,863	3,449	2,662	1,568
% Northern Pike	0.08%	0.05%	0.06%		0.11%	0.28%			0.13%	0.08%	0.05%
% SMB pre-opener	0.16%	0.51%	0.35%	0.22%	0.76%	0.63%	0.53%	0.84%	0.47%	0.39%	0.93%
% Largemouth Bass	0.05%					0.07%	0.02%			0.02%	0.02%
% Yellow Perch	0.65%	0.61%	1.14%	0.85%	1.17%	1.52%	2.75%	2.34%	3.06%	2.94%	2.77%
% Walleye	0.57%	0.44%	0.39%	0.68%	0.42%	1.53%	0.54%	0.35%	0.76%	0.63%	0.41%
% All Other	3.13%	3.83%	3.28%	3.52%	3.78%	4.87%	4.31%	5.03%	5.55%	4.37%	2.79%
Part G: Charter fishing boats.											
Seasonal (5½ month) estimates of fishing effort for charter boats:											
Fishing Boat Trips	14,163	8,789	9,589	9,284	9,099	9,448	9,012	9,885	8,612	8,332	7,632
Boat Angler Trips	71,471	42,374	48,045	47,406	45,872	48,726	47,015	50,142	44,773	43,124	38,880
Boat Angler Hours	529,274	300,302	322,531	311,993	310,568	340,751	322,072	347,188	288,231	275,652	256,420
Anglers/Boat Trip	5.01	4.82	5.01	5.11	5.04	5.16	5.22	5.07	5.20	5.18	5.09
Hours/ Boat Trip	7.38	7.09	6.71	6.58	6.77	6.99	6.85	6.92	6.44	6.39	6.60
Monthly estimates of boat trips for charter boats:											
April	921	375	129	186	505	401	210	331	428	300	599
May	2,476	1,555	1,546	1,590	1,572	1,299	1,227	1,712	1,425	1,119	733
June	1,614	1,140	711	1,063	531	1,221	930	974	657	873	648
July	2,167	1,537	1,568	1,457	2,037	2,237	1,455	1,917	2,112	2,174	1,826
August	4,610	2,630	4,086	3,038	2,791	2,732	3,588	2,949	3,259	2,513	2,622
September	2,376	1,552	1,549	1,950	1,664	1,559	1,602	2,002	731	1,353	1,203
Seasonal estimates of boat trips among four geographic areas for charter boats:											
West	3,763	2,333	2,151	2,759	1,870	2,810	2,371	2,624	2,837	2,658	2,060
West/Central	1,551	800	1,217	1,094	954	1,387	472	1,056	933	842	813
East/Central	5,015	3,586	3,477	3,280	4,283	3,292	3,854	4,235	3,512	3,263	2,879
East	3,835	2,069	2,745	2,152	1,993	1,960	2,315	1,971	1,329	1,570	1,880
Percent of total seasonal fishing effort by charter boats:											
Fishing Boat Trips	10.6%	11.0%	11.4%	11.0%	13.9%	11.9%	12.9%	12.9%	13.9%	13.7%	13.6%
Boat Angler Trips	19.3%	20.6%	21.3%	21.0%	25.2%	22.2%	24.2%	22.6%	25.5%	25.1%	24.2%
Boat Angler Hours	26.6%	30.0%	29.6%	28.3%	33.4%	30.6%	32.7%	28.2%	31.8%	30.7%	30.2%

Table A3. Estimated numbers of fish other than coho salmon, Chinook salmon, rainbow trout, Atlantic salmon, brown trout, lake trout, smallmouth bass, yellow perch, walleye, or sea or silver lamprey, that were harvested and caught April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of fish harvested:											
Unidentified Fish	3	0	0	33	0	0	0	0	0	0	0
Bowfin	1	0	0	0	0	0	0	0	0	0	0
American Eel	8	0	0	0	0	0	0	0	0	0	0
Alewife	36	0	0	31	0	0	0	0	365	0	14
Gizzard Shad	4	0	0	0	0	0	0	0	0	0	0
Cisco	30	0	0	0	0	0	0	0	76	187	247
Lake Whitefish	0	0	0	0	0	0	0	0	11	13	0
Pink Salmon	3	0	16	0	0	23	0	0	0	0	0
Unidentified Salmonine	16	0	0	0	0	0	0	0	0	0	0
Northern Pike	94	0	22	0	135	0	40	0	0	14	132
Common carp	5	0	0	0	0	0	0	0	0	0	45
Unidentified Redhorse	0	0	0	0	0	15	0	0	0	0	0
Yellow Bullhead	2	0	0	0	0	0	0	0	0	0	0
Brown Bullhead	121	0	70	0	45	0	0	0	0	0	0
Channel Catfish	70	121	0	0	0	0	0	0	0	0	0
Threespine Stickleback	1	0	0	0	0	0	0	0	0	0	0
White Perch	2,025	149	0	0	0	0	0	0	20	0	0
White Bass	358	0	0	0	0	0	0	0	0	0	0
Rock Bass	3,470	1,119	644	133	473	363	1,115	526	131	135	688
Pumpkinseed	512	318	192	228	658	0	95	29	20	0	0
Bluegill	108	82	0	0	562	29	79	87	140	329	0
Largemouth Bass	102	49	0	0	269	108	149	88	32	0	132
Black Crappie	35	0	0	0	1,301	0	0	0	0	0	26
Freshwater Drum	524	347	194	158	76	0	0	0	0	0	0
Round Goby	88	4,415	2,865	10,996	16,807	28,974	39,611	36,003	13,138	12,770	9,182
Seasonal (5½ month) estimates of fish caught:											
Unidentified Fish	34	81	0	48	0	48	250	213	0	19	24
Lake Sturgeon	2	0	0	0	0	0	0	0	0	0	27
Longnose Gar	0	0	0	43	0	0	0	72	0	0	0
Bowfin	22	25	0	0	45	0	0	0	0	0	0
American Eel	99	0	0	0	0	0	0	0	0	0	0
Alewife	477	52	0	31	32	0	45	43	736	220	27
Gizzard Shad	13	0	0	0	0	0	0	0	0	0	14
Cisco	41	0	0	0	0	0	0	0	181	229	375
Lake Whitefish	0	0	0	0	0	0	0	0	11	13	0
Pink salmon	3	0	16	0	0	23	0	0	0	0	0
Unidentified Salmonine	308	544	20	32	251	31	281	14	106	113	0
Rainbow Smelt	12	0	0	0	0	0	0	0	0	0	0
Northern Pike	370	79	214	44	166	2,191	235	1,370	900	62	204
Muskellunge	2	19	0	0	0	0	0	0	0	0	0
Chain Pickerel	0	0	0	0	0	0	690	422	32	0	0
Common Carp	101	140	0	61	15	19	114	38	62	26	72
White Sucker	31	0	0	0	29	14	14	0	36	13	0
Unidentified Redhorse	14	0	0	0	0	45	0	0	0	0	0
Yellow Bullhead	2	0	0	0	0	0	0	0	0	0	0
Brown Bullhead	166	0	70	0	45	0	0	0	0	0	0
Channel Catfish	173	121	0	0	0	0	198	0	15	0	19
Threespine Stickleback	4	0	0	0	0	0	0	0	0	0	0
White perch	5,350	207	0	0	0	30	606	0	83	101	0
White Bass	1,589	19	16	31	111	72	14	257	20	25	2,533
Rock Bass	17,207	5,849	3,610	3,381	2,731	4,608	4,495	2,546	991	818	1,840
Pumpkinseed	1,704	1,094	1,040	461	1,994	1,369	2,774	577	222	28	36
Bluegill	313	82	0	429	1,198	306	284	146	349	1,257	77
Largemouth Bass	563	217	311	82	1,306	1,177	1,313	594	190	227	516
Black Crappie	87	0	0	21	1,390	18	0	0	0	0	26
Freshwater Drum	8,885	4,379	3,072	1,914	1,255	686	360	266	701	240	525
Round Goby	192	4,928	10,201	20,371	34,336	62,615	63,407	58,310	21,033	25,290	13,484

Table A4. Residency for boat anglers interviewed April 15 – September 30, 1985-2012. Shown are percent contributions the most common states or provinces, and for the most common counties among New York resident anglers.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
	State or Province of Residence - Percent Contribution										
Connecticut	2.1	2.0	2.2	1.7	1.8	2.4	1.6	1.7	1.6	1.3	1.5
Florida	0.3	0.4	0.3	0.4	0.3	0.5	0.4	0.4	0.4	0.4	0.4
Maine	0.7	1.2	0.9	1.0	1.3	1.0	0.9	0.9	0.8	0.7	0.7
Maryland	0.3	0.2	0.3	0.2	0.5	0.1	0.2	0.1	0.2	0.2	0.3
Massachusetts	4.1	3.1	3.2	3.3	3.1	2.9	3.3	3.3	3.0	2.7	2.6
Michigan	0.4	0.0	0.2	0.4	0.1	1.2	0.3	0.3	0.4	0.6	0.2
New Hampshire	1.2	1.4	1.0	1.1	1.5	1.3	1.2	1.2	1.1	0.8	0.9
New Jersey	4.5	4.1	4.4	3.3	3.8	3.8	3.3	3.8	3.0	3.0	2.6
New York	61.5	64.8	60.9	61.2	60.2	61.6	59.6	60.8	61.8	61.3	60.6
Ohio	4.5	3.4	2.3	3.2	3.0	2.8	4.5	3.5	2.6	4.0	3.9
Pennsylvania	16.4	16.4	19.8	19.2	19.5	17.6	19.8	18.9	20.4	20.4	21.9
Province of Ontario	0.2	0.0	0.1	0.0	0.0	0.4	0.1	0.4	0.3	0.3	0.1
Province of Quebec	0.2	0.0	0.3	0.1	0.1	0.0	0.2	0.1	0.1	0.1	0.0
Vermont	2.1	1.9	2.6	3.0	2.4	2.8	2.0	2.8	2.3	2.1	2.5
Virginia	0.2	0.1	0.3	0.3	0.2	0.2	0.3	0.2	0.2	0.2	0.1
West Virginia	0.4	0.2	0.3	0.3	0.3	0.3	0.7	0.4	0.3	0.4	0.5
Total of all Listed States & Provinces:	99.0	99.2	99.0	98.7	98.3	98.7	98.5	98.7	98.4	98.4	98.9
	County of Residence Among NY Anglers - Percent Contribution										
County Bordering Lake Ontario:											
Cayuga	2.2	3.2	2.6	2.7	3.7	2.9	4.2	3.0	3.3	2.6	2.2
Jefferson	2.6	1.8	1.2	2.4	2.0	2.3	2.4	2.2	1.6	1.5	3.2
Monroe	25.0	22.2	23.4	23.2	20.0	21.9	18.8	20.0	18.7	16.5	16.2
Niagara	8.8	7.6	6.9	9.0	7.9	9.5	6.6	7.3	7.8	10.9	9.4
Orleans	3.7	3.3	4.0	4.0	3.1	2.9	4.0	3.8	4.9	4.2	4.1
Oswego	10.1	13.1	12.0	11.0	13.5	11.3	12.8	13.0	13.1	13.6	12.5
Wayne	10.3	15.6	14.8	11.5	12.4	11.4	11.5	9.5	9.5	9.6	10.3
Border Co. Total	62.9	66.9	64.9	63.9	62.7	62.3	60.4	58.8	58.8	59.0	57.9
Other NY Counties:											
Albany	1.3	1.1	1.4	1.1	1.5	2.0	1.2	1.0	1.1	1.0	1.0
Broome	1.9	1.7	1.8	1.9	2.0	1.6	1.4	2.1	2.5	1.9	1.8
Dutchess	1.0	0.9	1.0	1.3	1.2	0.7	0.5	0.6	0.6	0.3	0.3
Erie	4.5	2.4	2.8	3.5	3.7	4.1	3.4	3.4	3.8	5.8	5.2
Genesee	1.6	1.1	1.2	1.7	1.4	1.1	1.2	1.9	2.1	1.6	2.5
Livingston	0.8	0.7	0.7	0.7	0.7	0.7	0.8	0.7	0.6	0.6	1.0
Oneida	2.1	1.7	1.5	1.0	2.1	1.9	1.9	1.8	1.8	2.1	1.4
Onondaga	5.8	5.6	6.4	5.7	5.5	5.6	6.9	5.4	6.0	6.4	6.4
Ontario	1.5	1.4	1.3	1.6	1.6	1.5	1.1	1.5	1.7	1.6	1.7
Orange	0.8	0.9	1.5	0.8	1.2	1.1	1.7	1.3	1.2	0.5	0.8
Saratoga	1.0	0.7	0.8	0.7	0.7	0.7	0.6	1.0	0.8	0.7	0.6
Total of all Listed Counties:	85.2	85.1	85.4	83.9	84.3	83.1	81.1	79.5	80.9	81.5	80.7

Table A5a. Trout and salmon catch and harvest data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	163,878	71,614	85,471	106,900	76,075	111,200	78,060	120,477	89,092	110,196	107,456
Catch	253,798	139,962	151,737	167,707	120,785	189,916	125,686	223,316	167,405	221,977	196,625
% Harvested	64.3	51.2	56.3	63.7	63.0	58.6	62.1	53.9	53.2	49.6	54.7
Monthly estimates of harvest for all fishing boats:											
April	19,253	8,471	1,410	4,940	5,720	8,197	2,432	6,635	5,939	5,050	10,045
May	35,138	11,319	17,806	27,268	16,436	22,638	12,493	29,432	11,638	16,139	16,015
June	18,620	6,793	7,071	7,949	2,919	12,419	6,896	5,050	8,025	10,387	10,135
July	25,706	10,369	15,217	16,650	14,072	22,507	12,851	24,171	21,904	36,207	22,706
August	44,971	23,027	31,468	28,142	24,148	30,604	28,919	32,685	34,636	29,189	34,770
September	20,191	11,634	12,500	21,949	12,781	14,835	14,471	22,504	6,950	13,225	13,785
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	54,658	25,555	25,593	33,572	24,718	39,131	32,750	49,310	37,266	33,864	32,631
West/Central	18,564	4,174	7,880	10,214	8,650	9,618	2,901	8,174	6,523	8,356	9,216
East/Central	48,711	28,606	29,052	28,760	30,505	37,160	20,158	40,795	29,674	39,819	31,076
East	41,945	13,277	22,945	34,353	12,200	25,291	22,250	22,197	15,629	28,157	34,535
Monthly estimates of catch for all fishing boats:											
April	29,484	19,506	5,081	7,325	9,360	14,246	3,709	11,261	8,804	12,236	19,347
May	54,300	19,929	33,809	46,320	28,660	51,039	24,727	76,635	20,573	35,558	37,204
June	33,028	13,603	12,298	19,353	5,366	20,947	12,552	11,836	18,745	22,222	24,230
July	46,353	22,438	27,887	26,838	22,868	36,489	23,301	35,487	46,270	82,252	42,491
August	65,033	47,198	54,872	41,412	37,709	47,626	41,721	55,836	62,916	50,484	55,996
September	25,600	17,288	17,790	26,458	16,823	19,567	19,676	32,261	10,096	19,225	17,357
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	89,264	53,586	53,922	62,223	46,148	77,192	57,467	103,965	72,072	93,566	73,727
West/Central	34,724	18,610	18,923	23,987	17,028	20,602	7,754	30,121	22,128	22,100	26,231
East/Central	69,738	49,549	47,343	38,344	42,280	57,450	31,072	62,190	51,736	67,426	49,058
East	60,072	18,216	31,550	43,150	15,328	34,674	29,398	27,040	21,471	38,885	47,609
Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:											
% Harvest	99.4	99.3	99.8	99.9	99.2	99.6	99.8	99.9	99.8	99.9	100.0
% Catch	99.3	99.4	99.8	99.8	99.2	99.7	99.6	99.8	99.6	99.8	99.7
Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon:											
% Harvest	45.4	55.7	53.4	50.5	61.0	47.9	53.7	50.5	50.3	47.3	47.5
% Catch	38.4	40.9	40.5	39.7	46.2	37.5	42.6	35.5	39.9	34.8	33.3

Table A5b. Trout and salmon catch and harvest rate data collected April 15 – September 30, 1985-2012. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	1.458	1.494	1.486	1.858	1.578	1.922	1.520	1.940	1.776	2.222	2.332
Catch/Boat Trip	2.268	2.921	2.637	2.910	2.506	3.286	2.444	3.593	3.329	4.473	4.258
Harv/Angler Trip	0.504	0.530	0.516	0.632	0.530	0.644	0.509	0.634	0.586	0.745	0.774
Catch/Angler Trip	0.783	1.036	0.916	0.990	0.842	1.101	0.819	1.174	1.098	1.500	1.414
Harv/Angler Hour	0.086	0.094	0.095	0.115	0.094	0.114	0.090	0.105	0.105	0.132	0.137
Catch/Angler Hr.	0.133	0.183	0.168	0.180	0.149	0.195	0.144	0.195	0.198	0.266	0.250
Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon:											
April	1.756	2.971	0.440	2.061	1.421	2.734	0.847	1.838	2.275	2.006	4.246
May	1.664	1.603	2.010	2.105	2.001	2.056	1.720	1.998	1.238	2.005	1.909
June	1.627	1.176	1.478	1.482	1.035	2.083	1.418	0.949	2.052	2.396	1.973
July	1.615	1.768	2.120	1.529	1.704	2.195	1.386	2.765	2.363	3.321	2.448
August	1.504	1.371	1.640	1.997	1.666	1.828	1.752	2.150	1.971	2.065	2.693
September	0.898	1.208	0.876	1.852	1.236	1.366	1.367	1.546	1.006	1.372	1.723
Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	1.916	2.126	2.294	2.336	2.242	2.428	2.630	2.657	2.614	2.300	2.575
West/Central	1.202	0.836	1.347	1.431	1.267	1.377	0.676	1.059	1.170	1.656	1.650
East/Central	1.494	1.611	1.628	1.650	1.787	2.233	1.171	2.128	1.765	2.631	2.282
East	1.193	1.012	1.013	1.847	0.919	1.397	1.277	1.331	1.154	1.919	2.431
Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon:											
April	2.834	6.842	1.586	3.056	2.326	4.752	1.291	3.119	3.373	4.859	8.177
May	2.599	2.835	3.824	3.577	3.498	4.636	3.397	5.201	2.188	4.400	4.435
June	2.863	2.369	2.556	3.581	1.930	3.527	2.568	2.227	4.809	5.117	4.644
July	2.866	3.794	3.888	2.456	2.769	3.564	2.511	4.059	4.948	7.544	4.581
August	2.179	2.812	2.858	2.939	2.600	2.845	2.528	3.668	3.480	3.569	4.335
September	1.170	1.797	1.244	2.232	1.621	1.800	1.859	2.210	1.464	1.994	2.169
Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	3.137	4.468	4.830	4.321	4.163	4.789	4.617	5.601	5.055	6.344	5.818
West/Central	2.417	3.721	3.227	3.339	2.485	2.950	1.800	3.898	3.969	4.379	4.697
East/Central	2.145	2.787	2.652	2.200	2.486	3.456	1.801	3.227	3.051	4.448	3.587
East	1.700	1.387	1.393	2.322	1.155	1.918	1.682	1.624	1.586	2.650	3.337
Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	4.849	4.814	4.835	5.970	5.239	5.816	4.800	6.170	5.245	6.319	6.690
Catch/Boat Trip	6.315	6.912	6.508	7.365	6.297	7.787	6.136	8.044	7.826	9.359	8.583
Harv/Angler Trip	0.972	0.997	0.968	1.170	1.037	1.131	0.921	1.216	1.006	1.211	1.313
Catch/Angler Trip	1.262	1.431	1.302	1.443	1.247	1.514	1.177	1.585	1.500	1.794	1.685
Harv/Angler Hour	0.132	0.140	0.144	0.176	0.153	0.161	0.134	0.175	0.156	0.190	0.198
Catch/Angler Hr.	0.171	0.202	0.193	0.217	0.184	0.216	0.172	0.229	0.233	0.282	0.254
Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.924	0.794	0.827	1.091	0.746	1.187	0.846	1.140	1.062	1.404	1.466
Catch/Boat Trip	1.617	2.080	1.876	2.080	1.644	2.436	1.686	2.750	2.404	3.497	3.399
Harv/Angler Trip	0.361	0.331	0.336	0.430	0.298	0.461	0.335	0.426	0.411	0.554	0.565
Catch/Angler Trip	0.631	0.868	0.762	0.820	0.657	0.945	0.667	1.027	0.931	1.379	1.309
Harv/Angler Hour	0.067	0.066	0.068	0.085	0.058	0.090	0.065	0.075	0.079	0.104	0.107
Catch/Angler Hr.	0.117	0.172	0.154	0.162	0.127	0.185	0.129	0.180	0.179	0.259	0.247

Table A6. Parameters used to assess angling quality among boats interviewed April 15 – September 30, 1985-2012. Parameters are given separately for boats seeking any or all species of trout and salmon, and for boats seeking smallmouth bass during the traditional open season (begins 3rd Saturday in June). Changes in daily bag limits and size limits for trout and salmon invalidate comparisons of boats harvesting daily bag limits over the entire 28-year data series; therefore, data on bag limits are presented only for 2003-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Part A: Boats seeking any or all species of trout and salmon.											
Percent boats with zero harvest of:											
Any Trout or Salmon	54.6%	54.6%	52.3%	48.1%	57.4%	49.1%	55.6%	51.1%	51.6%	45.3%	44.9%
Any Fish Species	54.2%	54.3%	52.2%	47.9%	57.2%	48.9%	55.3%	50.8%	51.5%	45.2%	44.8%
Percent boats with zero catch of:											
Any Trout or Salmon	42.5%	35.0%	37.3%	32.6%	41.6%	31.5%	41.1%	32.4%	35.1%	26.7%	24.3%
Any Fish Species	40.0%	33.1%	35.1%	30.2%	40.2%	30.8%	39.6%	31.9%	34.5%	26.1%	23.8%
Percent boats harvesting the daily bag limit - 3 lake trout per angler in 1998-2006, 2 lake trout per angler in 2007-present:											
Charters-Party Only	-	0.6%	0.0%	0.3%	0.9%	1.1%	2.1%	3.1%	1.2%	2.6%	5.3%
Charters-All Anglers	-	0.0%	0.0%	0.0%	0.0%	0.0%	0.7%	1.9%	0.6%	0.0%	2.0%
Noncharter Boats	-	0.1%	0.0%	0.0%	0.0%	0.1%	0.1%	0.0%	0.0%	0.5%	0.0%
Percent boats harvesting the daily bag limit of 3 coho salmon, Chinook salmon, rainbow trout, or brown trout, in aggregate, per angler:											
Charters-Party Only	-	16.5%	16.0%	22.8%	16.1%	21.8%	12.1%	24.2%	19.5%	21.4%	22.1%
Charters-All Anglers	-	3.3%	3.4%	3.5%	1.9%	3.6%	1.9%	3.1%	4.3%	2.8%	4.6%
Noncharter Boats	-	1.7%	1.5%	2.0%	0.5%	2.7%	0.9%	1.4%	1.9%	3.0%	3.7%
Part B: Boats seeking smallmouth bass during the traditional open season.											
Percent boats with zero harvest of:											
Smallmouth Bass	61.7%	66.5%	71.6%	72.1%	77.2%	77.2%	82.1%	84.7%	79.0%	82.7%	79.7%
Any Fish Species	60.0%	64.0%	68.2%	66.6%	67.8%	59.6%	65.6%	71.2%	65.0%	72.3%	63.9%
Percent boats with zero catch of:											
Smallmouth Bass	24.6%	15.1%	30.8%	29.0%	42.8%	43.1%	50.3%	53.6%	56.2%	58.8%	53.6%
Any Fish Species	20.8%	14.2%	27.5%	24.8%	28.2%	22.4%	27.7%	36.5%	37.6%	35.1%	34.6%
Percent boats harvesting the daily bag limit of 5 smallmouth bass per angler:											
All Boats Combined	6.1%	9.6%	6.8%	3.4%	3.7%	2.8%	1.0%	0.3%	1.2%	2.6%	0.6%

Table A7a. Coho salmon harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	10,693	5,079	3,376	5,487	9,255	14,541	4,912	12,931	9,223	7,380	8,259
Catch	13,894	6,801	4,935	8,849	12,198	25,510	6,666	21,376	12,908	11,915	12,494
% Harvested	77.0	74.7	68.4	62.0	75.9	57.0	73.7	60.5	71.5	61.9	66.1
Monthly estimates of harvest for all fishing boats:											
April	3,107	419	128	673	1,634	1,604	618	1,446	1,178	968	392
May	2,131	1,002	493	1,820	4,759	6,168	1,176	3,087	1,353	946	1,787
June	577	521	50	357	178	2,515	33	441	918	653	163
July	448	238	135	36	214	265	143	476	1,864	2,362	503
August	2,547	1,313	2,114	439	1,644	2,367	513	1,816	2,860	853	3,437
September	1,883	1,586	456	2,163	824	1,622	2,429	5,666	1,049	1,599	1,978
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	4,638	2,253	1,142	1,816	3,110	9,014	1,310	5,692	5,269	3,635	3,001
West/Central	1,957	416	65	565	681	910	111	566	772	765	411
East/Central	2,533	1,628	709	1,097	3,831	2,702	1,251	2,727	1,537	1,546	1,968
East	1,566	782	1,459	2,009	1,633	1,915	2,240	3,945	1,645	1,434	2,880
Monthly estimates of catch for all fishing boats:											
April	4,275	853	155	875	2,269	2,352	976	2,183	1,543	2,324	686
May	2,985	1,347	932	3,025	6,022	13,798	2,107	9,559	2,164	1,926	4,047
June	850	1,002	50	1,788	698	3,799	255	685	1,542	1,277	734
July	683	254	207	301	263	386	242	686	2,734	3,357	830
August	2,955	1,441	2,957	591	1,881	3,313	513	2,096	3,652	1,190	3,888
September	2,147	1,904	634	2,268	1,064	1,863	2,573	6,167	1,272	1,840	2,308
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	6,245	2,999	2,273	4,368	5,062	17,668	2,517	12,152	7,285	6,476	5,875
West/Central	2,991	835	208	924	876	1,383	304	1,354	1,636	1,837	1,072
East/Central	2,958	2,136	928	1,495	4,501	3,960	1,506	3,388	2,050	1,922	2,350
East	1,700	831	1,526	2,061	1,759	2,499	2,340	4,482	1,937	1,679	3,197
Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:											
% Harvest	99.5	100.0	100.0	100.0	94.5	100.0	100.0	100.0	100.0	100.0	100.0
% Catch	99.4	99.7	100.0	100.0	95.8	100.0	100.0	100.0	100.0	99.5	100.0
Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon:											
% Harvest	39.4	60.3	38.8	44.8	56.3	44.8	51.4	39.8	56.9	42.1	40.6
% Catch	33.0	47.9	28.3	36.8	49.4	37.9	40.6	26.2	44.2	28.2	28.5

Table A7b. Coho salmon harvest and catch rate data collected April 15 – September 30, 1985-2012. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.098	0.107	0.059	0.095	0.183	0.252	0.096	0.208	0.184	0.149	0.179
Catch/Boat Trip	0.127	0.142	0.086	0.154	0.244	0.443	0.130	0.345	0.258	0.239	0.271
Harv/Angler Trip	0.034	0.038	0.020	0.032	0.061	0.085	0.032	0.068	0.061	0.050	0.060
Catch/Angler Trip	0.044	0.050	0.030	0.052	0.082	0.148	0.044	0.113	0.085	0.080	0.090
Harv/Angler Hour	0.006	0.007	0.004	0.006	0.011	0.015	0.006	0.011	0.011	0.009	0.011
Catch/Angler Hr.	0.007	0.009	0.005	0.010	0.014	0.026	0.008	0.019	0.015	0.014	0.016
Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.295	0.147	0.040	0.281	0.406	0.535	0.215	0.401	0.451	0.384	0.166
May	0.110	0.144	0.056	0.141	0.533	0.560	0.162	0.210	0.144	0.118	0.213
June	0.053	0.093	0.010	0.067	0.065	0.429	0.007	0.085	0.237	0.151	0.032
July	0.032	0.041	0.019	0.003	0.026	0.026	0.015	0.054	0.202	0.217	0.054
August	0.090	0.078	0.110	0.031	0.113	0.142	0.031	0.120	0.158	0.060	0.266
September	0.080	0.165	0.032	0.182	0.080	0.149	0.229	0.389	0.153	0.166	0.247
Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.161	0.189	0.102	0.126	0.283	0.559	0.105	0.307	0.370	0.247	0.237
West/Central	0.112	0.083	0.011	0.079	0.100	0.131	0.026	0.073	0.139	0.152	0.074
East/Central	0.086	0.092	0.040	0.063	0.196	0.164	0.073	0.142	0.092	0.102	0.145
East	0.050	0.060	0.064	0.108	0.124	0.106	0.129	0.238	0.122	0.098	0.203
Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.392	0.299	0.048	0.365	0.564	0.784	0.340	0.605	0.591	0.923	0.290
May	0.154	0.194	0.106	0.234	0.692	1.253	0.290	0.649	0.230	0.232	0.482
June	0.076	0.176	0.010	0.333	0.255	0.648	0.054	0.132	0.398	0.296	0.143
July	0.048	0.043	0.029	0.028	0.032	0.038	0.026	0.078	0.296	0.308	0.090
August	0.103	0.086	0.154	0.042	0.130	0.199	0.031	0.138	0.202	0.084	0.301
September	0.094	0.198	0.044	0.191	0.103	0.171	0.243	0.424	0.185	0.191	0.288
Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.217	0.250	0.204	0.304	0.460	1.096	0.202	0.655	0.511	0.436	0.464
West/Central	0.178	0.167	0.036	0.129	0.129	0.199	0.071	0.175	0.294	0.364	0.192
East/Central	0.100	0.121	0.052	0.086	0.236	0.240	0.088	0.177	0.122	0.127	0.173
East	0.054	0.063	0.067	0.111	0.134	0.139	0.134	0.271	0.144	0.115	0.225
Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.282	0.369	0.139	0.272	0.588	0.712	0.289	0.522	0.614	0.377	0.440
Catch/Boat Trip	0.304	0.393	0.148	0.361	0.680	1.056	0.310	0.569	0.668	0.407	0.467
Harv/Angler Trip	0.057	0.076	0.028	0.053	0.116	0.138	0.056	0.103	0.118	0.072	0.086
Catch/Angler Trip	0.061	0.081	0.030	0.071	0.135	0.205	0.059	0.112	0.128	0.078	0.092
Harv/Angler Hour	0.008	0.011	0.004	0.008	0.017	0.020	0.008	0.015	0.018	0.011	0.013
Catch/Angler Hr.	0.008	0.011	0.004	0.011	0.020	0.029	0.009	0.016	0.020	0.012	0.014
Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.068	0.051	0.043	0.063	0.091	0.166	0.056	0.149	0.096	0.103	0.128
Catch/Boat Trip	0.097	0.090	0.074	0.115	0.145	0.327	0.093	0.302	0.174	0.206	0.232
Harv/Angler Trip	0.027	0.021	0.018	0.025	0.036	0.064	0.022	0.056	0.037	0.041	0.049
Catch/Angler Trip	0.038	0.037	0.030	0.045	0.058	0.127	0.037	0.113	0.067	0.081	0.089
Harv/Angler Hour	0.005	0.004	0.004	0.005	0.007	0.013	0.004	0.010	0.007	0.008	0.009
Catch/Angler Hr.	0.007	0.007	0.006	0.009	0.011	0.025	0.007	0.020	0.013	0.015	0.017

Table A8. Total length (inches), weight (lbs), and age statistics for coho salmon sampled April 15 - September 30 during the 1985-2012 NYSDEC Lake Ontario fishing boat surveys.

	Year Sampled										
	1985-02 avg.	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mean length and weight data for coho salmon sampled April 15 - September 30:											
Mean Length (in)	23.9	23.5	24.5	24.7	24.6	24.6	25.5	23.9	25.1	24.0	26.1
Mean Weight (lbs)	-	6.3	7.1	6.9	6.5	6.6	8.1	6.3	7.2	6.3	8.3
Estimated weight (lbs) for standard length coho salmon sampled April 15 - September 30:											
Standard Length											
18.0 inches	-	2.19	2.01	1.74	1.90	1.80	1.97	1.90	1.84	1.87	2.01
20.0 inches	-	3.18	2.96	2.63	2.81	2.67	2.92	2.82	2.75	2.79	2.92
22.0 inches	-	4.45	4.19	3.82	3.99	3.83	4.16	4.04	3.96	4.01	4.11
24.0 inches	-	6.04	5.77	5.36	5.50	5.32	5.75	5.61	5.52	5.57	5.60
26.0 inches	-	8.01	7.73	7.33	7.40	7.19	7.75	7.59	7.50	7.54	7.45
28.0 inches	-	10.34	10.08	9.74	9.67	9.46	10.15	9.98	9.90	9.92	9.66
30.0 inches	-	13.25	13.03	12.83	12.54	12.33	13.18	13.00	12.96	12.95	12.41
Percent length composition of coho salmon sampled April 15 - September 30:											
<15.0 in	0.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15.0-15.9 in	0.8%	0.0%	1.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
16.0-16.9 in	0.5%	0.0%	2.9%	0.0%	0.0%	0.0%	0.9%	0.7%	0.0%	0.0%	0.0%
17.0-17.9 in	2.3%	2.8%	2.9%	0.0%	0.0%	1.5%	1.8%	4.3%	0.0%	1.4%	0.0%
18.0-18.9 in	3.1%	11.1%	7.4%	0.9%	0.0%	2.5%	6.4%	6.1%	0.5%	7.7%	0.8%
19.0-19.9 in	6.4%	9.7%	2.9%	6.6%	0.9%	6.5%	10.1%	7.6%	3.3%	6.3%	3.1%
20.0-20.9 in	10.2%	6.9%	10.3%	13.2%	6.6%	8.5%	2.8%	7.2%	1.9%	10.6%	7.7%
21.0-21.9 in	12.9%	5.6%	2.9%	12.3%	11.9%	15.9%	0.9%	10.1%	12.2%	9.6%	7.7%
22.0-22.9 in	10.4%	6.9%	4.4%	11.3%	17.7%	9.0%	1.8%	10.4%	7.5%	5.3%	7.7%
23.0-23.9 in	8.5%	8.3%	2.9%	7.5%	15.0%	5.0%	3.7%	2.2%	9.9%	6.7%	4.6%
24.0-24.9 in	6.2%	9.7%	7.4%	5.7%	9.7%	3.0%	3.7%	4.0%	15.0%	9.6%	3.8%
25.0-25.9 in	5.7%	9.7%	8.8%	1.9%	6.6%	1.0%	5.5%	6.8%	11.7%	11.1%	5.4%
26.0-26.9 in	6.0%	9.7%	11.8%	0.0%	4.4%	8.0%	15.6%	11.2%	9.9%	5.8%	6.2%
27.0-27.9 in	6.6%	9.7%	16.2%	9.4%	8.4%	11.9%	15.6%	15.5%	8.5%	8.7%	14.6%
28.0-28.9 in	7.2%	5.6%	4.4%	13.2%	8.0%	13.4%	17.4%	9.4%	5.6%	9.1%	16.9%
29.0-29.9 in	5.4%	1.4%	8.8%	9.4%	7.5%	7.5%	8.3%	3.6%	7.5%	4.8%	9.2%
30.0-30.9 in	4.2%	0.0%	1.5%	5.7%	1.3%	6.0%	2.8%	0.7%	3.8%	2.4%	8.5%
31.0-31.9 in	1.8%	1.4%	0.0%	2.8%	1.8%	0.5%	0.0%	0.0%	1.4%	0.5%	3.1%
32.0-32.9 in	1.0%	0.0%	1.5%	0.0%	0.0%	0.0%	1.8%	0.0%	1.4%	0.0%	0.0%
>32.9 in	0.2%	1.4%	1.5%	0.0%	0.0%	0.0%	0.9%	0.4%	0.0%	0.5%	0.8%
Percent age composition of coho salmon sampled April 15 - September 30:											
Age-1	4.8%	0.0%	9.2%	1.0%	2.6%	1.6%	0.0%	0.4%	0.0%	0.0%	0.0%
Age-2	94.5%	98.8%	87.0%	97.9%	97.4%	93.8%	93.3%	99.6%	99.9%	99.3%	98.0%
Age-3	0.6%	1.2%	3.8%	1.1%	0.0%	4.6%	6.7%	0.0%	0.1%	0.7%	2.0%
Length data (inches) for age-2 coho salmon sampled April 15 - September 30:											
April Mean	20.6	20.7	19.0	20.7	21.3	20.6	18.7	18.5	21.4	19.4	21.0
September Mean	28.2	26.2	26.8	28.6	28.6	28.2	27.4	27.2	29.3	28.2	28.2
Avg Monthly Gain	1.7	1.3	1.8	1.7	1.6	1.7	1.9	2.0	1.7	1.9	1.6

Table A9a. Chinook salmon harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	54,370	31,525	51,443	68,957	39,439	53,336	35,520	54,964	31,676	46,333	55,137
Catch	73,362	62,094	92,042	102,792	59,606	84,842	55,776	101,427	61,960	97,899	88,851
% Harvested	73.9	50.8	55.9	67.1	66.2	62.9	63.7	54.2	51.1	47.3	62.1
Monthly estimates of harvest for all fishing boats:											
April	2,089	1,224	176	80	381	15	117	200	156	86	2,180
May	7,387	3,629	8,471	14,209	4,513	4,422	4,385	12,978	3,932	1,594	5,358
June	2,464	820	1,314	1,747	586	3,584	1,334	887	3,804	2,166	4,858
July	6,695	4,116	9,540	11,931	8,241	13,883	5,293	16,984	5,282	17,509	11,004
August	22,096	12,752	21,472	22,685	18,228	20,112	16,195	13,086	13,909	16,885	21,746
September	13,639	8,984	10,470	18,304	7,489	11,320	8,195	10,829	4,592	8,093	9,991
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	23,421	13,421	16,461	24,747	14,083	17,947	14,790	23,605	10,927	14,042	17,459
West/Central	6,104	1,879	3,032	5,601	3,643	4,072	880	2,957	1,750	2,047	3,277
East/Central	11,835	7,491	14,336	16,211	15,177	16,863	11,126	18,057	12,160	17,550	16,097
East	13,010	8,734	17,614	22,398	6,535	14,454	8,724	10,345	6,839	12,694	18,305
Monthly estimates of catch for all fishing boats:											
April	2,933	2,118	491	195	591	45	117	448	156	267	3,781
May	11,440	5,556	16,846	23,378	10,597	11,611	9,057	40,831	5,866	4,511	11,827
June	5,326	3,548	3,622	7,880	1,425	7,531	2,999	3,537	10,250	8,483	10,058
July	10,083	11,182	19,234	17,884	12,689	20,033	9,946	23,944	16,280	42,582	19,848
August	27,583	26,467	37,862	31,298	25,089	31,108	21,965	19,623	23,084	31,239	31,097
September	15,997	13,223	13,987	22,157	9,216	14,514	11,692	13,043	6,307	10,817	12,239
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	35,638	28,615	34,419	41,953	26,022	35,059	26,841	53,358	23,577	43,599	34,937
West/Central	9,584	7,258	9,133	13,027	6,333	8,209	2,810	9,887	9,774	7,038	9,223
East/Central	14,134	15,131	23,783	21,049	19,532	22,138	14,994	26,077	20,061	30,606	22,321
East	14,005	11,090	24,707	26,763	7,719	19,436	11,132	12,105	8,548	16,657	22,370
Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:											
% Harvest	99.8	99.8	100.0	99.9	100.0	99.9	100.0	100.0	100.0	100.0	100.0
% Catch	99.8	99.9	100.0	99.8	99.9	99.9	100.0	100.0	100.0	99.9	100.0
Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon:											
% Harvest	39.3	50.0	48.2	49.9	53.9	46.1	52.8	41.6	42.8	40.2	42.7
% Catch	35.0	39.5	38.3	40.7	39.3	36.0	43.0	27.8	35.8	32.3	32.3

Table A9b. Chinook salmon harvest and catch rate data collected April 15 – September 30, 1985-2012. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.475	0.661	0.896	1.198	0.825	0.925	0.693	0.886	0.633	0.935	1.197
Catch/Boat Trip	0.646	1.303	1.603	1.784	1.246	1.472	1.089	1.635	1.238	1.975	1.928
Harv/Angler Trip	0.164	0.234	0.311	0.407	0.277	0.310	0.232	0.290	0.209	0.314	0.398
Catch/Angler Trip	0.223	0.462	0.557	0.607	0.419	0.493	0.365	0.534	0.408	0.662	0.640
Harv/Angler Hour	0.028	0.041	0.057	0.074	0.049	0.055	0.041	0.048	0.038	0.056	0.070
Catch/Angler Hr.	0.038	0.082	0.102	0.111	0.074	0.088	0.064	0.089	0.073	0.118	0.113
Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.108	0.429	0.055	0.033	0.095	0.005	0.041	0.055	0.060	0.034	0.921
May	0.312	0.523	0.959	1.098	0.567	0.402	0.604	0.881	0.418	0.198	0.639
June	0.200	0.147	0.275	0.326	0.214	0.611	0.280	0.171	0.981	0.502	0.946
July	0.419	0.702	1.334	1.095	0.998	1.359	0.572	1.943	0.572	1.606	1.189
August	0.729	0.759	1.119	1.610	1.257	1.204	0.982	0.860	0.769	1.196	1.684
September	0.586	0.932	0.734	1.544	0.724	1.042	0.774	0.744	0.670	0.839	1.249
Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.736	1.125	1.476	1.723	1.277	1.113	1.189	1.272	0.766	0.954	1.378
West/Central	0.328	0.376	0.518	0.784	0.534	0.580	0.205	0.383	0.314	0.406	0.587
East/Central	0.364	0.424	0.807	0.930	0.905	1.022	0.651	0.941	0.726	1.159	1.184
East	0.397	0.665	0.778	1.204	0.496	0.802	0.501	0.624	0.507	0.867	1.288
Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.158	0.743	0.153	0.081	0.147	0.015	0.041	0.124	0.060	0.106	1.598
May	0.481	0.800	1.910	1.806	1.331	1.055	1.247	2.772	0.624	0.560	1.410
June	0.419	0.636	0.757	1.445	0.521	1.285	0.630	0.680	2.643	1.967	1.958
July	0.653	1.907	2.689	1.643	1.536	1.962	1.074	2.739	1.763	3.906	2.145
August	0.921	1.576	1.974	2.221	1.731	1.864	1.332	1.291	1.278	2.208	2.407
September	0.704	1.373	0.981	1.869	0.888	1.334	1.104	0.896	0.920	1.122	1.529
Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	1.157	2.399	3.086	2.911	2.359	2.175	2.158	2.875	1.654	2.959	2.757
West/Central	0.528	1.454	1.561	1.825	0.928	1.172	0.655	1.280	1.753	1.394	1.652
East/Central	0.443	0.858	1.339	1.207	1.163	1.341	0.877	1.359	1.198	2.022	1.640
East	0.431	0.845	1.091	1.439	0.585	1.078	0.640	0.731	0.634	1.137	1.575
Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	1.376	1.900	2.629	3.808	2.403	2.685	2.148	2.319	1.588	2.260	3.087
Catch/Boat Trip	1.655	2.960	3.733	4.628	2.645	3.335	2.749	2.859	2.596	3.838	3.765
Harv/Angler Trip	0.274	0.393	0.526	0.746	0.476	0.522	0.412	0.457	0.304	0.433	0.606
Catch/Angler Trip	0.330	0.613	0.747	0.907	0.524	0.649	0.527	0.563	0.498	0.736	0.739
Harv/Angler Hour	0.037	0.055	0.078	0.112	0.070	0.074	0.060	0.066	0.047	0.068	0.092
Catch/Angler Hr.	0.045	0.086	0.111	0.137	0.077	0.092	0.077	0.081	0.077	0.116	0.112
Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.335	0.400	0.555	0.712	0.466	0.593	0.395	0.615	0.436	0.670	0.822
Catch/Boat Trip	0.489	0.953	1.184	1.254	0.928	1.120	0.748	1.403	0.958	1.603	1.564
Harv/Angler Trip	0.131	0.167	0.225	0.281	0.186	0.230	0.156	0.230	0.169	0.264	0.316
Catch/Angler Trip	0.191	0.398	0.481	0.494	0.371	0.434	0.296	0.524	0.371	0.632	0.602
Harv/Angler Hour	0.024	0.033	0.045	0.055	0.036	0.045	0.030	0.040	0.033	0.050	0.060
Catch/Angler Hr.	0.035	0.079	0.097	0.098	0.072	0.085	0.057	0.092	0.072	0.119	0.114

Table A10. Total length (inches), weight (lbs), and age statistics for Chinook salmon sampled April 15 - September 30 during the 1985-2012 NYSDEC Lake Ontario fishing boat surveys.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mean length and weight data for chinook salmon sampled April 15 - September 30:											
Mean Length (in)	32.0	32.1	30.3	32.4	32.9	32.6	32.1	31.6	29.7	29.6	31.4
Mean Weight (lbs)	-	14.7	12.8	15.3	15.9	14.5	15.4	14.5	13.4	12.8	14.1
Estimated weight (lbs) for standard length chinook salmon sampled July & August:											
Standard Length:											
16.0 inches	-	1.49	1.39	1.37	1.42	1.37	1.47	1.31	1.47	1.36	1.34
20.0 inches	-	3.02	2.90	2.85	2.90	2.81	3.01	2.77	3.04	2.89	2.82
24.0 inches	-	5.42	5.33	5.22	5.24	5.07	5.47	5.15	5.55	5.39	5.23
28.0 inches	-	8.83	8.87	8.66	8.59	8.33	9.00	8.65	9.18	9.09	8.76
32.0 inches	-	13.55	13.86	13.48	13.25	12.84	13.92	13.62	14.27	14.35	13.77
36.0 inches	-	19.77	20.52	19.93	19.40	18.82	20.44	20.32	21.04	21.46	20.50
40.0 inches	-	27.61	29.06	28.17	27.21	26.40	28.74	28.97	29.69	30.64	29.17
Percent length composition of chinook salmon sampled April 15 - September 30:											
<16.0 in	1.5%	0.0%	0.7%	0.4%	0.1%	0.6%	0.3%	0.3%	0.2%	0.9%	0.5%
16.0-17.9 in	3.1%	2.1%	1.8%	1.3%	0.7%	0.3%	1.2%	1.3%	2.4%	3.5%	0.8%
18.0-19.9 in	3.7%	1.2%	2.7%	2.1%	3.4%	0.8%	1.9%	3.1%	9.1%	7.8%	1.6%
20.0-21.9 in	3.4%	1.6%	3.4%	0.6%	3.7%	0.8%	1.9%	2.1%	8.9%	5.7%	3.5%
22.0-23.9 in	3.5%	3.3%	3.9%	2.2%	3.4%	1.7%	3.6%	3.0%	8.7%	3.9%	3.0%
24.0-25.9 in	4.5%	4.2%	6.1%	4.5%	3.2%	3.8%	6.3%	5.6%	5.5%	4.3%	5.3%
26.0-27.9 in	6.0%	7.0%	10.8%	6.7%	4.8%	6.0%	7.0%	6.4%	5.9%	5.8%	6.8%
28.0-29.9 in	6.8%	9.1%	14.0%	6.2%	7.2%	8.6%	6.4%	7.9%	5.7%	6.7%	12.8%
30.0-31.9 in	7.4%	11.4%	15.8%	10.7%	7.3%	15.2%	12.1%	12.6%	6.3%	13.7%	14.0%
32.0-33.9 in	10.3%	14.4%	13.3%	17.6%	9.9%	17.5%	12.6%	17.5%	10.2%	21.2%	17.7%
34.0-35.9 in	13.4%	22.6%	12.0%	22.0%	16.6%	22.1%	17.1%	19.9%	12.9%	16.2%	15.9%
36.0-37.9 in	17.7%	17.4%	11.2%	19.4%	23.1%	15.7%	17.1%	14.7%	12.6%	7.5%	9.6%
38.0-39.9 in	13.0%	5.1%	4.1%	5.5%	12.4%	6.1%	11.1%	4.7%	7.0%	1.9%	6.1%
40.0-41.9 in	5.0%	0.5%	0.3%	0.8%	4.1%	0.7%	1.3%	0.8%	4.3%	0.8%	2.2%
42.0-43.9 in	0.6%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.1%	0.4%	0.0%	0.1%
>43.9 in	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Percent age composition of chinook salmon sampled April 15 - September 30:											
Age-0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Age-1	12.6%	5.3%	6.7%	3.5%	9.0%	3.2%	3.1%	4.8%	33.7%	22.2%	5.0%
Age-2	34.5%	35.8%	57.1%	31.6%	28.9%	46.4%	47.9%	29.5%	24.9%	68.9%	70.8%
Age-3	48.6%	58.7%	35.4%	64.1%	57.8%	47.7%	46.6%	64.8%	38.6%	8.6%	24.1%
Age-4	4.2%	0.2%	0.7%	0.7%	4.3%	2.7%	2.3%	0.9%	2.8%	0.2%	0.2%
Age-3&4 combined	52.8%	58.9%	36.1%	64.9%	62.1%	50.4%	49.0%	65.7%	41.4%	8.8%	24.2%

Table A11. Mean length at age data (total length in inches) for Chinook salmon sampled July-September during the 1991-2012 NYSDEC Lake Ontario fishing boat surveys.

	Year	July		August		September	
Age	Sampled	Mean Length	(n)	Mean Length	(n)	Mean Length	(n)
Age-1	1991	18.74	(8)	19.23	(22)	22.52	(9)
	1992	18.93	(38)	20.49	(53)	22.04	(35)
	1993	18.44	(9)	18.14	(61)	19.37	(33)
	1994	16.40	(1)	17.79	(9)	18.59	(12)
	1995	18.62	(6)	20.53	(4)	-	(0)
	1996	18.58	(15)	19.66	(74)	21.85	(24)
	1997	19.06	(9)	19.18	(45)	20.43	(23)
	1998	20.12	(10)	19.63	(22)	21.13	(3)
	1999	20.58	(19)	20.08	(26)	23.69	(12)
	2000	20.53	(24)	20.56	(17)	23.20	(10)
	2001	18.75	(25)	19.33	(22)	21.65	(10)
	2002	17.86	(10)	19.94	(9)	21.75	(6)
	2003	18.83	(3)	17.48	(10)	21.20	(6)
	2004	18.00	(6)	18.00	(36)	19.84	(23)
	2005	18.12	(25)	18.98	(14)	19.93	(3)
	2006	19.61	(37)	20.97	(38)	23.57	(9)
	2007	18.82	(6)	20.82	(9)	21.84	(14)
	2008	18.51	(8)	19.62	(6)	21.10	(1)
	2009	19.34	(13)	19.05	(25)	22.40	(1)
	2010	20.53	(55)	21.56	(67)	23.42	(30)
	2011	19.31	(77)	20.88	(49)	22.11	(20)
	2012	19.61	(11)	21.48	(12)	24.30	(1)
	91-'12 avg	19.36	(415)	19.80	(630)	21.51	(285)
Age-2	1991	27.40	(30)	28.96	(75)	31.58	(24)
	1992	28.69	(32)	30.00	(122)	32.42	(47)
	1993	29.57	(22)	30.98	(121)	31.61	(43)
	1994	27.27	(60)	28.77	(80)	28.85	(100)
	1995	28.14	(42)	28.74	(49)	31.94	(7)
	1996	31.90	(2)	29.50	(27)	30.52	(12)
	1997	29.95	(61)	30.45	(239)	32.14	(52)
	1998	30.93	(32)	31.68	(77)	33.87	(15)
	1999	29.68	(12)	31.17	(38)	32.95	(41)
	2000	30.28	(28)	32.17	(49)	33.82	(17)
	2001	30.14	(61)	31.86	(67)	32.34	(32)
	2002	30.35	(6)	31.52	(55)	32.54	(36)
	2003	28.64	(56)	29.98	(35)	31.93	(26)
	2004	28.26	(126)	29.48	(203)	30.71	(106)
	2005	28.18	(102)	29.60	(118)	31.65	(78)
	2006	29.15	(75)	29.96	(106)	30.93	(30)
	2007	29.87	(131)	30.29	(163)	32.09	(91)
	2008	27.62	(68)	30.36	(102)	32.13	(82)
	2009	27.33	(80)	29.04	(68)	31.12	(33)
	2010	29.64	(39)	32.39	(36)	33.73	(20)
	2011	30.80	(185)	32.92	(180)	34.09	(86)
	2012	30.33	(121)	32.34	(155)	34.02	(76)
	91-'12 avg	29.2	(1371)	30.6	(2163)	31.96	(1054)

Table A11 (continued). Mean length at age data (total length in inches) for Chinook salmon.

	Year	July		August		September	
Age	Sampled	Mean Length	(n)	Mean Length	(n)	Mean Length	(n)
Age-3	1991	36.81	(44)	37.47	(105)	38.15	(148)
	1992	36.12	(40)	37.24	(124)	37.74	(129)
	1993	37.09	(20)	37.42	(211)	36.90	(110)
	1994	35.86	(91)	36.30	(204)	36.24	(107)
	1995	35.97	(74)	36.34	(134)	36.96	(113)
	1996	36.39	(9)	37.15	(98)	37.89	(76)
	1997	35.21	(7)	36.87	(58)	37.72	(18)
	1998	36.92	(41)	37.33	(194)	37.35	(31)
	1999	36.67	(15)	38.35	(111)	38.29	(85)
	2000	36.20	(23)	37.49	(108)	37.96	(37)
	2001	36.23	(42)	37.26	(51)	37.77	(20)
	2002	38.70	(1)	37.21	(51)	37.17	(42)
	2003	35.14	(28)	35.57	(64)	35.71	(112)
	2004	34.78	(52)	36.12	(160)	35.88	(69)
	2005	34.65	(111)	35.90	(278)	35.86	(172)
	2006	35.77	(107)	36.93	(231)	36.71	(121)
	2007	35.19	(127)	35.63	(168)	35.95	(127)
	2008	35.24	(44)	36.51	(132)	37.09	(83)
	2009	34.35	(147)	35.19	(148)	35.59	(141)
	2010	35.53	(23)	37.41	(79)	37.97	(27)
	2011	36.18	(28)	37.58	(17)	38.79	(12)
	2012	36.66	(35)	37.69	(71)	38.37	(21)
	91-'12 avg	35.54	(1109)	36.72	(2797)	36.85	(1801)
Age-4	1991	39.42	(6)	39.87	(21)	39.77	(10)
	1992	40.78	(4)	39.74	(9)	39.25	(12)
	1993	37.37	(3)	38.27	(22)	39.06	(7)
	1994	38.40	(5)	38.55	(15)	39.05	(4)
	1995	38.57	(9)	37.83	(15)	37.78	(5)
	1996	37.50	(2)	39.14	(29)	40.37	(23)
	1997	-	(0)	39.52	(18)	39.68	(4)
	1998	-	(0)	37.97	(6)	-	(0)
	1999	-	(0)	39.73	(6)	39.30	(5)
	2000	-	(0)	-	(0)	-	(0)
	2001	37.20	(2)	-	(0)	41.40	(1)
	2002	-	(0)	36.75	(2)	42.10	(1)
	2003	-	(0)	-	(0)	37.00	(1)
	2004	36.10	(1)	37.36	(5)	37.80	(1)
	2005	35.80	(2)	38.63	(4)	36.00	(2)
	2006	37.54	(7)	38.68	(21)	37.10	(2)
	2007	37.13	(3)	36.63	(11)	37.71	(8)
	2008	36.67	(3)	37.69	(9)	37.20	(2)
	2009	39.50	(1)	36.68	(4)	-	(0)
	2010	37.60	(2)	37.08	(4)	39.85	(2)
	2011	36.70	(1)	-	(0)	-	(0)
	2012	-	(0)	40	(1)	-	(0)
	91-'12 avg	38.11	(51)	38.61	(202)	39.24	(90)

Table A12. Chinook salmon relative harvest (age-specific harvest per 150,000 boat trips) by year class and year sampled, from the 1985-2012 NYSDEC Lake Ontario fishing boat surveys.

Year	Fing Equiv	Chinook Salmon Harvested Per 150,000 Boat Trips				
Class	Stocked	Age-1	Age-2	Age-3	Age-4	Total
1981	862,840				1,594	
1982	1,175,354			22,529	1,177	
1983	2,544,180		17,511	27,129	3,802	
1984	2,957,230	15,066	25,040	45,305	3,555	88,996
1985	3,252,830	11,971	32,146	39,890	7,435	91,443
1986	2,810,771	12,077	24,115	63,952	3,337	103,481
1987	3,368,296	9,445	34,039	41,097	5,713	90,330
1988	3,104,104	9,050	21,120	41,277	2,353	73,891
1989	3,018,754	3,483	22,269	27,327	3,714	56,794
1990	2,964,722	5,336	19,283	35,704	3,651	63,974
1991	3,129,453	10,412	26,706	54,789	3,464	95,371
1992	3,004,329	10,003	37,467	35,071	7,934	90,637
1993	1,846,892	2,465	12,505	26,866	3,170	45,006
1994	1,221,491	1,072	5,928	12,405	1,092	20,497
1995	1,364,090	16,070	52,594	39,323	2,384	110,370
1996	1,495,138	10,003	20,263	42,021	0	72,287
1997	1,911,040	5,462	18,568	29,401	453	53,884
1998	1,903,929	10,849	21,047	21,477	627	54,000
1999	1,767,524	8,722	29,542	22,215	193	60,671
2000	1,906,543	8,149	25,685	58,334	977	93,144
2001	1,893,686	5,322	35,518	47,586	1,320	89,858
2002	1,908,002	5,254	76,817	115,363	5,275	202,709
2003	1,700,374	9,060	56,861	71,548	3,785	141,254
2004	1,962,565	6,310	35,774	66,249	2,437	110,770
2005	2,075,169	11,131	64,365	48,487	1,196	125,180
2006	1,898,083	4,449	49,807	86,156	2,618	143,031
2007	2,055,075	3,270	39,227	36,675	244	79,415
2008	1,038,844	6,339	23,630	12,123	296	42,388
2009	1,981,055	31,988	96,707	43,212		
2010	1,911,756	31,194	127,157			
2011	2,060,874	8,899				

Table A12 (continued). Chinook salmon relative harvest by year class and year sampled.

Year Sampled	Salmonid Boat Trips	Chinook Salmon Harvested Per 150,000 Boat Trips				
		Age-1	Age-2	Age-3	Age-4	Total
1985	126,155	15,066	17,511	22,529	1,594	56,700
1986	148,950	11,971	25,040	27,129	1,177	65,316
1987	165,678	12,077	32,146	45,305	3,802	93,366
1988	160,805	9,445	24,115	39,890	3,555	77,097
1989	177,223	9,050	34,039	63,952	7,435	114,477
1990	181,867	3,483	21,120	41,097	3,337	69,038
1991	152,357	5,336	22,269	41,277	5,713	74,594
1992	118,054	10,412	19,283	27,327	2,353	59,536
1993	103,125	10,003	26,706	35,704	3,714	76,125
1994	102,718	2,465	37,467	54,789	3,651	98,372
1995	92,346	1,072	12,505	35,071	3,464	52,112
1996	70,151	16,070	5,928	26,866	7,934	56,796
1997	64,351	10,003	52,594	12,405	3,170	78,174
1998	64,060	5,462	20,263	39,323	1,092	66,138
1999	60,573	10,849	18,568	42,021	2,384	73,825
2000	64,589	8,722	21,047	29,401	0	59,170
2001	63,026	8,149	29,542	21,477	453	59,730
2002	50,826	5,322	25,685	22,215	627	53,848
2003	47,622	5,254	35,518	58,334	193	99,298
2004	57,397	9,060	76,817	47,586	977	134,440
2005	57,510	6,310	56,861	115,363	1,320	179,857
2006	47,812	11,131	35,774	71,548	5,275	123,731
2007	57,620	4,449	64,365	66,249	3,785	138,848
2008	51,229	3,270	49,807	48,487	2,437	104,005
2009	62,028	6,339	39,227	86,156	1,196	132,917
2010	50,059	31,988	23,630	36,675	2,618	94,916
2011	49,548	31,194	96,707	12,123	244	140,267
2012	46,059	8,899	127,157	43,212	296	179,564

Table A13. Number of fingerling equivalents and average size (grams) of Chinook salmon stocked into Lake Ontario from 1981-2012 by NYSDEC, Ontario Ministry of Natural Resources and pen-rearing cooperators. Calculations previously described in Eckert (2007).

	DEC Stocked Fish						OMNR Stocked Fish				Total Lake Ontario	
	Salmon River		Caledonia		Pen Reared		OMNR Hatchery		Pen Reared		Chinook Salmon	
Year Class	Number Stocked	Avg Size	Number Stocked	Avg Size	Number Stocked	Avg Size	Number Stocked	Avg Size	Number Stocked	Avg Size	Number Stocked	Avg Size
1981	379,941	1.8	479,300	3.1			3,599	2.3			862,840	2.4
1982	888,400	2.1	184,000	3.7			102,954	2.5			1,175,354	2.3
1983	2,064,260	3.8	455,000	4.2			24,920	1.8			2,544,180	3.8
1984	2,609,750	3.5	195,000	2.0			152,480	2.0			2,957,230	3.1
1985	2,957,800	4.8					295,030	4.4			3,252,830	4.7
1986	1,848,800	4.2	663,200	4.5			298,771	4.9			2,810,771	4.4
1987	2,495,000	4.9	616,330	4.6			256,966	4.2			3,368,296	4.8
1988	2,305,000	4.5	543,000	4.5			256,104	5.1			3,104,104	4.6
1989	2,212,200	4.5	540,000	4.9			266,554	4.4			3,018,754	4.6
1990	2,180,000	5.3	540,000	4.5			244,722	4.1			2,964,722	5.0
1991	2,794,000	5.1			41,000	4.1	294,453	4.8			3,129,453	5.1
1992	2,655,691	4.6			46,260	3.9	302,378	5.0			3,004,329	4.7
1993	1,557,300	4.5			40,000	3.8	249,592	5.1			1,846,892	4.6
1994	944,000	5.0			40,000	3.9	237,491	4.5			1,221,491	4.8
1995	1,136,666	4.6					227,424	4.3			1,364,090	4.5
1996	1,300,000	4.6					195,138	3.8			1,495,138	4.4
1997	1,604,980	5.1					306,060	4.6			1,911,040	4.9
1998	1,546,000	5.0			49,763	7.6	308,166	4.6			1,903,929	4.9
1999	1,183,000	4.7	90,000	4.5	315,000	4.5	179,524	4.3			1,767,524	4.6
2000	1,252,300	4.7	90,000	4.1	300,000	4.8	264,243	4.1			1,906,543	4.5
2001	1,202,800	4.9	118,610	3.9	300,000	5.0	272,276	4.0			1,893,686	4.6
2002	1,211,000	5.3	123,000	4.3	299,496	5.4	274,506	4.4			1,908,002	5.0
2003	1,167,240	4.7	110,400	3.5	189,356	4.5	223,233	3.9	10,145	5.4	1,700,374	4.4
2004	928,160	4.7	451,030	3.9	322,269	5.3	251,103	4.1	10,004	5.2	1,962,565	4.5
2005	994,660	5.3	421,280	4.1	386,599	5.3	262,621	4.7	10,010	6.0	2,075,169	5.0
2006	1,035,680	3.9	342,200	3.5	313,100	6.1	197,107	3.9	9,997	5.7	1,898,083	4.1
2007	1,477,670	5.1			313,100	6.7	254,307	4.7	9,998	5.7	2,055,075	5.2
2008	559,524	6			224,702	5.9	241,875	4.1	12,743	6.6	1,038,844	5.3
2009	1,411,957	4.9			313,600	7.2	233,820	4.5	21,678	4.4	1,981,055	5.1
2010	1,024,046	5.6			506,560	6.4	341,390	4.9	39,820	8.9	1,911,756	5.7
2011	1,260,584	5.3			508,670	6.4	249,079	4.3	42,541	7.7	2,060,874	5.4

Table A14a. Rainbow trout harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	27,122	8,245	11,376	7,557	10,750	12,861	19,685	24,060	23,856	16,131	12,617
Catch	37,817	13,943	20,182	13,528	17,959	25,892	33,943	54,501	46,249	36,533	32,975
% Harvested	72.3	59.1	56.4	55.9	59.9	49.7	58.0	44.1	51.6	44.2	38.3
Monthly estimates of harvest for all fishing boats:											
April	1,415	492	106	259	186	228	262	473	463	56	199
May	6,036	1,202	3,986	1,320	1,872	2,619	2,481	1,698	1,548	410	939
June	4,036	2,124	653	1,038	526	1,112	978	813	2,406	1,095	2,156
July	3,446	740	1,376	1,584	1,901	3,666	2,889	5,816	4,831	7,299	4,301
August	9,281	3,305	3,752	2,274	1,948	3,613	9,800	10,096	13,568	4,587	4,381
September	2,908	380	1,504	1,082	4,318	1,622	3,275	5,164	1,040	2,684	640
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	16,055	5,254	6,483	5,144	6,763	8,537	14,945	19,388	18,973	11,637	8,622
West/Central	3,152	492	1,069	594	1,516	1,578	760	1,728	1,447	2,023	1,245
East/Central	6,501	2,364	3,570	1,171	2,102	2,335	3,603	2,221	3,065	2,340	1,852
East	1,413	135	255	648	369	411	377	722	370	131	898
Monthly estimates of catch for all fishing boats:											
April	2,356	1,257	371	415	399	429	565	1,197	867	305	442
May	8,665	2,087	7,794	3,100	3,736	7,264	5,840	7,418	2,724	2,060	3,100
June	5,767	3,993	928	2,567	787	2,708	2,197	2,676	4,828	1,813	6,515
July	4,684	1,119	2,169	2,291	3,004	6,504	6,026	9,053	8,856	18,448	11,100
August	12,266	4,730	6,665	3,628	3,912	6,520	14,823	22,335	27,121	9,037	10,858
September	4,079	756	2,255	1,526	6,120	2,467	4,492	11,822	1,851	4,869	960
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	22,135	7,903	11,616	9,664	10,945	16,537	23,556	35,347	36,512	26,897	22,064
West/Central	5,406	1,493	2,234	1,437	3,383	3,130	1,727	12,065	3,891	3,377	5,355
East/Central	8,539	4,322	5,993	1,595	3,249	5,382	8,040	5,824	5,166	5,164	4,195
East	1,738	225	339	832	382	843	620	1,266	681	1,096	1,361
Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:											
% Harvest	99.7	99.7	100.0	99.8	100.0	100.0	99.8	100.0	100.0	99.8	100.0
% Catch	99.6	98.8	99.3	99.9	100.0	99.9	99.7	99.8	99.9	99.9	100.0
Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon:											
% Harvest	48.8	59.0	63.9	52.0	66.3	50.0	59.4	50.7	49.8	50.2	45.9
% Catch	39.9	40.9	45.0	36.8	51.1	36.8	47.0	34.7	35.5	33.5	27.1

Table A14b. Rainbow trout harvest and catch rate data collected April 15 – September 30, 1985-2012. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.264	0.173	0.198	0.131	0.225	0.223	0.384	0.388	0.477	0.325	0.274
Catch/Boat Trip	0.364	0.289	0.349	0.235	0.376	0.449	0.661	0.877	0.923	0.737	0.716
Harv/Angler Trip	0.090	0.061	0.069	0.045	0.076	0.075	0.129	0.127	0.157	0.109	0.091
Catch/Angler Trip	0.125	0.103	0.121	0.080	0.126	0.150	0.221	0.287	0.305	0.247	0.238
Harv/Angler Hour	0.015	0.011	0.013	0.008	0.013	0.013	0.023	0.021	0.028	0.019	0.016
Catch/Angler Hr.	0.021	0.018	0.022	0.015	0.022	0.027	0.039	0.048	0.055	0.044	0.042
Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.116	0.173	0.033	0.108	0.046	0.076	0.091	0.131	0.177	0.022	0.084
May	0.301	0.173	0.453	0.101	0.235	0.238	0.342	0.115	0.165	0.051	0.112
June	0.380	0.376	0.137	0.194	0.192	0.190	0.199	0.156	0.620	0.254	0.420
July	0.237	0.126	0.192	0.146	0.230	0.359	0.312	0.665	0.523	0.669	0.465
August	0.326	0.197	0.196	0.161	0.134	0.217	0.594	0.665	0.750	0.323	0.339
September	0.146	0.040	0.105	0.091	0.418	0.149	0.309	0.355	0.152	0.278	0.080
Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.687	0.440	0.581	0.357	0.613	0.530	1.201	1.044	1.331	0.789	0.680
West/Central	0.170	0.099	0.183	0.083	0.222	0.227	0.177	0.224	0.260	0.401	0.223
East/Central	0.197	0.133	0.201	0.067	0.125	0.141	0.209	0.116	0.183	0.155	0.136
East	0.037	0.010	0.011	0.035	0.028	0.023	0.022	0.044	0.027	0.009	0.063
Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.198	0.441	0.116	0.173	0.099	0.143	0.197	0.332	0.332	0.121	0.187
May	0.436	0.299	0.885	0.238	0.469	0.660	0.804	0.504	0.290	0.256	0.370
June	0.545	0.707	0.179	0.479	0.288	0.459	0.449	0.515	1.238	0.417	1.268
July	0.309	0.172	0.300	0.211	0.364	0.637	0.647	1.035	0.959	1.692	1.199
August	0.424	0.282	0.345	0.257	0.270	0.391	0.899	1.465	1.500	0.638	0.841
September	0.203	0.079	0.158	0.129	0.592	0.227	0.424	0.811	0.270	0.505	0.120
Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.926	0.661	1.041	0.672	0.992	1.026	1.893	1.904	2.561	1.826	1.741
West/Central	0.311	0.298	0.376	0.201	0.495	0.447	0.399	1.559	0.698	0.669	0.959
East/Central	0.261	0.238	0.332	0.091	0.194	0.326	0.466	0.300	0.307	0.340	0.309
East	0.045	0.016	0.015	0.045	0.029	0.047	0.036	0.076	0.050	0.075	0.096
Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.931	0.586	0.771	0.435	0.805	0.702	1.340	1.236	1.391	0.981	0.759
Catch/Boat Trip	1.050	0.687	0.963	0.551	1.035	1.040	1.828	1.919	1.925	1.484	1.169
Harv/Angler Trip	0.185	0.121	0.154	0.085	0.159	0.136	0.257	0.244	0.267	0.188	0.149
Catch/Angler Trip	0.208	0.142	0.193	0.108	0.205	0.202	0.351	0.378	0.369	0.284	0.230
Harv/Angler Hour	0.025	0.017	0.023	0.013	0.024	0.019	0.037	0.035	0.041	0.030	0.023
Catch/Angler Hr.	0.028	0.020	0.029	0.016	0.030	0.029	0.051	0.055	0.057	0.045	0.035
Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.152	0.085	0.086	0.074	0.093	0.133	0.187	0.227	0.289	0.194	0.178
Catch/Boat Trip	0.248	0.205	0.228	0.176	0.226	0.337	0.421	0.680	0.717	0.587	0.626
Harv/Angler Trip	0.059	0.036	0.035	0.029	0.037	0.052	0.074	0.085	0.112	0.077	0.068
Catch/Angler Trip	0.097	0.086	0.093	0.069	0.090	0.131	0.167	0.254	0.278	0.232	0.241
Harv/Angler Hour	0.011	0.007	0.007	0.006	0.007	0.010	0.014	0.015	0.022	0.014	0.013
Catch/Angler Hr.	0.018	0.017	0.019	0.014	0.017	0.026	0.032	0.045	0.054	0.044	0.046

Table A15. Length (total length in inches) and weight (lbs) statistics for rainbow trout sampled April 15 – September 30 during the 1985-2012 NYSDEC Lake Ontario fishing boat surveys.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mean length and weight data for rainbow trout sampled April 15 - September 30:											
Mean Length (in)	24.4	23.5	24.4	24.4	24.2	24.9	25.1	25.0	25.3	24.7	24.9
Mean Weight (lbs)	-	6.0	6.2	6.0	5.9	6.0	6.2	6.0	6.8	6.1	5.9
Estimated weight (lbs) for standard length rainbow trout sampled April 15 - September 30:											
Standard Length:											
18.0 inches	-	2.62	2.28	2.42	2.43	2.07	2.22	2.10	2.40	2.09	2.05
20.0 inches	-	3.51	3.12	3.25	3.26	2.86	3.02	2.89	3.26	2.92	2.83
22.0 inches	-	4.57	4.15	4.25	4.25	3.83	3.99	3.85	4.30	3.95	3.80
24.0 inches	-	5.82	5.37	5.41	5.42	5.00	5.13	5.00	5.53	5.21	4.97
26.0 inches	-	7.27	6.80	6.77	6.78	6.38	6.47	6.36	6.97	6.71	6.35
28.0 inches	-	8.89	8.44	8.29	8.30	7.97	7.99	7.92	8.60	8.46	7.94
30.0 inches	-	10.77	10.36	10.05	10.06	9.85	9.77	9.75	10.51	10.53	9.82
32.0 inches	-	12.88	12.54	12.03	12.04	12.00	11.78	11.84	12.67	12.92	11.98
Percent length composition of rainbow trout sampled April 15 - September 30:											
<15.0 in	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15.0-15.9 in	0.3%	0.0%	0.0%	0.0%	0.0%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%
16.0-16.9 in	1.1%	1.2%	1.3%	0.0%	0.5%	0.0%	0.3%	0.2%	0.0%	0.0%	0.0%
17.0-17.9 in	2.2%	4.7%	1.3%	1.5%	1.0%	0.4%	0.3%	1.5%	0.3%	1.3%	0.5%
18.0-18.9 in	4.2%	10.6%	5.2%	3.7%	2.9%	3.5%	3.8%	1.2%	1.1%	1.3%	0.5%
19.0-19.9 in	6.8%	7.1%	7.7%	5.2%	5.4%	2.6%	1.4%	3.2%	1.6%	3.3%	1.6%
20.0-20.9 in	8.1%	12.9%	5.8%	7.5%	8.3%	7.5%	4.8%	5.4%	4.1%	4.6%	5.3%
21.0-21.9 in	9.1%	10.6%	9.7%	5.2%	9.3%	9.7%	8.7%	8.2%	8.5%	12.8%	7.4%
22.0-22.9 in	9.0%	3.5%	9.0%	17.9%	7.8%	8.4%	10.4%	9.2%	11.8%	12.1%	10.1%
23.0-23.9 in	8.8%	5.9%	10.3%	9.0%	15.6%	15.4%	6.2%	9.9%	11.5%	10.8%	16.0%
24.0-24.9 in	7.6%	8.2%	8.4%	9.0%	13.2%	5.3%	9.3%	7.7%	10.4%	7.5%	12.2%
25.0-25.9 in	6.9%	5.9%	8.4%	6.7%	8.3%	5.3%	8.7%	12.6%	8.5%	7.9%	11.2%
26.0-26.9 in	6.3%	5.9%	3.2%	8.2%	5.4%	7.5%	12.5%	10.1%	11.8%	11.1%	7.4%
27.0-27.9 in	6.8%	7.1%	7.7%	8.2%	6.8%	8.4%	12.5%	9.4%	9.0%	8.2%	12.8%
28.0-28.9 in	6.2%	1.2%	4.5%	4.5%	6.3%	10.1%	9.3%	9.9%	7.4%	9.5%	5.3%
29.0-29.9 in	5.1%	4.7%	4.5%	6.7%	4.4%	6.2%	6.6%	5.0%	4.9%	4.3%	3.7%
30.0-30.9 in	4.5%	2.4%	4.5%	1.5%	2.4%	4.4%	2.8%	4.0%	4.9%	3.6%	3.2%
31.0-31.9 in	3.0%	3.5%	5.8%	2.2%	1.5%	2.6%	1.4%	1.7%	1.4%	1.3%	1.1%
32.0-32.9 in	1.9%	3.5%	0.6%	1.5%	0.0%	1.8%	0.0%	0.7%	1.9%	0.0%	0.5%
33.0-33.9 in	1.0%	1.2%	0.6%	1.5%	0.5%	0.4%	0.3%	0.0%	0.5%	0.3%	1.1%
>33.9 in	0.8%	0.0%	1.3%	0.0%	0.5%	0.0%	0.7%	0.0%	0.3%	0.0%	0.0%

Table A16. Atlantic salmon harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	392	18	19	15	0	14	79	532	624	398	310
Catch	1,439	102	50	270	158	214	233	1,273	1,826	1,519	592
% Harvested	27.5	17.6	38.0	5.6	0.0	6.5	33.9	41.8	34.2	26.2	52.4
Monthly estimates of harvest for all fishing boats:											
April	72	18	19	15	0	0	0	105	98	128	29
May	171	0	0	0	0	0	28	222	79	95	183
June	58	0	0	0	0	14	0	15	24	54	46
July	34	0	0	0	0	0	16	66	301	76	51
August	50	0	0	0	0	0	0	124	108	25	0
September	7	0	0	0	0	0	35	0	15	21	0
Seasonal estimates of harvest among four geographic areas for all fishing boats:											
West	97	18	0	0	0	14	51	226	205	236	126
West/Central	66	0	0	0	0	0	0	161	182	0	0
East/Central	111	0	19	15	0	0	0	74	204	106	93
East	118	0	0	0	0	0	28	71	33	56	91
Monthly estimates of catch for all fishing boats:											
April	266	18	19	15	31	0	0	201	273	296	56
May	468	39	30	0	17	72	88	430	223	439	387
June	190	0	0	47	0	114	64	66	231	171	46
July	233	45	0	171	0	28	16	211	648	212	90
August	199	0	0	37	110	0	30	365	372	340	13
September	83	0	0	0	0	0	35	0	79	62	0
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	335	59	31	34	72	116	52	363	560	526	242
West/Central	250	0	0	131	31	70	36	337	397	366	46
East/Central	441	43	19	60	0	0	47	509	650	339	211
East	414	0	0	44	55	28	98	63	219	287	93
Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:											
% Harvest	98.6	100	100	100		100	100	100	100	100	100
% Catch	97.6	100	100	54.81481	100	100	100	100.0	100	100	100
Seasonal rates of harvest and catch per 100 trips for boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.316	0.038	0.033	0.026	0.000	0.024	0.154	0.858	1.247	0.803	0.673
Catch/Boat Trip	1.147	0.214	0.087	0.257	0.330	0.371	0.455	2.052	3.648	3.066	1.285
Harv/Angler Trip	0.110	0.013	0.011	0.009	0.000	0.008	0.052	0.280	0.411	0.269	0.224
Catch/Angler Trip	0.400	0.076	0.030	0.088	0.111	0.124	0.152	0.671	1.203	1.028	0.427
Harv/Angler Hour	0.019	0.002	0.002	0.002	0.000	0.001	0.009	0.047	0.074	0.048	0.039
Catch/Angler Hr.	0.068	0.013	0.006	0.016	0.020	0.022	0.027	0.111	0.217	0.183	0.075

Table A17a. Brown trout harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	33,950	22,141	14,991	20,702	13,667	27,855	14,989	23,148	18,311	32,937	23,305
Catch	47,270	40,423	23,003	32,709	21,957	46,258	22,030	33,484	32,604	49,661	39,507
% Harvested	71.7	54.8	65.2	63.3	62.2	60.2	68.0	69.1	56.2	66.3	59.0
Monthly estimates of harvest for all fishing boats:											
April	9,232	5,930	845	3,912	3,304	5,795	1,420	4,023	3,855	3,558	5,802
May	12,159	5,098	4,382	9,655	4,117	9,083	3,828	11,256	2,266	12,255	5,436
June	4,493	2,460	4,497	3,867	1,068	4,052	4,164	2,393	611	4,941	1,456
July	4,112	3,210	1,853	2,187	3,630	4,570	3,280	576	7,782	6,695	5,631
August	3,327	4,814	3,390	744	1,398	4,100	1,945	4,538	3,543	4,968	4,307
September	627	629	24	337	150	256	352	362	255	519	672
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	2,737	3,139	834	1,376	453	2,633	1,052	209	1,153	2,563	2,006
West/Central	3,345	899	2,874	1,713	1,164	2,667	541	1,744	1,487	2,163	2,792
East/Central	18,428	16,353	9,864	9,905	9,322	15,145	3,969	17,399	11,156	16,327	8,932
East	9,440	1,749	1,418	7,708	2,727	7,410	9,427	3,796	4,515	11,883	9,575
Monthly estimates of catch for all fishing boats:											
April	12,368	10,294	2,556	5,795	4,342	10,656	1,996	5,997	5,501	8,160	10,558
May	16,307	9,987	6,448	14,907	5,181	15,302	5,983	15,838	3,913	17,584	9,446
June	5,962	3,210	6,001	5,442	1,262	5,337	6,110	3,463	1,342	6,658	3,345
July	6,364	5,537	2,575	4,025	5,225	9,167	4,692	888	14,421	10,026	7,751
August	5,332	10,271	5,115	2,163	5,567	5,347	2,654	6,720	6,993	6,193	7,236
September	938	1,123	308	377	381	449	595	579	434	1,041	1,171
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	4,195	6,170	1,458	2,829	828	3,828	1,408	344	2,043	4,760	4,122
West/Central	6,467	5,173	4,984	5,688	2,273	6,652	1,162	3,182	3,005	5,710	6,836
East/Central	24,532	26,598	14,930	13,170	14,537	25,705	6,117	25,272	20,730	22,945	13,860
East	12,076	2,482	1,632	11,022	4,319	10,073	13,344	4,686	6,826	16,246	14,689
Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:											
% Harvest	98.8	98.2	99.1	100.0	99.3	98.6	98.9	99.4	98.9	99.8	99.8
% Catch	98.4	98.6	99.1	100.0	99.1	98.9	98.3	98.9	97.8	99.8	98.8
Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon:											
% Harvest	43.0	58.9	59.5	49.4	73.2	51.1	43.9	70.3	54.7	53.3	55.6
% Catch	36.7	45.4	46.9	39.2	59.1	42.2	34.1	59.6	49.8	43.4	42.3

Table A17b. Brown trout harvest and catch rate data collected April 15 – September 30, 1985-2012. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.319	0.457	0.259	0.360	0.284	0.477	0.289	0.371	0.362	0.664	0.505
Catch/Boat Trip	0.447	0.837	0.397	0.568	0.455	0.794	0.423	0.534	0.637	1.000	0.848
Harv/Angler Trip	0.110	0.162	0.090	0.122	0.095	0.160	0.097	0.121	0.119	0.223	0.168
Catch/Angler Trip	0.154	0.297	0.138	0.193	0.153	0.266	0.142	0.175	0.210	0.335	0.282
Harv/Angler Hour	0.019	0.029	0.016	0.022	0.017	0.028	0.017	0.020	0.021	0.040	0.030
Catch/Angler Hr.	0.026	0.052	0.025	0.035	0.027	0.047	0.025	0.029	0.038	0.060	0.050
Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.964	2.080	0.264	1.632	0.821	1.933	0.494	1.114	1.477	1.413	2.452
May	0.633	0.707	0.488	0.746	0.517	0.825	0.527	0.764	0.241	1.522	0.648
June	0.426	0.404	0.940	0.721	0.357	0.655	0.851	0.438	0.140	1.134	0.283
July	0.287	0.547	0.252	0.201	0.440	0.438	0.352	0.066	0.834	0.614	0.603
August	0.116	0.287	0.177	0.053	0.096	0.240	0.116	0.298	0.196	0.352	0.334
September	0.030	0.065	0.002	0.028	0.015	0.024	0.033	0.025	0.029	0.054	0.084
Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.106	0.246	0.075	0.096	0.041	0.163	0.082	0.011	0.081	0.174	0.158
West/Central	0.266	0.180	0.491	0.240	0.170	0.383	0.126	0.226	0.267	0.429	0.500
East/Central	0.584	0.918	0.548	0.568	0.556	0.899	0.226	0.908	0.658	1.079	0.653
East	0.280	0.134	0.063	0.415	0.200	0.406	0.541	0.220	0.330	0.808	0.674
Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon:											
April	1.287	3.611	0.798	2.418	1.079	3.555	0.695	1.661	2.108	3.241	4.462
May	0.855	1.411	0.720	1.152	0.644	1.390	0.816	1.074	0.416	2.184	1.126
June	0.564	0.523	1.255	1.012	0.428	0.867	1.228	0.617	0.329	1.518	0.579
July	0.437	0.931	0.353	0.371	0.633	0.888	0.505	0.102	1.498	0.920	0.827
August	0.189	0.612	0.267	0.154	0.383	0.312	0.158	0.441	0.387	0.439	0.560
September	0.047	0.117	0.019	0.032	0.034	0.041	0.056	0.035	0.056	0.108	0.146
Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.160	0.500	0.127	0.197	0.075	0.237	0.111	0.019	0.143	0.323	0.325
West/Central	0.527	1.027	0.852	0.794	0.324	0.955	0.268	0.413	0.539	1.131	1.224
East/Central	0.782	1.494	0.833	0.755	0.865	1.533	0.345	1.306	1.201	1.513	1.000
East	0.358	0.189	0.072	0.593	0.320	0.554	0.760	0.274	0.501	1.105	1.020
Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	1.022	1.574	0.946	1.132	1.129	1.556	0.754	1.650	1.174	2.128	1.698
Catch/Boat Trip	1.218	2.212	1.142	1.421	1.465	2.131	0.862	2.022	1.903	2.611	2.187
Harv/Angler Trip	0.204	0.326	0.189	0.222	0.224	0.302	0.145	0.325	0.225	0.408	0.333
Catch/Angler Trip	0.243	0.458	0.229	0.278	0.290	0.414	0.165	0.398	0.365	0.500	0.429
Harv/Angler Hour	0.028	0.046	0.028	0.033	0.033	0.043	0.021	0.047	0.035	0.064	0.050
Catch/Angler Hr.	0.033	0.065	0.034	0.042	0.043	0.059	0.024	0.057	0.057	0.079	0.065
Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.203	0.221	0.124	0.216	0.092	0.273	0.194	0.129	0.195	0.371	0.268
Catch/Boat Trip	0.318	0.547	0.251	0.410	0.226	0.542	0.332	0.253	0.377	0.678	0.582
Harv/Angler Trip	0.080	0.092	0.050	0.085	0.037	0.106	0.077	0.048	0.075	0.146	0.103
Catch/Angler Trip	0.124	0.228	0.102	0.161	0.090	0.210	0.131	0.094	0.146	0.267	0.224
Harv/Angler Hour	0.015	0.018	0.010	0.017	0.007	0.021	0.015	0.008	0.015	0.027	0.020
Catch/Angler Hr.	0.023	0.045	0.021	0.032	0.017	0.041	0.025	0.017	0.028	0.050	0.042

Table A18. Length (inches), weight (lbs), age, and fin clip statistics for brown trout sampled April 15 – September 30 during the 1985-2012 NYSDEC Lake Ontario fishing boat surveys.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mean length and weight data for brown trout sampled April 15 - September 30:											
Mean Length (in)	20.0	20.1	20.8	19.9	20.5	20.0	20.0	19.0	20.8	20.7	20.4
Mean Weight (lbs)	-	5.01	5.39	4.39	5.33	4.62	4.59	3.70	5.39	5.30	4.92
Estimated weight (lbs) for standard length brown trout sampled April 15 - September 30:											
16.0 inches	-	2.23	2.18	2.04	2.33	2.01	2.11	1.99	2.32	2.16	1.96
18.0 inches	-	3.21	3.13	2.97	3.32	2.98	3.06	2.88	3.30	3.15	2.89
20.0 inches	-	4.47	4.36	4.18	4.61	4.28	4.30	4.05	4.54	4.44	4.13
22.0 inches	-	6.04	5.88	5.70	6.18	5.94	5.83	5.50	6.06	6.06	5.70
24.0 inches	-	7.94	7.72	7.56	8.09	8.01	7.71	7.27	7.89	8.04	7.64
26.0 inches	-	10.22	9.92	9.81	10.36	10.55	9.96	9.41	10.06	10.44	10.00
28.0 inches	-	12.85	12.46	12.42	12.97	13.54	12.58	11.89	12.54	13.23	12.78
Percent length composition of brown trout sampled April 15 - September 30:											
<15.0 in	1.7%	0.9%	0.0%	0.0%	0.6%	0.0%	0.0%	0.4%	0.2%	0.1%	0.0%
15.0-15.9 in	2.0%	2.8%	1.1%	0.4%	0.3%	1.7%	1.3%	3.3%	0.2%	0.1%	1.7%
16.0-16.9 in	6.2%	7.7%	4.4%	3.4%	4.8%	5.0%	7.0%	16.7%	3.1%	1.6%	4.8%
17.0-17.9 in	12.5%	14.8%	5.9%	15.3%	10.3%	11.6%	11.4%	21.1%	8.3%	7.0%	17.4%
18.0-18.9 in	17.5%	17.9%	22.1%	27.5%	17.0%	17.5%	17.8%	20.7%	14.0%	16.6%	15.7%
19.0-19.9 in	15.9%	15.6%	18.0%	17.9%	12.8%	18.0%	16.9%	10.3%	14.0%	19.3%	14.8%
20.0-20.9 in	12.5%	9.4%	12.1%	11.1%	13.1%	17.0%	14.1%	8.6%	18.8%	16.9%	10.2%
21.0-21.9 in	9.5%	5.7%	6.6%	5.8%	14.1%	11.0%	10.8%	4.4%	13.3%	11.4%	7.6%
22.0-22.9 in	7.0%	7.1%	5.1%	6.6%	8.7%	6.6%	7.7%	4.2%	10.2%	10.1%	5.7%
23.0-23.9 in	4.8%	4.3%	8.5%	3.8%	5.1%	4.6%	3.5%	3.9%	7.1%	6.9%	6.3%
24.0-24.9 in	3.6%	4.0%	4.4%	3.0%	5.4%	2.9%	4.2%	3.3%	2.4%	3.9%	5.9%
25.0-25.9 in	2.7%	3.7%	4.4%	2.1%	4.5%	2.0%	3.1%	1.7%	2.6%	2.0%	3.9%
26.0-26.9 in	2.1%	2.3%	2.9%	1.3%	2.2%	1.1%	2.0%	0.9%	3.8%	2.0%	1.7%
27.0-27.9 in	1.0%	1.7%	0.7%	1.1%	0.6%	0.5%	0.2%	0.4%	1.0%	1.0%	2.0%
28.0-28.9 in	0.6%	1.4%	1.5%	0.4%	0.0%	0.1%	0.0%	0.0%	0.7%	0.6%	1.5%
>28.9 in	0.5%	0.9%	2.2%	0.4%	0.3%	0.4%	0.0%	0.2%	0.2%	0.4%	0.7%
Percent fin clip composition of brown trout sampled April 15 - September 30:											
No Clips	75.8%	67.0%	65.1%	67.2%	80.4%	86.6%	88.4%	81.4%	87.6%	88.7%	92.4%
LV	1.8%	4.3%	4.0%	5.5%	2.9%	2.0%	0.2%	3.0%	2.9%	1.2%	0.4%
LV-Ad	4.1%	2.3%	4.8%	7.5%	3.5%	1.9%	3.1%	6.1%	2.6%	0.6%	1.7%
LP	2.2%	12.0%	6.6%	3.6%	1.0%	0.3%	0.0%	0.4%	0.0%	0.0%	0.0%
LP-Ad	4.3%	1.1%	7.0%	4.1%	3.5%	2.6%	1.7%	1.1%	2.6%	4.3%	2.2%
Ad	1.3%	10.8%	6.3%	2.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
RV	4.2%	0.6%	1.5%	4.0%	3.5%	2.8%	4.8%	4.4%	2.1%	0.6%	0.7%
RV-Ad	0.4%	0.0%	0.0%	0.8%	1.3%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
RP	4.6%	1.1%	3.3%	3.0%	2.9%	2.0%	1.4%	2.6%	1.0%	2.6%	1.5%
RP-Ad	0.0%	0.3%	0.0%	0.2%	0.0%	0.0%	0.0%	0.2%	0.0%	0.1%	0.0%
Misc.	1.2%	0.6%	1.5%	2.1%	1.0%	1.7%	0.4%	0.9%	1.2%	1.9%	1.1%
Percent age composition of brown trout sampled April 15 - September 30:											
Age-1	-	0.4%	0.0%	0.0%	0.5%	0.0%	0.0%	0.2%	0.4%	0.0%	0.0%
Age-2	-	75.0%	66.0%	81.9%	72.5%	85.6%	78.9%	80.0%	80.6%	78.7%	74.6%
Age-3	-	20.0%	26.3%	14.4%	23.6%	11.6%	19.6%	17.2%	15.2%	17.2%	21.3%
Age-4	-	4.1%	5.3%	3.2%	3.4%	2.2%	1.0%	2.4%	3.4%	3.9%	3.3%
Age-5+	-	0.5%	2.4%	0.5%	0.0%	0.5%	0.5%	0.2%	0.4%	0.3%	0.7%
Mean length (inches) of aged brown trout sampled in April 15-30:											
Age-2	-	17.9	17.9	18.1	17.8	18.4	17.7	17.4	18.2	18.6	17.9
Age-3	-	22.6	22.0	23.1	22.5	21.7	23.2	21.8	23.1	22.8	23.1

Table A19a. Lake trout harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	37,333	4,606	4,250	4,181	2,964	2,570	2,875	4,842	5,403	7,017	7,829
Catch	79,704	16,054	11,490	9,527	8,656	7,147	6,757	11,241	11,753	24,336	22,206
% Harvested	42.6	28.7	37.0	43.9	34.2	36.0	42.5	43.1	46.0	28.8	35.3
Monthly estimates of harvest for all fishing boats:											
April	3,334	388	136	0	215	555	15	388	188	255	1,442
May	7,252	389	473	264	1,173	345	594	190	2,461	840	2,311
June	6,993	868	557	940	560	1,142	387	501	262	1,478	1,456
July	10,970	2,065	2,298	913	86	122	1,229	254	1,845	2,266	1,216
August	7,660	843	739	2,000	930	390	465	3,026	648	1,871	899
September	1,125	54	47	64	0	15	184	483	0	308	505
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	7,705	1,470	657	489	309	963	602	190	739	1,751	1,417
West/Central	3,940	488	840	1,741	1,646	391	609	1,018	885	1,358	1,491
East/Central	9,291	770	554	361	73	115	209	317	1,552	1,950	2,134
East	16,397	1,877	2,199	1,590	936	1,101	1,454	3,318	2,227	1,959	2,786
Monthly estimates of catch for all fishing boats:											
April	7,230	4,965	1,490	30	1,728	765	15	1,235	464	885	3,823
May	14,322	875	1,759	1,910	2,855	2,993	1,539	2,558	5,660	8,956	8,397
June	14,893	1,824	1,696	1,615	1,193	1,457	927	1,395	552	3,789	3,533
July	24,281	4,301	3,685	2,166	1,688	371	2,276	705	3,247	7,626	2,871
August	16,646	3,806	2,253	3,676	1,151	1,285	1,712	4,699	1,678	2,484	2,903
September	2,332	283	606	129	40	275	288	649	151	596	679
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	20,596	7,790	4,107	3,362	2,968	3,962	2,924	2,387	2,095	11,226	6,487
West/Central	9,975	3,391	2,346	2,780	4,132	1,158	1,681	3,296	3,346	3,772	3,699
East/Central	19,068	1,284	1,690	956	461	265	289	1,120	3,079	6,419	6,121
East	30,066	3,588	3,346	2,428	1,094	1,763	1,864	4,438	3,233	2,920	5,899
Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:											
% Harvest	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
% Catch	99.4	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon:											
% Harvest	58.5	68.8	77.7	69.7	93.7	56.7	81.3	88.7	69.6	64.9	67.2
% Catch	43.8	33.9	42.7	38.0	47.4	26.7	48.0	55.0	48.1	33.1	33.5

Table A19b. Lake trout harvest and catch rate data collected April 15 – September 30, 1985-2012. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.299	0.097	0.074	0.073	0.062	0.045	0.056	0.078	0.108	0.142	0.170
Catch/Boat Trip	0.672	0.337	0.200	0.166	0.181	0.124	0.132	0.181	0.235	0.491	0.482
Harv/Angler Trip	0.105	0.034	0.026	0.025	0.021	0.015	0.019	0.026	0.036	0.047	0.056
Catch/Angler Trip	0.233	0.120	0.070	0.056	0.061	0.042	0.044	0.059	0.077	0.165	0.160
Harv/Angler Hour	0.018	0.006	0.005	0.005	0.004	0.003	0.003	0.004	0.006	0.008	0.010
Catch/Angler Hr.	0.040	0.021	0.013	0.010	0.011	0.007	0.008	0.010	0.014	0.029	0.028
Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.266	0.136	0.042	0.000	0.053	0.185	0.005	0.107	0.072	0.101	0.609
May	0.302	0.056	0.054	0.020	0.147	0.031	0.082	0.013	0.262	0.104	0.276
June	0.564	0.156	0.116	0.175	0.205	0.195	0.081	0.096	0.068	0.343	0.283
July	0.638	0.352	0.321	0.084	0.010	0.012	0.133	0.029	0.200	0.208	0.131
August	0.241	0.050	0.039	0.142	0.064	0.023	0.028	0.199	0.036	0.132	0.070
September	0.057	0.006	0.003	0.005	0.000	0.001	0.017	0.033	0.000	0.032	0.063
Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.223	0.123	0.059	0.034	0.028	0.060	0.048	0.010	0.052	0.119	0.112
West/Central	0.322	0.098	0.144	0.244	0.241	0.056	0.142	0.132	0.159	0.269	0.267
East/Central	0.260	0.044	0.031	0.021	0.004	0.007	0.012	0.017	0.093	0.129	0.157
East	0.427	0.143	0.097	0.086	0.071	0.061	0.084	0.200	0.165	0.134	0.196
Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon:											
April	0.769	1.742	0.465	0.013	0.429	0.255	0.005	0.342	0.178	0.351	1.616
May	0.648	0.126	0.200	0.148	0.359	0.272	0.212	0.174	0.602	1.113	1.001
June	1.241	0.327	0.355	0.301	0.437	0.249	0.195	0.268	0.142	0.879	0.688
July	1.405	0.733	0.515	0.199	0.204	0.036	0.246	0.081	0.352	0.699	0.310
August	0.532	0.227	0.117	0.261	0.079	0.077	0.104	0.309	0.093	0.176	0.225
September	0.117	0.029	0.042	0.011	0.004	0.025	0.027	0.045	0.022	0.062	0.085
Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon:											
West	0.661	0.653	0.368	0.234	0.269	0.246	0.235	0.129	0.147	0.763	0.512
West/Central	0.857	0.679	0.401	0.389	0.605	0.166	0.392	0.427	0.600	0.747	0.662
East/Central	0.546	0.073	0.095	0.055	0.027	0.016	0.017	0.058	0.184	0.424	0.450
East	0.800	0.274	0.148	0.131	0.083	0.098	0.107	0.268	0.240	0.199	0.415
Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	1.231	0.382	0.350	0.323	0.314	0.159	0.268	0.435	0.440	0.552	0.690
Catch/Boat Trip	2.063	0.656	0.520	0.401	0.463	0.208	0.372	0.626	0.662	0.976	0.975
Harv/Angler Trip	0.251	0.079	0.070	0.063	0.062	0.031	0.051	0.086	0.084	0.106	0.135
Catch/Angler Trip	0.414	0.136	0.104	0.079	0.092	0.041	0.071	0.123	0.127	0.187	0.191
Harv/Angler Hour	0.034	0.011	0.010	0.010	0.009	0.004	0.007	0.012	0.013	0.017	0.020
Catch/Angler Hr.	0.056	0.019	0.015	0.012	0.014	0.006	0.010	0.018	0.020	0.029	0.029
Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon:											
Harv/Boat Trip	0.162	0.037	0.020	0.026	0.005	0.023	0.013	0.010	0.040	0.060	0.067
Catch/Boat Trip	0.453	0.270	0.137	0.122	0.117	0.108	0.083	0.097	0.147	0.394	0.384
Harv/Angler Trip	0.063	0.015	0.008	0.010	0.002	0.009	0.005	0.004	0.015	0.024	0.026
Catch/Angler Trip	0.176	0.113	0.056	0.048	0.047	0.042	0.033	0.036	0.057	0.155	0.148
Harv/Angler Hour	0.012	0.003	0.002	0.002	0.000	0.002	0.001	0.001	0.003	0.004	0.005
Catch/Angler Hr.	0.032	0.022	0.011	0.009	0.009	0.008	0.006	0.006	0.011	0.029	0.028

Table A20. Length and weight statistics for lake trout sampled April 15 - September 30 during the 1985-2012 NYSDEC Lake Ontario fishing boat surveys.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Mean length and weight of lake trout sampled April - September:											
Mean Length (in)	24.9	27.0	25.7	26.8	24.5	26.8	26.5	25.1	23.4	25.5	26.3
Mean weight (lbs)	-	8.25	7.21	8.24	6.28	8.61	8.03	6.81	5.71	7.37	8.00
Percent length composition of lake trout sampled April - September:											
<15.0 inches	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%
15-15.9 inches	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	0.0%	0.0%
16-16.9 inches	0.4%	0.0%	0.0%	0.0%	0.0%	1.9%	0.0%	1.3%	1.6%	0.0%	0.0%
17-17.9 inches	1.2%	0.0%	0.0%	2.6%	0.0%	1.9%	0.0%	0.0%	4.1%	0.8%	0.9%
18-18.9 inches	1.7%	0.0%	2.8%	0.0%	2.6%	1.9%	0.0%	3.8%	7.3%	2.5%	3.4%
19-19.9 inches	3.2%	10.0%	4.2%	2.6%	10.3%	3.8%	2.0%	10.1%	2.4%	4.2%	1.7%
20-20.9 inches	5.0%	3.3%	7.0%	2.6%	7.7%	5.7%	0.0%	7.6%	10.6%	4.2%	2.6%
21-21.9 inches	8.9%	6.7%	7.0%	2.6%	5.1%	5.7%	6.0%	3.8%	13.0%	6.7%	6.8%
22-22.9 inches	11.3%	3.3%	12.7%	10.5%	2.6%	3.8%	14.0%	3.8%	9.8%	7.5%	4.3%
23-23.9 inches	13.4%	16.7%	14.1%	5.3%	20.5%	3.8%	14.0%	3.8%	14.6%	10.8%	3.4%
24-24.9 inches	14.3%	6.7%	11.3%	18.4%	15.4%	5.7%	6.0%	10.1%	4.9%	8.3%	6.8%
25-25.9 inches	10.1%	3.3%	5.6%	7.9%	17.9%	3.8%	6.0%	11.4%	3.3%	15.0%	14.5%
26-26.9 inches	6.3%	3.3%	0.0%	7.9%	2.6%	3.8%	6.0%	5.1%	5.7%	7.5%	11.1%
27-27.9 inches	3.2%	0.0%	0.0%	2.6%	0.0%	9.4%	10.0%	17.7%	1.6%	11.7%	15.4%
28-28.9 inches	2.5%	0.0%	1.4%	0.0%	0.0%	13.2%	12.0%	8.9%	7.3%	1.7%	5.1%
29-29.9 inches	3.5%	3.3%	11.3%	2.6%	0.0%	11.3%	6.0%	1.3%	4.1%	2.5%	4.3%
30-30.9 inches	5.7%	13.3%	1.4%	7.9%	5.1%	9.4%	4.0%	3.8%	4.1%	4.2%	7.7%
31-31.9 inches	4.3%	10.0%	8.5%	7.9%	2.6%	7.5%	0.0%	2.5%	1.6%	3.3%	7.7%
32-32.9 inches	2.2%	3.3%	2.8%	7.9%	2.6%	0.0%	6.0%	3.8%	2.4%	5.0%	0.9%
33-33.9 inches	1.5%	10.0%	5.6%	2.6%	2.6%	0.0%	4.0%	1.3%	0.0%	1.7%	0.0%
34-34.9 inches	0.6%	6.7%	2.8%	7.9%	0.0%	1.9%	2.0%	0.0%	0.0%	1.7%	2.6%
>34.9 inches	0.4%	0.0%	1.4%	0.0%	2.6%	5.7%	2.0%	0.0%	0.0%	0.8%	0.9%
30.0+ inches	14.7%	43.3%	22.5%	34.2%	15.4%	24.5%	18.0%	11.4%	8.1%	16.7%	19.7%
25.0-29.9 inches	25.6%	10.0%	18.3%	21.1%	20.5%	41.5%	40.0%	44.3%	22.0%	38.3%	50.4%

Note: Size groups enclosed by the box indicate lake trout theoretically protected from harvest in New York waters of Lake Ontario by the NYSDEC slot limit (25 to <30 inches). Most of these "illegal" fish are within one inch of either side of the slot limit and likely result from measurement errors by the anglers. Also, the fishing boat survey does sample a few fish captured in Canadian waters but landed at New York locations, and which are not protected from harvest by the DEC slot limit. From 1985-1992 a variety of size limits were in effect in New York waters. In 1985-1987, there was only a small minimum size limit in effect. In 1988, and the first half of the 1989 fishing season, the 25 to <30 inch slot limit was in effect. During the second half of the 1989 fishing season, and from 1990-1992, there was a 27 to <30 inch slot limit. From 1993-2006, the 25 to <30 inch slot limit was reinstated. In October 2006, the lake trout creel limit was reduced from three fish per angler per day to two fish, while allowing one of the two fish per angler to be between 25 to <30 inches.

Table A21a. Smallmouth bass harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	50,982	65,633	34,380	32,816	17,759	19,058	11,104	6,833	4,892	6,442	5,683
Catch	258,198	405,723	178,472	145,172	73,781	78,661	50,727	30,494	18,048	25,795	24,032
% Harvested	20.9	16.2	19.3	22.6	24.1	24.2	21.9	22.4	27.1	25.0	23.6
Monthly estimates of harvest for all fishing boats:											
April	2	0	0	34	0	0	0	2	0	0	0
May	67	0	0	0	0	0	0	0	0	0	0
June	8,672	6,886	4,281	7,186	3,392	2,651	4,721	1,565	1,258	268	1,178
July	15,344	16,868	7,817	8,571	6,240	7,280	2,084	647	1,643	668	2,702
August	17,416	27,134	16,442	10,012	7,139	5,987	2,687	1,695	1,727	3,331	1,377
September	9,481	14,744	5,840	7,013	989	3,139	1,612	2,923	265	2,176	426
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	4,120	3,649	231	382	384	1,048	882	163	182	254	800
West/Central	3,704	3,477	438	2,105	320	626	376	108	43	261	36
East/Central	25,244	46,569	16,404	22,220	5,864	9,579	3,522	3,250	1,785	700	1,940
East	17,915	11,938	17,306	8,109	11,191	7,805	6,324	3,312	2,882	5,227	2,907
Monthly estimates of catch for all fishing boats:											
April	499	208	395	236	1,955	91	979	240	136	22	82
May	7,111	632	3,744	5,883	691	915	1,180	1,264	483	1,299	1,558
June	34,054	32,349	20,491	30,540	11,643	15,557	16,685	5,734	2,159	1,604	4,987
July	82,815	121,406	47,252	40,646	28,348	19,726	12,168	3,983	4,437	8,026	9,561
August	90,979	184,630	62,295	43,948	24,084	32,958	13,757	11,115	8,571	10,407	5,611
September	42,740	66,499	44,294	23,919	7,060	9,414	5,958	8,159	2,263	4,437	2,234
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	25,138	36,371	7,239	3,204	2,825	6,354	6,400	1,610	2,565	2,459	5,768
West/Central	38,492	55,695	22,412	21,694	3,664	10,043	2,140	2,143	384	799	1,048
East/Central	126,722	259,083	86,978	83,054	40,039	42,400	22,653	15,862	9,462	5,830	6,648
East	67,846	54,573	61,843	37,219	27,253	19,864	19,534	10,878	5,638	16,706	10,567
Percent of seasonal harvest and catch made by boats seeking smallmouth bass during the **traditional open season**:											
% Harvest	92.0	93.0	93.3	96.1	96.4	92.8	87.6	69.0	83.8	96.4	88.5
% Catch	87.1	93.9	88.2	89.9	89.7	79.7	77.7	58.2	62.6	78.1	85.9
Estimates of catch by boats seeking smallmouth bass during the **catch and release season**:											
April	-	-	-	-		0.0	0.0	0.0	0	0	0
May	-	-	-	-		0	196	422	28	0	196
June	-	-	-	-		3482	88	24	55	502	24
Total	-	-	-	-		3482	284	446	83	502	220
Percent of seasonal catch made by boats seeking smallmouth bass during the **catch and release season**:											
% Catch	-	-	-	-		4.4	0.6	1.5	0.5	1.9	0.9

Table A21b. Smallmouth bass harvest and catch rate data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal rates of harvest and catch for boats seeking smallmouth bass during the **traditional open season**:											
Harv/Boat Trip	2.067	2.200	1.435	1.426	1.260	1.219	0.760	0.544	0.700	0.992	0.811
Catch/Boat Trip	9.724	13.734	7.044	5.905	4.873	4.323	3.082	2.047	1.928	3.219	3.327
Harv/Angler Trip	0.892	0.987	0.637	0.668	0.553	0.534	0.341	0.250	0.339	0.451	0.372
Catch/Angler Trip	4.226	6.162	3.125	2.765	2.140	1.893	1.380	0.939	0.933	1.464	1.528
Harv/Angler Hour	0.263	0.285	0.200	0.215	0.178	0.171	0.117	0.097	0.126	0.145	0.120
Catch/Angler Hr.	1.252	1.776	0.981	0.891	0.689	0.606	0.472	0.363	0.346	0.471	0.492
Monthly harvest rates per boat trip for boats seeking smallmouth bass during the **traditional open season**:											
April & May	-	-	-	-	-	-	-	-	-	-	-
June	1.876	1.576	1.679	1.474	1.069	0.885	1.807	0.877	1.948	0.259	0.701
July	1.784	1.765	0.920	1.078	1.006	1.460	0.401	0.125	0.694	0.225	0.943
August	2.320	2.369	2.003	1.554	1.907	1.152	0.702	0.399	0.498	1.886	0.829
September	2.318	3.332	1.122	1.889	0.902	1.283	0.530	1.070	0.305	2.353	0.585
Seasonal harvest rates per boat trip among geographic areas for boats seeking smallmouth bass during the **traditional open season**:											
West	1.338	1.112	0.189	0.233	0.314	0.521	0.783	0.118	0.169	0.312	0.605
West/Central	0.945	0.656	0.109	0.608	0.144	0.238	0.107	0.074	0.065	0.333	0.000
East/Central	2.174	2.716	1.352	1.857	0.862	1.306	0.538	0.584	0.388	0.209	0.720
East	2.800	2.743	2.675	1.422	2.688	2.055	1.470	1.053	2.013	2.761	1.449
Monthly catch rates per boat trip for boats seeking smallmouth bass during the **traditional open season**:											
April & May	-	-	-	-	-	-	-	-	-	-	-
June	6.161	6.840	5.979	5.725	3.625	2.514	6.279	2.796	2.907	0.612	2.940
July	9.404	12.920	5.450	5.057	4.568	3.690	2.148	0.932	1.581	2.871	3.766
August	11.758	16.081	7.535	6.861	6.221	6.358	2.628	2.236	2.058	4.803	3.210
September	9.928	15.672	9.367	6.334	5.235	3.606	2.473	2.701	1.779	3.944	3.016
Seasonal catch rates per boat trip among geographic areas for boats seeking smallmouth bass during the **traditional open season**:											
West	7.012	11.732	4.584	1.681	1.463	2.758	5.000	0.796	1.605	1.450	5.397
West/Central	8.392	10.592	6.209	6.088	1.470	2.292	0.732	1.031	0.514	0.739	0.534
East/Central	10.454	15.305	6.140	6.285	5.278	5.434	2.881	2.499	1.545	1.103	2.086
East	10.000	12.614	9.788	6.246	6.545	4.428	4.329	2.748	3.585	8.264	5.204
Seasonal catch rates for boats seeking smallmouth bass during the **catch and release season**:											
Catch/Boat Trip	-	-	-	-		7.020	0.774	0.693	0.284	2.100	0.422
Catch/Angler Trip	-	-	-	-		3.831	0.402	0.417	0.153	1.887	0.170
Catch/Angler Hr.	-	-	-	-		1.625	0.151	0.181	0.099	1.035	0.072
Monthly catch rates per boat trip for boats seeking smallmouth bass during the **catch and release season**:											
April	-	-	-	-	-	-	-	-	-	-	
May	-	-	-	-		0	4.558	1.323	0.118	0	0.590
June	-	-	-	-		9.949	0.272	0.074	1.000	2.523	0.127

Table A22. Yellow perch harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	7,961	8,171	18,380	8,942	13,858	25,630	33,589	51,653	18,405	31,830	16,701
Catch	15,953	23,179	39,026	33,209	39,801	87,736	67,342	102,442	61,816	65,394	35,836
% Harvested	56.8	35.3	47.1	26.9	34.8	29.2	49.9	50.4	29.8	48.7	46.6
Monthly estimates of harvest for all fishing boats:											
April	11	0	0	0	0	0	29	0	1,198	0	2,653
May	1,077	378	29	1,588	0	1,220	1,357	0	7,656	112	4,203
June	1,383	708	1,464	2,933	7,360	7,566	10,349	34,963	3,665	2,194	6,116
July	2,071	1,905	2,202	486	1,476	5,039	3,612	2,810	1,906	5,637	1,913
August	1,147	3,976	8,617	232	2,233	5,149	6,114	7,816	3,648	16,979	1,755
September	2,272	1,203	6,069	3,703	2,789	6,656	12,128	6,064	332	6,908	61
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	2,188	870	119	3,575	521	15	61	-	468	-	14
West/Central	775	866	3,420	110	1,240	908	3,824	1,035	1,080	30	2,816
East/Central	3,327	6,412	14,564	4,979	8,499	24,252	26,845	19,372	9,762	22,363	7,814
East	1,671	24	277	278	3,598	454	2,858	31,246	7,094	9,438	6,057
Monthly estimates of catch for all fishing boats:											
April	53	-	-	30	186	-	69	143	1,962	-	5,293
May	1,704	492	145	6,152	462	5,980	3,443	95	37,864	112	10,211
June	3,240	2,404	5,773	12,984	16,614	17,363	25,153	52,025	5,287	5,055	13,440
July	3,546	6,436	6,154	7,733	10,323	16,158	8,637	10,792	4,371	14,419	2,508
August	2,994	11,021	14,488	1,261	3,631	18,513	10,494	23,739	11,735	29,676	4,298
September	4,415	2,825	12,466	5,049	8,585	29,722	19,545	15,648	596	16,132	86
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	2,917	1,154	465	5,263	1,737	1,405	77	2,444	906	-	49
West/Central	1,498	3,334	7,209	2,314	3,232	2,878	5,999	1,749	2,026	193	4,384
East/Central	8,231	17,747	30,324	23,855	26,915	78,438	51,333	58,517	40,091	50,878	20,510
East	3,307	944	1,027	1,777	7,917	5,016	9,933	39,732	18,793	14,323	10,893

Table A23. Walleye harvest and catch data collected April 15 – September 30, 1985-2012.

	Year Surveyed										
	1985-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Seasonal (5½ month) estimates of harvest and catch for all fishing boats:											
Harvest	597	560	352	2,465	164	1,403	116	123	106	458	130
Catch	735	690	443	2,715	408	4,508	130	147	301	531	130
% Harvested	73.6	81.2	79.5	90.8	40.2	31.1	89.2	83.7	35.2	86.3	100.0
Monthly estimates of harvest for all fishing boats:											
April	0	0	0	0	0	0	0	0	0	0	0
May	113	64	0	106	73	0	28	14	0	16	50
June	46	108	280	0	0	1,112	32	0	0	26	0
July	55	19	0	0	15	114	28	0	0	88	80
August	272	308	72	2,340	15	77	28	109	44	160	0
September	111	61	0	19	62	101	0	0	62	168	0
Seasonal estimates of harvest among geographic areas for all fishing boats:											
West	63	22	29	0	72	187	29	44	106	86	84
West/Central	2	0	0	0	0	45	32	0	0	0	22
East/Central	57	96	0	24	77	34	56	14	0	0	0
East	475	442	323	2441	15	1137	0	66	0	372	24
Monthly estimates of catch for all fishing boats:											
April	9	0	91	0	31	0	0	10	0	15	0
May	132	64	0	146	286	0	28	28	0	16	50
June	57	108	280	0	0	3,991	32	0	0	26	0
July	90	112	0	47	15	142	28	0	0	147	80
August	325	345	72	2,458	15	199	42	109	213	160	0
September	122	61	0	64	62	176	0	0	87	168	0
Seasonal estimates of catch among geographic areas for all fishing boats:											
West	88	170	29	132	286	413	43	47	180	142	84
West/Central	4	0	0	0	0	62	32	0	0	0	22
East/Central	86	93	92	24	107	66	55	29	0	20	0
East	557	427	322	2559	15	3967	0	71	121	369	24

Table A24. Estimates of sea and silver lampreys observed by boat anglers April 15 – September 30, 1986-2012.

	Year Surveyed										
	1986-02 avg	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Monthly and seasonal estimates of lampreys observed:											
April	223	225	31	355	138	564	87	218	429	558	575
May	568	387	624	2,033	731	2,117	688	1,769	551	1,618	1,266
June	318	268	330	800	178	1,059	296	150	372	769	294
July	296	462	636	891	1,288	2,147	390	1,358	486	1,155	460
August	447	1,609	1,170	1,120	1,173	2,009	954	1,142	697	842	707
September	97	420	356	1,072	381	528	399	526	64	184	138
Total	1,950	3,370	3,147	6,272	3,889	8,423	2,814	5,164	2,599	5,125	3,441
Seasonal estimates of lampreys observed among four geographic areas:											
West	822	1,587	1,146	1,881	1,381	2,830	1,194	2,026	946	1,163	1,147
West/Central	247	581	283	654	530	713	18	540	338	565	609
East/Central	495	827	804	1,865	1,572	3,051	845	2,126	799	1,812	1,007
East	385	375	914	1,872	406	1,829	757	472	516	1,585	678
Percentage of lampreys observed that were attached to angler caught trout and salmon:											
Percent	99.0%	100.0%	100.0%	98.5%	98.3%	98.5%	98.3%	97.0%	98.9%	96.8%	97.9%
Monthly and seasonal estimates of lampreys attached to angler caught trout & salmon, per 1000 trout & salmon caught:											
April	8.81	11.54	6.10	48.50	14.74	39.57	23.32	19.36	48.73	45.60	29.72
May	11.14	19.42	18.46	43.89	25.51	41.48	27.82	23.08	26.78	45.50	34.03
June	9.85	19.70	26.83	41.34	33.17	50.56	23.58	12.67	19.85	34.61	12.13
July	8.33	20.59	22.81	33.20	56.32	58.84	16.74	38.27	10.50	14.04	10.83
August	7.59	34.09	21.32	27.05	31.11	42.18	22.87	20.45	11.08	16.68	12.63
September	4.84	24.29	20.01	40.52	22.65	26.98	20.28	16.30	6.34	9.57	7.95
Total	8.75	24.08	20.74	37.40	32.20	44.35	22.39	23.12	15.53	23.09	17.50
Seasonal estimates of lampreys attached to angler caught trout & salmon by geographic area, per 1000 trout & salmon caught:											
West	10.2	29.6	21.3	30.2	29.9	36.7	20.8	19.5	13.1	12.4	15.6
West/Central	8.9	31.2	15.0	27.3	31.1	34.6	2.3	17.9	15.3	25.6	23.2
East/Central	8.0	16.7	17.0	48.6	37.2	53.1	27.2	34.2	15.4	26.9	20.5
East	7.8	20.6	29.0	43.4	26.5	52.7	25.8	17.5	24.0	40.8	14.2
Seasonal percent composition of salmonine host species to which the lampreys were attached:											
Coho Salmon	2.6%	2.2%	1.0%	1.6%	2.7%	3.4%	4.3%	2.6%	3.2%	3.4%	2.9%
Chinook Salmon	32.9%	62.9%	74.3%	60.4%	78.8%	58.6%	64.3%	73.1%	51.6%	37.4%	60.0%
Rainbow Trout	7.1%	11.2%	8.9%	5.2%	3.5%	5.6%	10.4%	10.9%	14.0%	5.6%	8.6%
Atlantic Salmon	0.7%	1.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	3.2%	0.0%	2.1%
Brown Trout	16.8%	12.4%	13.9%	28.6%	14.2%	31.7%	20.0%	13.5%	26.9%	47.5%	22.1%
Lake Trout	39.8%	10.1%	2.0%	4.2%	0.9%	0.7%	0.9%	0.0%	1.1%	6.1%	4.3%
Seasonal proportion of total host-specific angler catch with attached lampreys:											
Coho Salmon	0.52%	1.11%	0.63%	1.09%	0.83%	1.08%	1.76%	0.59%	0.64%	1.40%	1.13%
Chinook Salmon	1.01%	3.41%	2.54%	3.63%	5.05%	5.69%	3.11%	3.54%	2.14%	1.90%	3.35%
Rainbow Trout	0.50%	2.72%	1.39%	2.38%	0.75%	1.78%	0.83%	0.98%	0.78%	0.76%	1.29%
Atlantic Salmon	3.66%	37.12%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	4.54%	0.00%	17.95%
Brown Trout	0.84%	1.03%	1.90%	5.41%	2.46%	5.65%	2.45%	1.97%	2.12%	4.74%	2.78%
Lake Trout	1.14%	2.12%	0.54%	2.70%	0.39%	0.86%	0.35%	0.00%	0.24%	1.25%	0.96%

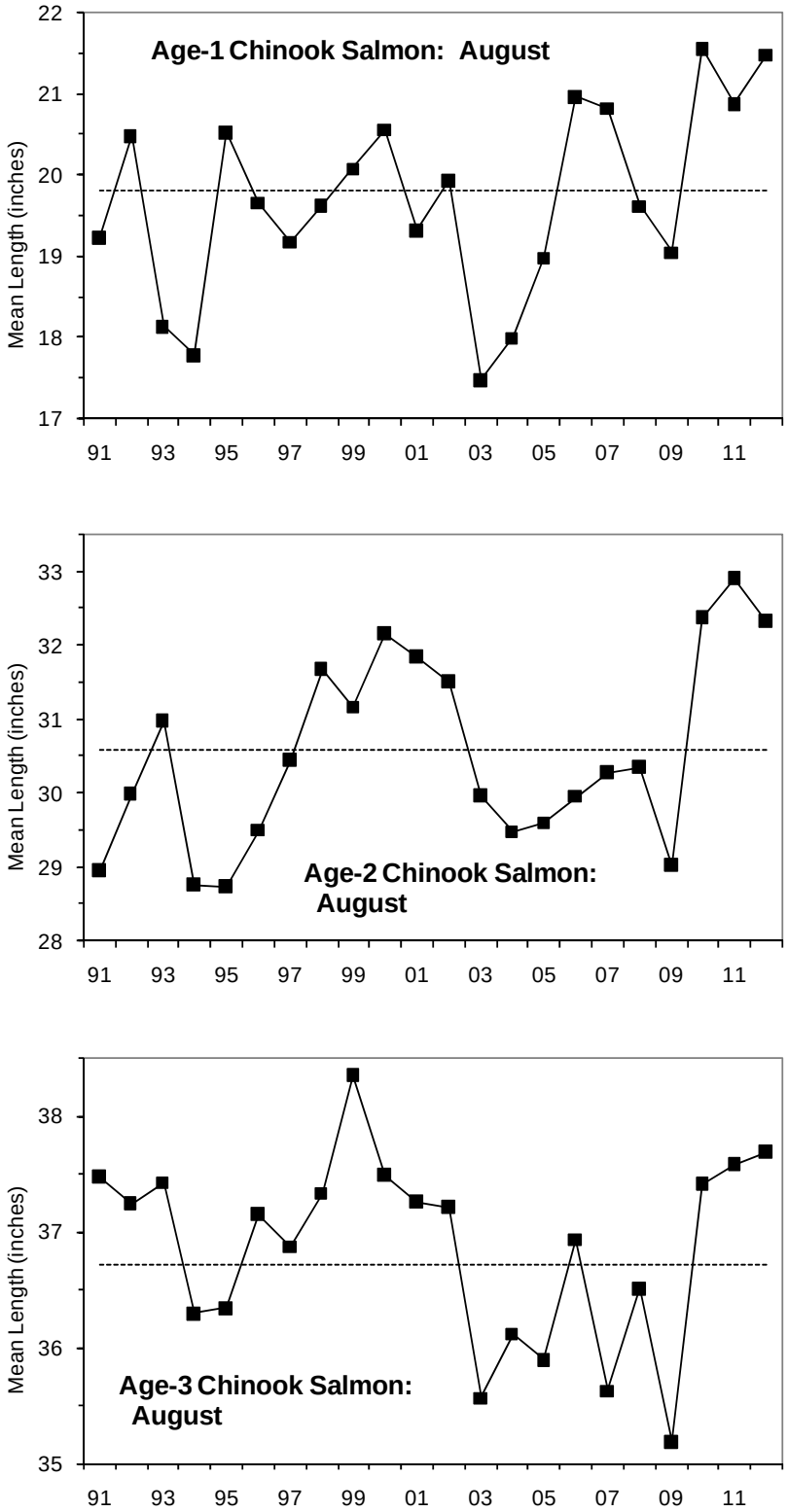

Figure A1. Mean length (total length in inches) of age-1, age-2, and age-3 Chinook salmon sampled in August during the 1991-2012 NYSDEC Lake Ontario fishing boat surveys.

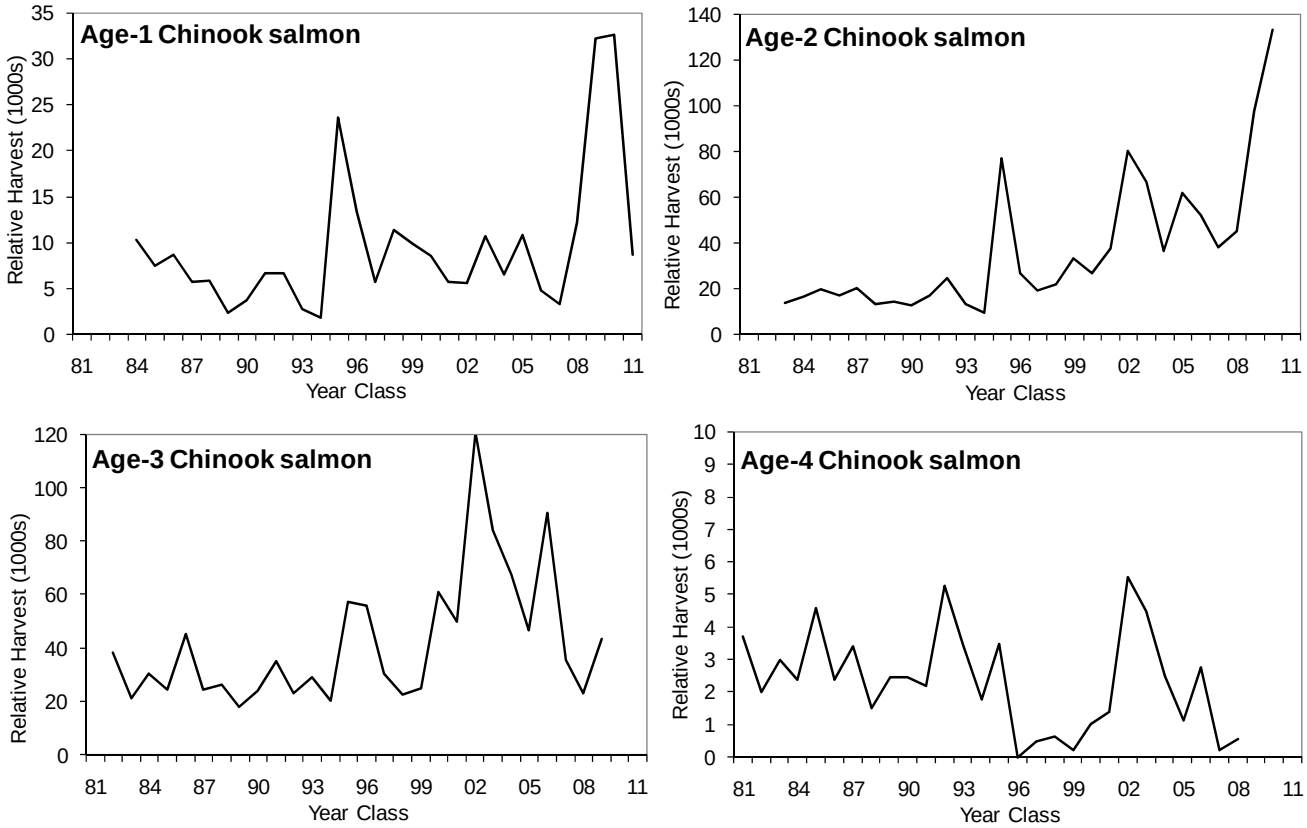

Figure A2. Relative harvest (age-specific harvest per 150,000 fishing boat trips, per 2,000,000 fingerling equivalents stocked) of age-1, age-2, age-3, and age-4 Chinook salmon from the 1985-2012 NYSDEC Lake Ontario fishing boat surveys.

2012 Mass Marking of Chinook Salmon in Lake Ontario

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Chinook salmon (*Oncorynchus tshawytscha)* is the top predator in Lake Ontario and supports a multi-million dollar sportfishery in New York State and the Province of Ontario, Canada. Each year the New York State Department of Environmental Conservation (New York) and the Ontario Ministry of Natural Resources (Ontario) stock 2.3 million Chinook salmon into Lake Ontario at dozens of sites around the lake. An unknown number of wild smolts are also produced in tributaries from "natural" spawning, but it was unknown how many of these wild fish survive and contribute to the sportfishery (Everitt 2006, Bishop et al. 2010). It is important for fisheries managers to know the relative contributions of hatchery and wild salmon in the lake to better understand how their stocking decisions can influence Chinook salmon population dynamics and predator/prey balance in Lake Ontario.

Each fall, adult Chinook salmon return to Lake Ontario tributaries for spawning. NYSDEC maintains a "broodstock" collection site at the Salmon River Hatchery (SRH) near Altmar, NY (Figure 1) where eggs are collected from adult salmon after they enter the hatchery through a series of fish ladders. Fertilized eggs are incubated and typically hatch in late December, and the salmon fry are raised until springtime when they are stocked as fingerlings at sites around the lake. NYSDEC aims to stock fingerlings prior to smolting, a stage when the fish undergo a physical transformation and "imprint" or memorize a complex map of smells that helps them return to spawn at the site where they smolted. NYSDEC stocking strategies attempt to balance the assumed benefits of higher survival gained by stocking larger fish against stocking fish prior to smolting so these fish will imprint (i.e., "home") to stocking sites rather than to the hatchery. Maximizing homing and minimizing straying is very important for providing a late-summer lake fishery and a fall tributary fishery at stocking sites around the lake. New York must also maintain a sufficient number of spawners returning to the SRH so that egg collection and stocking targets can be sustained. New York stocks about 350,000 Chinook salmon at the Salmon River annually to maintain runs that provide eggs. Fingerlings for Salmon River broodstock are held at the hatchery until after smolting occurs to increase imprinting to the hatchery and then are stocked at the mouth of the River in June. Fingerlings stocked at other sites around the lake are stocked in April-May, prior to smolting. The degree that stocked fish stray or home to broodstock waters or to other stocking sites in Lake Ontario and the inter-annual or among-site variation is unknown. This information is, however, important for fisheries managers to evaluate current stocking strategies in meeting fisheries objectives.

In 2008, the NYSDEC purchased an automated fish-marking trailer (AutoFish) from Northwest Marine Technology Incorporated. The AutoFish system is capable of adipose clipping and/or applying coded wire tags (CWTs) to salmon and trout automatically at a high rate of speed and accuracy (referred to as "mass marking"). This allows agencies to quickly mark millions of salmon and trout with relatively little effort, enabling the execution of studies that were previously not feasible. Study objectives selected in 2008 were: 1) to determine the relative proportion of wild and hatchery Chinook salmon in the Lake Ontario harvest; and 2) to determine the relative degree of homing and straying to the SRH.

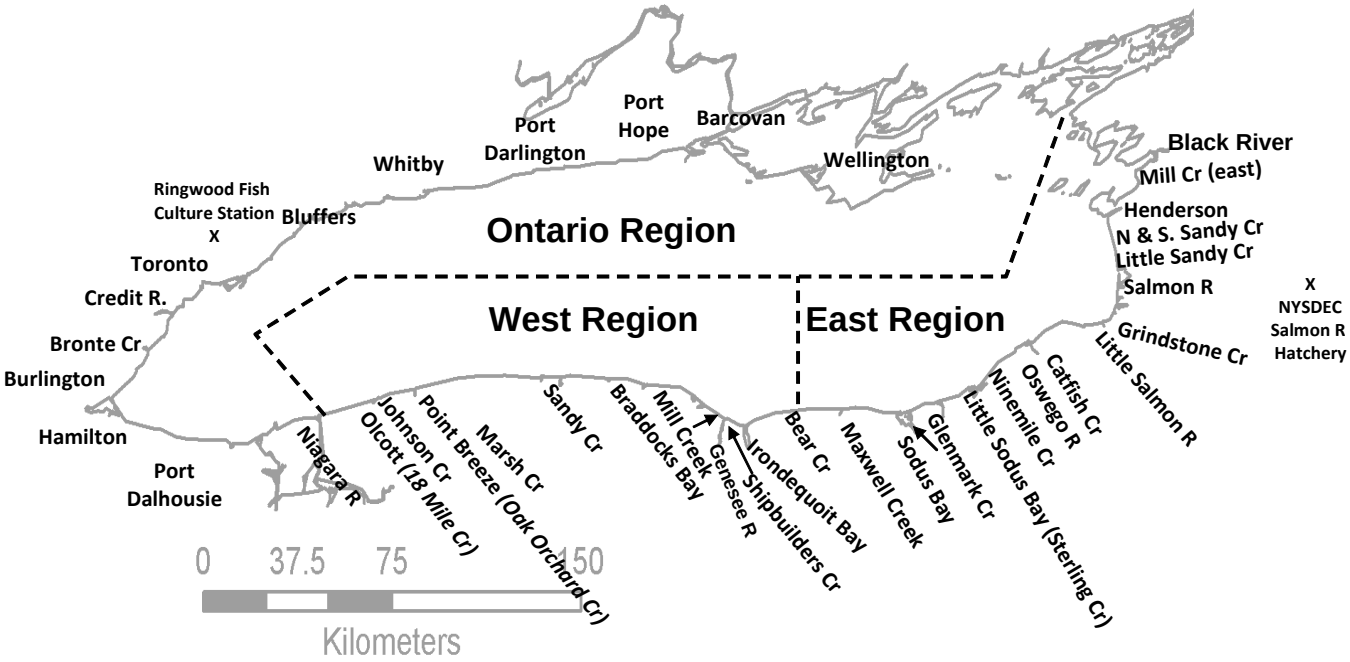

Figure 1. Map of Lake Ontario showing sampling regions and other locations in this report.

The results reported here reflect preliminary observations on the relative contributions of wild and hatchery Chinook salmon to the Lake Ontario fishery for the 2008 (ages 1-4), 2009 (ages 1-3), 2010 (ages 1-2), and 2011 (age-1) year classes (YC), and the degree of homing and straying by stocked fish to the Salmon River Hatchery (2008-2010 YC). A more complete picture of the range and variability of wild reproduction, homing and straying will develop as these YC of marked fish are examined throughout their entire life cycle.

Methods

To determine the proportions of wild and hatchery Chinook salmon in Lake Ontario, all Chinook salmon stocked by New York and Ontario of the 2008-2011 YC were marked with an adipose fin (AD) clip[1]. Those fish captured later in the fishery or in the hatchery without an AD clip were considered wild. The combined annual stocking target for Lake Ontario was 2.3 million Chinook salmon during the study period (NY: 1.76 million from SRH; ON: 550K from Ringwood Hatchery); however, conditions at SRH led to unplanned stocking reductions in 2008 and 2010, with 800,000 and 1.583 million Chinook salmon stocked by New York in 2008 and 2010, respectively (Bishop and Prindle 2008, Connerton 2012). Ontario stocked their annual target of approximately 550,000 in 2008 and 2009, and stocked 669,442 fish in 2010 that included an additional 96,653 surplus fish (marked with AD clip and coded wire tag [CWT]) stocked in the Niagara River (OMNR 2011). CWTs are 1/25 inch (1.1 mm) long and are inserted into the salmon's snout prior to stocking. A number engraved on the wire tag identifies a fish's stocking origin.

To determine the degree of homing and straying to broodstock waters (the hatchery), fish stocked at the Salmon River, NY received AD clips and unique CWTs from 2008-2010. Fish stocked at other stocking sites in NY and Ontario were marked with an AD clip only or an AD clip and some other unique CWT. Despite the unplanned stocking reductions in New York in 2008 (by 50%) and in 2010 (by 12%), stocking levels at Salmon River were maintained in those years at about 350,000 fish to ensure adequate future broodstock returns and consistency across study years (Table 1).

[1] Fish stocked in pens in the Province of Ontario from 2008-2011 were hand-clipped because the marking trailer was transported to Ontario after the normal pen stocking period in early April. All other hatchery fish in Ontario waters and NY were processed by the AutoFish trailer. Total number of fish stocked into pens in Ontario was 25,485 fish in 2008, 39,148 in 2009, 81,141 in 2010, and 72,603 in 2011.

During 2009-2011, a proportion of the fish at other stocking sites in NY and ON also received uniquely numbered CWTs for evaluations of other stocking strategies including shore and tributary stocking in Ontario and shore and pen stocking programs in NY (Table 1). Results of those studies will be evaluated through 2016 and will be presented in future reports. Chinook salmon were not marked in 2012. Marking and tagging of pen and shore stocked salmon in NY was planned for 2012; however it was postponed until 2013 due to unusually high temperatures at pen sites in April, 2012.

Marking Quality Control

The AutoFish system has built-in quality control features that verified removal of the adipose fin and checked for the presence of a CWT for each fish. Fish marked AD-CWT were returned to the hatchery, but fish without an AD clip and/or CWT were rejected and sent to a holding area where they were clipped and tagged manually. In addition, marking quality was manually verified by agency staff during AutoFish operation from 2008-2011. For each lot/raceway of fish, the operator checked 100 fish from each of the six marking lines to ensure clip quality and CWT presence, and to detect any problems with individual marking lines. Samples of fish exiting the trailer were also checked prior to entering the hatchery (100 fish per day), in raceways after entering the hatchery (100 fish per raceway), and at rearing pens prior to stocking (~100 fish per pen per year 2010-2011).

Although rare, coded-wire-tagged fish are most likely to shed their CWTs up to 30 days after initial tagging. To estimate CWT retention for this study and to check clip quality each year, a sample of Chinook salmon at SRH was checked for an AD clip and a CWT at least 30 days post tagging and prior to stocking using a portable CWT detector.

Field Sampling

In New York, two survey teams sampled angler caught marked and unmarked Chinook salmon as part of the New York Lake Ontario Fishing Boat Survey conducted annually from April - September, 2009-2012 (Lantry and Eckert 2013). Two technicians were also deployed by the U.S. Fish and Wildlife Service from July-October 2010-2011 (hereafter referred to as 'headhunters'), specifically to process Chinook salmon for mark and tag recovery during both the lake and tributary angling seasons. In 2012,

Table 1. Numbers (1000s) of mass marked Chinook salmon stocked by Ontario and New York in Lake Ontario from 2008-2011. (AD=adipose clip, AD-CWT=adipose clip+tag).

Stocking	Mark	2008	2009	2010	2011
New York					
Salmon R.	AD-CWT	356	360	339	-
	AD	-	-	-	356
Other Sites	AD-CWT	-	-	851	851
	AD	443	1398	341	562
Ontario					
Credit R.	AD-CWT	85	20	21	21
	AD	-	75	65	78
Other Sites	AD	442	351	381	380
	AD-CWT	-	101	202	104
Total		1326	2305	2200	2352

Note: For details regarding numbers stocked at individual sites see OMNR 2012 and Connerton 2012.

NYSDEC deployed two headhunters from June-October, and an additional two headhunters from July-October particularly to increase sampling effort for recovery of tags. In each year of the study, Chinook salmon were measured for total length (TL) and round weight, examined for fin clips and CWTs, and a sample of scales was collected from each fish for determining age. Headhunters focused on high-use angling ports, fishing derbies, and cleaning stations. At some lake ports that were not easily surveyed (e.g., ports without cleaning stations or without many public access sites: Point Breeze, Genesee River, or Sodus Bay), groups of anglers at marinas were contacted periodically by phone and arrangements were made to sample the day's catch at private docks.

During fall tributary fishing from September 15-October 31 of 2010-2012, headhunters focused on major tributaries in New York including the Niagara River, Eighteen Mile Creek, Oak Orchard Creek, Sandy Creek, and Genesee River in the western region, and Oswego River and Salmon River in the east (Figure 1). Since most fish were sampled from cleaning stations, anglers were asked where their fish were caught to identify and record capture locations. Additional recovery efforts were made by walking streams and sampling anglers' catches, and in 2012, by sampling salmon carcasses found dead in the streams.

Most Chinook salmon collected in New York waters were aged from acetate impressions of fish scales by counting annuli using 2x-10x magnification (n=

3,593 in 2010, 4,587 in 2011, 4,485 in 2012). Fish containing CWTs were aged using their tag's unique code which identified stocking location and age. All Salmon River-stocked fish (2008-2010 YC, Table 1) contained tag code 23 for all YC, so scales were used to age these fish. Some fish were brought to headhunters that were already cleaned and filleted by anglers. In these cases (n=30 in 2010, n=188 in 2011, n=169 in 2012), only total lengths were measured, the fish were checked for fin clips and tags, and ages for these fish were determined using monthly stratified age-length keys established from each year's scale ageing. Salmon carcasses sampled from streams in 2012 (n=683) were measured for TL, checked for fin clips and tags, and those without CWTs (n=530) were aged using monthly stratified age-length keys established based on scale ageing of 2012 samples. In 2012, increased sampling effort led to an additional 2,003 samples, and these were aged using monthly stratified age-length keys.

In Ontario, samples came from three sources: 1) angler caught fish sampled at high-use ports conducted from June 25-September 4, 2010; 2) the western Lake Ontario angling survey conducted from May- August, 2011 and 2012 at selected ports; and 3) tournaments and derbies throughout the summer 2011-2012 (for details of these programs, see OMNR 2013). In 2010-2012, Chinook salmon were measured for fork length, round weight, and examined for fin clips and CWTs (n= 404, 499 and 877, respectively). Fork length (FL) was converted to TL by TL= 1.052(FL) + 18.939 (OMNR unpublished data). A subsample of Chinook salmon otoliths was collected for ageing in 2010-2012 (n=204, 241, 171 respectively), and ages were determined by counting annuli on thin-sectioned otoliths. Ages of the remaining fish were determined based on CWTs or with monthly stratified age-length keys established from otoliths, CWTs and scale ageing in 2011-2012.

Salmon River Hatchery Sampling

To determine the degree of homing and straying to the SRH, samples of Chinook salmon were checked for an AD clip and CWT as they entered the hatchery during egg-take operations in October of 2009-2012. For spawning purposes, Chinook salmon were sorted daily by sex, and males were further sorted into "jack"-sized males (age-1) and older-sized males (ages-2-4). Jack-sized males were counted but not spawned. Older males (ages 2-4) were spawned, measured for TL and round weight, examined for fin clips and CWTs, and scales were collected for ageing. Females were similarly sampled prior to stripping their eggs (see Prindle and Bishop, [2013] for TL, weight and age distribution results). In 2010-2011, 2-4 samples of jacks (~50 fish per sample, total 93 in 2011, and 174 in 2010) were set aside and measured for TL, weight, and checked for the presence of an AD clip and CWT. Scales were also collected for ageing to identify small age-2 males in the samples. In 2010-2011, 4-6 additional samples of 38-100 jacks <27 inches TL were examined for the presence of a clip and tag, but were not sampled for scales. Age was assumed for these samples using the 27 inch TL cutoff, which was later verified by ageing the fish collected in the initial samples (i.e., no age-2 males were found to be <30.1 inches TL in 2010 and <27.7 in TL in 2011). In 2012, age-1 jacks (2011 YC) were not part of the SRH homing study; however sampling of these fish was conducted as part of regular annual reporting of biological characteristics of salmon at the hatchery (see Prindle and Bishop 2013). Jacks were checked for the presence of an AD clip (indicating fish stocked at Salmon River or some other site) and AD-CWTs (indicating a stray from another site). Snouts were collected from all fish containing CWTs, and tags were extracted and read at the USFWS Great Lakes Fish Tag and Recovery Laboratory in New Franken, WI.

Data Analysis

We determined the proportion of angler caught Chinook salmon that were wild and stocked in each year of sampling from 2009-2012 stratified by capture location (lake or tributary), by region (Ontario, NY east, and NY west, Figure 1), and by year class. To calculate 95% confidence intervals for each stratum, we used the Agresti-Coull method to approximate the binomial distribution (Agresti and Coull 1998). Confidence intervals were computed using R software version 2.14.2 with the binom package (R Core Development Team 2012, Sundar Dorai-Raj 2009). The proportions of wild salmon in each year class were compared among regions (west NY, east NY and Ontario) with a Pearson chi-square test for homogeneity (χ^2) to test the null hypothesis that the proportions of wild fish observed in regions within each year class were equal. Post-hoc tests to compare proportions between individual regions within each year class were done using the Scheffe-Marascuilo procedure (Marascuilo 1966). Statistical results were considered significant at alpha=0.05.

Chi-square and post hoc tests were done with StatTools (www.stattools.net/ StatToolsIndex.php).

To estimate homing and straying of mature fish to the Salmon River Hatchery, the proportions of Salmon River broodstock returning to the hatchery in the fall of each year were calculated for each year-class (i.e., 2008-2010 YC) from 2009-2012. Salmon River broodstock were identified by their unique CWT code (i.e., CWT #23 for Chinook salmon stocked at the mouth of the Salmon River). Fish stocked at other sites (hereafter referred to as "strays") were identified either by the presence of AD clip only or by an AD clip and a unique CWT code that differed from that used for the Salmon River stockings. Tagging of Salmon River broodstock was conducted from 2008-2010, therefore proportions for age-1 salmon were calculated in 2009, for ages 1 and 2 in 2010, for ages 1-3 in 2011, and for ages 2-4 in 2012. To estimate the percent of fish stocked at all other sites that strayed to the SRH as adults (i.e., estimated straying rate), we used the homing/straying ratios of each year class (i.e., observed in the hatchery returns) along with the stocking levels of each year class (Table 1, stocked in 2008-2010) and assumed equal survival and straying rates at all stocking sites. We note that it is unlikely that salmon survive at and stray from all sites equally, and future results from ongoing studies on the relative performance of shore stocked vs. pen-reared fish will provide additional insights into relative straying rates from individual sites to the hatchery; however, for now, we have grouped all other sites together to estimate an overall straying rate.

Results and Discussion

Quality Control

Manual quality control checks during the marking and tagging process showed excellent results with greater than 99% of the fish sampled having an adipose clip and greater than 99.5% of tagged fish sampled having a CWT (Table 2). Clipping quality and tag retention remained high when checked thirty days after tagging, with greater than 99% of fish AD-clipped and 98.6% of the Salmon River broodstock fish retaining their tags (2008-2010; Table 2).

Percent Wild in the Lake Ontario Angler Harvest

Lake Ontario mass-marking began with the 2008 stocking of spring fingerling Chinook salmon, and to date four year-classes of marked fish have recruited to the Lake Ontario sportfishery. The percentages of unclipped (wild) Chinook salmon are presented in Table 3 for each year class sampled from 2009-2012.

Table 2. Manual quality control results during operation of the AutoFish trailer at Salmon River Hatchery from 2008-2011.

Quality Control	**Year**			
During Trailer Operation				
	2008	2009	2010	2011
# fish checked for AD	9,483	17,636	17,620	22,978
% with AD clip	99.0	99.3	99.2	99.7
# fish checked for CWT	3,636	3,684	13,539	12,097
% with CWT	99.6	99.7	99.6	99.8
% with no AD, no CWT	0.3	0.2	0.04	0.12
% with AD, no CWT	0.1	0.12	0.13	0.04
30 Days Post-Tagging (Salmon R stocking)				
# of Fish Checked CWT	698	1174	1000	NT
% AD Clipped	99.7	99.1	ND	ND
% with CWT	98.7	98.6	99.1	NT
% with No AD, no CWT	0.3	0.1	ND	NT
% with AD, no CWT	1.4	1.3	ND	NT

NT= Salmon River broodstock were not tagged in 2011
ND= No data

In 2009, the only source of sampling was the NYSDEC Fishing Boat Survey where 45 age-1 salmon of the 2008 year class were sampled. Twenty-percent (20%) of these were wild; however, the sample size was low resulting in a large confidence interval (Table 3).

In 2010, a total of 2,234 angler-caught Chinook salmon were sampled from Lake Ontario by all lake collection efforts in Ontario and New York from April 15-September 15, 2010 (Table 3). Of these, 830 fish (37%) were age-1 (2009 year class) and 608 (27%) were age-2 (2008 year class). Two marked YC were recruited to the sportfishery and the proportions of wild Chinook salmon could be calculated for ages 1 and 2 (2009 and 2008 YC, respectively). For details about 2010 sample collection, see Connerton et al. (2011). The proportions of the 2009 year class that were wild at age-1 differed significantly among regions (χ^2=13.08, df=2, P=0.0014). In particular, the proportion of wild salmon observed in Ontario waters (35.4%) was significantly higher than New York regions, where 21.6% and 21.9% of the fish were wild in the west and east regions, respectively (west: χ^2=10.12, P=0.0063, east: χ^2=9.02, P=0.011). The proportions of wild age-2 salmon were not

significantly different between regions (χ^2=4.31, df=2, P=0.12); however the sample size in Ontario was low which led to a relatively wide confidence interval. The 2010 data from all regions were subsequently combined to produce a lake-wide estimate of 36.2% for age-2 fish (Table 3).

In 2011, a total of 3,563 Chinook Salmon caught by anglers in the open lake were sampled during collection efforts in Ontario and New York from April 15-September 15. Of these, 675 fish (19%) were age-1 (2010 year class), 2,359 (66%) were age-2 (2009 year class), and 491 (14%) were age-3 (2008 year class). Age-4 Chinook Salmon from the 2007 year class were not part of the study and represented about 1% of the samples collected. For other details about 2011 sample collections, see Connerton et al. (2012). Three marked YC were recruited to the sportfishery and the proportions of wild Chinook salmon were calculated for ages 1, 2, and 3 (2010, 2009 and 2008 YC respectively). For details about 2011 sample distribution among ages, see Connerton et al. (2012). Similar to 2010 results, the proportions of wild age-1 Chinook salmon in 2011 were significantly different among regions (χ^2=17.37, df=2, P=0.0002) and the percentage of wild age-1 Chinook salmon in Ontario waters (59.8%) was significantly higher than both NY regions (west 36.7%: χ^2=17.88, P=0.0001, east 46.7%: χ^2=6.33, P=0.04; Table 3). There was no significant difference between the NY regions (χ^2=2.0, P=0.06). The proportions of wild age-2 Chinook salmon were not significantly different among regions, (χ^2=3.96, df=2, P=0.14) where 37.9%, 36.1%, and 40.6% of age-2 salmon in NY west, NY east and Ontario were wild, respectively (Table 3). The proportions of wild age-3 also did not differ significantly among regions, (χ^2=1.38, df=2, P=0.50) where 33.3%, 37.4% and 32.7% of age-3 Chinook salmon in NY west, NY east and Ontario were wild, respectively; therefore the 2011 data from all regions were subsequently combined to produce lake-wide estimates of percent wild for ages 2 and 3 (37.3% and 35.2%, respectively; Table 3).

In 2012, a total 5,276 Chinook salmon caught by anglers in the open lake were sampled during collection efforts in Ontario and New York from April 15-September 15. Of these, 462 fish (8.7%) were age-1 (2011 year class), 3,159 (59.9%) were age-2 (2010 year class), 1,572 (29.8%) were age-3 (2009 year class), and 83 (1.6%) were age-4 (2008 year class). All Chinook salmon stocked by New York and Ontario were marked since 2008, thus the proportions of wild Chinook salmon were calculated for each age class sampled in 2012. The proportions of wild age-1 Chinook salmon in 2012 were significantly different among regions (χ^2=12.92, df = 2, α=0.002) and the percentage of wild age-1 Chinook salmon in Ontario waters (34.5%) was significantly higher than the NY east region (17.0%: χ^2=13.35, P=0.0013), but not the west (24.3%: χ^2=4.49, P=0.10; Table 3). There was no significant difference between the NY regions (χ^2=2.01, P=0.37). The proportions of wild age-2 Chinook salmon were significantly different among regions in 2012, (χ^2=38.29, df=2, P<0.0001), and the percentage of wild Chinook salmon in the NY east region (64.1%) was significantly higher than the NY west (52.9%, χ^2=37.9, P<0.0001) and the Ontario regions (59.9%, χ^2=6.42, P=0.04). The Ontario and NY west regions were not significantly different (χ^2=2.66, P=0.26). Significant differences were observed among regions for age-3 Chinook salmon as well (χ^2=17.34, df=2, P=0.0002), with significantly lower percentages of wild Chinook observed in the NY west region (44.3%) than the other regions (NY east: 57.7%, χ^2=15.43, P=0.0004; Ontario: 56.3%, χ^2=9.56, P=0.0084) which were not significantly different (χ^2=0.04, P=0.98). The proportions of wild age-4 Chinook salmon were not significantly different among NY regions (χ^2=1.63, df=1, P=0.20) where 69.2% and 54.4% of age-4 salmon in NY west and NY east were wild respectively (Table 3); however age-4 salmon are rare in Lake Ontario and sample size was low leading to relatively wide confidence limits. No age-4 Chinook salmon were sampled in Ontario.

Higher proportions of wild fish in the NY east region compared with NY west may be related to regional differences in the production of wild Chinook salmon in streams, i.e., as adults home to their natal streams and stage outside tributaries in late summer, we hypothesized that the regional differences in the proportion of wild fish would became more evident. We tested this idea, and the proportions of age-2 wild fish harvested by anglers in the west region, where wild production is low, declined significantly from 59.1% in June/July to 49.3% in August/September (χ^2=8.91, P=0.0028). In contrast, we observed significant increasing proportions of wild fish from 60.6% to 67.2% (χ^2=8.66, P=0.0033) in the NY east

Table 3. Numbers of clipped (stocked) and unclipped (presumed wild) angler-caught Chinook salmon observed by year class and region in the open waters of Lake Ontario, and estimated percent wild from 2009-2012. All stocked Chinook salmon were adipose clipped from 2008-2011 and only data from marked year classes and ages recruited to the fishery are shown.

		2008 Year Class					2009 Year Class					2010 Year Class					2011 Year Class				
Year Sampled	**Region**	**Age (yrs)**	**No Clip**	**AD clip**	**% Wild**	**[95 %CI]**	**Age (yrs)**	**No Clip**	**AD Clip**	**% Wild**	**[95% CI]**	**Age (yrs)**	**No Clip**	**AD Clip**	**% Wild**	**[95% CI]**	**Age (yrs)**	**No Clip**	**AD Clip**	**% Wild**	**[95% CI]**
2009	NY	1	9	36	20.0	[9.3, 34.0]															
	ON		-	-	-	-															
2010	NY west [1]	2	64	137	31.8	[25.8, 38.6]	1	83	301	21.6	[17.8, 26.0]										
	NY east[2]		114	198	36.5	[31.4, 42.0]		63	225	21.9	[17.5, 27.0]										
	ON [a]		42	53	44.2	[34.6, 54.2]		56	102	35.4	[28.4, 43.2]										
	Regions Combined		**220**	**388**	**36.2**	**[32.5, 40.1]**		**b**	**b**	**b**	**b**										
2011	NY west	3	46	92	33.3	[26.0, 41.5]	2	337	553	37.9	[34.7, 41.1]	1	83	143	36.7	[30.7, 43.2]					
	NY east		92	154	37.4	[31.6 43.6]		438	775	36.1	[33.5 38.9]		152	173	46.7	[41.4, 52.2]					
	ON [a]		35	72	32.7	[24.5, 42.1]		104	152	40.6	[34.7, 46.7]		73	49	59.8	[50.9, 68.1]					
	Regions Combined		**173**	**318**	**35.2**	**[30.9, 39.3]**		**881**	**1480**	**37.3**	**[35.5, 39.4]**		**b**	**b**	**b**	**b**					
2012	NY west	4	18	8	69.2	[49.9, 83.7]	3	189	238	44.3	[39.1,49.0]	2	610	543	52.9	[50.0,55.8]	1	34	109	24.3	[18.0, 32.0]
	NY east		31	26	54.4	[41.6,66.6]		292	220	56.9	[53.3, 60.5]		1286	720	64.1	[62.0, 66.2]		24	117	17.0	[11.7, 24.1]
	ON [a]		-	-	-	-		147	114	59.3	[53.1,65.2]		263	176	59.9	[55.3,64.4]		61	116	34.5	[27.9,41.7]
	Regions Combined		49	34	59.0	[48.3,69.0]		**b**	**b**	**b**	**b**		**b**	**b**	**b**	**b**		**b**	**b**	**b**	**b**

95 %CI=95% confidence intervals of % wild.

[a] See OMNR (2013) for program details;

[b] Data were not combined because the proportions among regions were not homogeneous (see text for explanation)

[1] NY west: Niagara River to Irondequoit Bay, NY east: Bear Creek Harbor to Black River

[2] Ontario: Most samples were collected from Port Credit, Bluffers, and Whitby where angling effort was highest, with additional samples from Port Hope, Wellington, and Hamilton (See OMNR 2013).

Table 4. Numbers of clipped and unclipped angler-caught Chinook salmon observed by year class and region in the New York tributaries of Lake Ontario, and estimated percent wild from 2010-2012. All stocked Chinook salmon were adipose clipped from 2008-2011 and only data from marked year classes and ages recruited to fishery are shown.

		2008 Year Class					2009 Year Class					2010 Year Class					2011 Year Class				
Year Sampled	**Tributaries**	**Age (yrs)**	**No Clip**	**AD clip**	**% Wild**	**[95 %CI]**	**Age (yrs)**	**No Clip**	**AD Clip**	**% Wild**	**[95% CI]**	**Age (yrs)**	**No Clip**	**AD Clip**	**% Wild**	**[95% CI]**	**Age (yrs)**	**No Clip**	**AD Clip**	**% Wild**	**[95% CI]**
2009	* Salmon River	1	8	17	32.0	[17.1, 51.7]															
2010	NY west	2	33	166	16.5	[12.0, 22.4]	1	19	139	12.0	[7.8, 18.1]										
	NY east		8	25	24.2	[12.6, 41.3]		2	47	4.1	[0.3, 14.5]										
	NY east & west		**41**	**191**	**17.6**	**[13.2, 23.1]**		**21**	**186**	**10.1**	**[6.7, 15.1]**										
	Salmon River		**99**	**73**	**57.5**	**[50.1, 64.7]**		**49**	**50**	**50.5**	**[40.7, 60.3]**										
2011	NY west	3	6	155	3.7	[1.5, 8.1]	2	19	562	3.3	[2.1 5.1]	1	9	61	12.9	[6.7, 22.8]					
	NY east		5	48	9.4	[3.7, 20.7]		12	209	5.4	[3.0, 9.3]		5	20	20.0	[8.4, 39.5]					
	NY east & west		**11**	**203**	**5.1**	**[2.8, 9.1]**		**31**	**771**	**3.9**	**[2.7, 5.4]**		**14**	**81**	**14.7**	**[8.8, 23.4]**					
	Salmon River		**57**	**143**	**28.5**	**[22.6, 35.1]**		**141**	**174**	**44.7**	**[39.3, 50.2]**		**60**	**19**	**75.9**	**[65.3, 84.1]**					
2012	NY west	4	0	14	0	[0, 16.2]	3	22	498	4.2	[2.8, 6.4]	2	47	764	5.7	[4.4,7.6]	1	2	32	5.9	[0.06, 20.1]
	NY east		4	9	30.8	[12.4,58.0]		68	258	20.9	[16.8, 25.6]		166	532	23.8	[20.8 27.1]		2	26	7.1	[0.01, 23.7]
	NY east & west		**a**	**a**	**a**	**a**		**a**	**a**	**a**	**a**		**a**	**a**	**a**	**a**		**4**	**58**	**6.4**	**[2.5, 15.5]**
	Salmon River		**7**	**1**	**87.5**	**[50.8, 99.9]**		**296**	**194**	**60.4**	**[56.0, 64.6]**		**638**	**215**	**74.8**	**[71.8, 77.6]**		**0**	**2**	**0**	**[0, 57.5]**

95 CI=95% confidence intervals.

* Limited data available in 2009 from sampling conducted in the Salmon River

[a] Data were not combined because the proportions among regions were not homogeneous (see text for explanation)

region where production in tributaries is higher. Similarly for age-3 Chinook salmon in the west region, the percentage of wild fish declined significantly from 51.9% in June/July to 33.8% in August/September (χ^2=10.43, P=0.0013). The proportion of wild age-3 fish in the east region, however, also declined significantly from 64.2% to 53.1% (χ^2=7.5, P=0.0062). More research is needed to understand the movement of fish and the onset of maturity and homing to natal streams.

Percent Wild in New York Tributaries

In New York, major tributaries were sampled during the fall Chinook salmon spawning season from September 15-October 31 each year from 2010 to 2012. Some sampling was also done in fall 2009 in the Salmon River. For details about 2010 and 2011 sample collection and sample distributions among ages and tributaries, see Connerton et al. (2011 and 2012, respectively). The percentages of unclipped (wild) Chinook salmon are presented in Table 4 for each year class sampled from 2009-2012.

In 2012, a total of 3,793 Chinook salmon were sampled from 25 NY tributaries including 583 salmon carcasses sampled directly from streams. Of these, 64 (2%) were age-1, 2,362 (62%) were age-2, 1,336 were age-3 (35%), and 35 (1%) were age-4. Mass-marking in Lake Ontario began in 2008, therefore the proportions of wild Chinook salmon were calculated for ages 1-4 (Table 4).

In western tributaries (total n=1,327), most samples came from Oak Orchard Creek (29.4%), Eighteen Mile Creek (21.8%) and the Niagara River (16.4%), with smaller samples collected from Johnson Creek (8.2%), Sandy Creek (7.2%), Genesee River (4.6%), Shipbuilders Creek (4.1%), Marsh Creek (2.3%), Sodus Bay (2.9%), Irondequoit Creek (1.8%), Mill Creek (1.3%), and Glenmark Creek (0.1%). The proportions of wild Chinook salmon in western tributaries were low in 2012 (Table 4), with only 5.9% of age-1, 5.7% of age-2, and 4.2% of age-3 Chinook salmon unclipped.

Samples from eastern Lake Ontario tributaries (total n=1,118) were from the Oswego River (17.4%), Little Salmon River (18.6%), Mill Creek (18.2%), South Sandy Creek (13.0%), Sterling Creek (14.2%), and the Black River (8.0%) with smaller samples from Stony (3.0%), Salmon (2.4%), Maxwell (1.7%), North Sandy (1.6%), Catfish (0.8%), Stony (0.7%), Grindstone (0.6%), and Bear Creeks (0.6%). The proportions of wild Chinook salmon observed in eastern tributaries were generally higher than western streams with 7.1% of age-1, 23.8% of age-2, 20.9% of age-3 and 30.8% of age-4 Chinook salmon unclipped.

In 2012, the percentages of wild age-1 Chinook salmon in tributaries were not significantly different among regions (χ^2=0.179, df=2, P=0.9143); therefore 2012 age-1 data from all regions were subsequently combined to produce tributary wide estimates of 6.7 [95% CI: (2.6, 15.9)]. Relatively few jacks were sampled in 2012, especially in the Salmon River, which resulted in wide confidence intervals. For ages 2-4, the percentages of wild Chinook salmon differed significantly among regions (age-2: χ^2=923.2 df = 2 P= <0.0001; age-3: χ^2=401.1, df=2, P<0.0001; age-4: χ^2=18.1, df=2, P=0.0001). In particular, the percentage of wild Chinook salmon at the Salmon River was significantly higher than NY west (age-2: χ^2=1651.2, P<0.0001; age-3: χ^2=557.7, P<0.0001; age-4: χ^2=56.0, P<0.0001) and NY east regions (age-2: χ^2=541.4, P<0.0001; age-3: χ^2=157.3, P<0.0001; age-4: χ^2=10.7, P =0.0047) for each age class (74.8%, 60.4%, and 87.5% wild in the SR, respectively). In addition, the percentages of wild fish in NY west were significantly lower than the NY east region (age-2: χ^2=98.9, P<0.0001; age-3: χ^2=47.3, P<0.0001; age-4: χ^2=1.78, P=0.41).

Relatively low proportions of wild fish in western streams compared with other regions were consistent with results in 2010-2011 (Table 4) and may result from several factors including warm temperatures, limited habitat and impassible barriers present in many western NY region tributaries. High angling pressure in these tributaries may also negatively affect levels of natural reproduction, either directly by harvest or as a result of high pre-spawn mortality caused by catch and release angling in warm streams (Everitt 2006). Significantly higher percentages of wild fish in the Salmon River compared to other NY tributaries were also consistent with results in 2010-2011 (Connerton et al. 2011, 2012). Considering that 70% of the total NY tributary harvest of Chinook salmon occurs in the Salmon River (Prindle and Bishop 2013a), and that there is a significantly higher percentage of wild fish compared with other tributaries, the Salmon River is likely the largest

single source of wild Chinook salmon in New York (Bishop et al. 2010). Everitt (2006) estimated that 5 million Chinook salmon parr were produced in the Salmon River watershed in 2005; however, it was unknown whether these parr survived. Apparently some portion does survive and represents an important component of both the lake and Salmon River sportfishery. More research is needed, however, to understand the cumulative wild production of all tributaries including in Ontario.

Straying and Homing to Salmon River Hatchery

Observed ratios of tagged Chinook salmon (i.e., stocked in Salmon River[2]) to untagged Chinook salmon (i.e., stocked at other sites) at the SRH suggested a high degree of homing by Salmon River broodstock fish to the SRH and a low degree of straying to the hatchery by fish stocked at other NY sites.

In 2012, Chinook salmon were examined for an AD clip and CWT during egg take operations at the SRH (Table 5). In 2012, only ages 2-4 were evaluated for straying because SRH fish were tagged from 2008-2010, thus fish from the 2011 YC returning to the Salmon River were not part of the study. The proportion of strays were 24.1% for clipped age-2 (CI= 19.9, 28.9] n=340), 18.6% of clipped age-3 (CI=11.7, 28.2 n=119), and 20.0% of clipped age-4 (all age-4, all days n=5). These percentages of strays correspond to homing: straying ratios of 3.1, 4.4, and 4.0 homing salmon to every 1 straying salmon for ages 2-4, respectively (Table 5). If all Chinook salmon strayed from other NY stocking sites to the hatchery, we would have expected much lower homing:straying ratios based on the stocking ratios of Salmon River to other NY sites from 2008-2010 (Table 5). Clearly this was not the case based on observed homing:straying ratios (Table 5). We estimated that 9.1%, 5.9%, and 20.0.% of ages 2-4 Chinook salmon stocked at other sites, respectively, strayed from other sites to the SRH to produce the homing:straying ratios observed at SRH in 2012 (Table 5). We performed the same calculations based on Chinook returns to SRH in 2010-2011 for each age of the 2008-2010 YC (Connerton et al. 2011, 2012), and to date, all results indicate a relatively high degree of homing by Salmon River fish and a low degree of straying; however, final conclusions cannot be drawn until all age classes from the 2008-2010 YC return to the hatchery.

Table 5. Ratios of AD-CWT to AD-only Chinook salmon observed at the NYSDEC Salmon River Fish Hatchery (SRH) in 2012. Observed ratios were used to estimate straying rates of age-2-4 salmon stocked at other New York sites. Age-1 (2011 YC) Chinook salmon were not part of the study in 2012.

Year Class	2008	2009	2010
Age (years)	4	3	2
Number AD-CWT salmon stocked at Salmon River (1000s)	356	360	339
Number of AD salmon stocked at other NY sites (1000s)	443	1398	1191
Stocking ratio of Salmon River to Other Sites	1:1.2	1:4	1:3.5
Proportion of strays at SRH	20.0%	18.6%	24.1%
Sample size (n)	5	119	340
Ratio of homing to straying observed at SRH	4.0:1.0	4.4:1.0	3.1:1.0
Estimated Straying Rate of fish stocked at other sites	20.0%	5.9%	9.1%

Samples from angler-harvested fish in the Salmon River and its tributaries in 2010-2011 generally indicated higher proportions of strays from other Lake Ontario stocking sites compared to results at the SRH (Connerton 2011, 2012). In 2012, 36.1% of age-2 (CI= [29.8, 42.7], n=208), 23.2% of age-3 (CI= [17.7, 29.7], n=190], and 0% of age-4 (CI= [-3.9, 83.3], n=1) clipped salmon observed in the Salmon River harvest were strays. As noted earlier, age-4 Chinook salmon are rare and only one of eight age-4 salmon sampled by headhunters from the Salmon River in 2012 was AD clipped, so no more analyses were conducted for this age class. The proportions of age-3 salmon that were strays were not significantly different from the proportion of strays observed in the hatchery (χ^2=1.52, P=0.22). The proportion of age-2 strays in the harvest was significantly higher

[2] As noted previously, fingerlings stocked for maintaining Salmon River broodstock are held at the hatchery until after smolting occurs to encourage imprinting and then stocked at the mouth of the River in June.

than the percentage returning to the SRH (χ^2=8.65, P=0.0033). When the stocking ratios of each year class are considered (as done in the hatchery sample, Table 4), the straying rates of the 2009-2010 YC were estimated to be 7.8%, and 16.0%, respectively. We will report a complete analysis of straying rates for the 2008-2010 YC to tributaries and the hatchery in 2014 after the 2010 YC returns to spawn at age-3.

Some unclipped Chinook salmon returned to the SRH in 2012, and these were likely wild fish given the high degree of clipping quality/CWT retention with the AutoFish system. The percentages of unclipped salmon were 1.5% for age-1 jacks (CI= [0, 5.9] n=128], 14.0% of age-2 males and females (CI= [11.0, 17.6], n=429), and 5.9% for age-3 males and females (CI= [2.7, 11.9], n=119). No age-4 salmon were unclipped (n=5). The low percentages of unclipped fish in the hatchery were in sharp contrast to the high percentages of wild Chinook salmon found in the Salmon River angler harvest sample, suggesting wild fish also display a low degree of straying into the SRH. Although wild fish are a substantial component of the Salmon River fishery, they do not contribute much to the hatchery broodstock; therefore, stocking at Salmon River is vital for maintaining current egg collection targets.

Fish stray not only *to* the Salmon River to spawn, but also *from* the Salmon River to other tributaries. Of the 2,102 AD clipped salmon sampled by headhunters in 2012, a total of 108 strays (5.0%) from SRH broodstock stockings were found in other tributaries including: 3 from the 2008 year class at Little Salmon River (n=2) and Salmon Creek (n=1); 48 from the 2009 year class at the Black River (n=1), Mill Creek near Sackets Harbor, (n=5), North Sandy Creek (n=1), S. Sandy (n=6), Little Salmon River (n=23), Oswego River (n=5), Sterling Creek (1), Salmon Creek (n=1), Bear Creek (1), Genesee River (n=1), Shipbuilders Creek (n=1), Oak Orchard Creek (n=1), and Marsh Creek (n=1); and 57 from the 2010 year class at Black River (n=3), Mill Creek near Sackets Harbor (n=11), North Sandy Creek (n=6), Little Salmon River (n=28), Grindstone Creek (n=3), Oswego River (n=3), Oak Orchard (n=1), Sandy Creek (n=1) and the Niagara River (n=1). In 2010-2011, the number of SRH strays recovered in other tributaries was low, i.e. 18 were recovered by headhunters in 2011 out of 1,055 AD clipped fish sampled (1.7%), and three out of 500 AD clipped fish sampled (0.6%) in 2010 (Connerton et al. 2011, 2012).

The highest proportions of SRH strays in 2012 were recovered in the Little Salmon River, where 34% of age-2 (out of 79 AD clipped salmon sampled) and 47.9% of age-3 (n= 48) were strays from the Salmon River. This site also contained a high proportion of strays from other sites with 36.7% of age-2 AD clipped salmon (n=79) originating from various sites including the Niagara River, Oak Orchard Creek, Sandy Creek, Genesee River, Sodus, Fairhaven, and the Oswego River. The Little Salmon River is not a Chinook stocking site, however it is only 6 miles from the Salmon River and apparently receives fish straying from both the SRH and fish stocked throughout the lake, possibly due to its proximity to the hatchery. Spatial patterns of straying and homing may become clearer as more tagged fish from the pen evaluation study return to streams in 2013-2016.

Summary

1. The proportions of wild Chinook salmon in Lake Ontario varied among regions in 2012 with a significantly higher percentage of wild age-1 fish observed in Ontario waters (34.5%) compared to the NY east (17.0%) region but not the west (24.3%); a significantly higher percentage of wild age-2 fish observed in the New York east region (64.1%) compared to the Ontario (59.9%) and NY west (52.9%) regions; and a significantly lower percentage of wild age-3 fish observed in the NY west region (44.3%) compared with Ontario and NY east regions (59.3% and 56.9%, respectively).

2. The proportion of wild Chinook salmon observed in tributaries varied among regions but was generally low in most tributaries except the Salmon River, where significantly higher proportions of wild Chinook salmon were observed (i.e., 70.8%, 60.4%, and 87.5% of ages 2-4 respectively) compared with other regions. In NY west tributaries, 5.9%, 5.7%, 4.2% and 0% of ages 1-4 Chinook salmon were wild, respectively. The proportions of wild Chinook salmon in NY east tributaries were significantly higher than the west region where 7.1%, 23.2%, 20.9% and 30.8% of ages 1-4, respectively, were wild.

3. Observed ratios of AD-CWT to AD-only Chinook salmon at the SRH suggest a high degree of homing by fish stocked at the Salmon River and a low degree of straying from other sites.

4. Straying from other sites to the SRH was generally low in 2012, with an estimated 9.1% of age-2, and 5.9% of age-3 Chinook salmon straying from other stocking sites to the hatchery.

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Eastern Basin of Lake Ontario Warmwater Fisheries Assessment, 1976-2012

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Each year the New York State Department of Environmental Conservation (NYSDEC) assesses the warmwater fish community in New York waters of Lake Ontario's eastern basin. This long-term assessment program was initiated in 1976 to establish abundance indices for warmwater fishes in the eastern basin, with emphasis on smallmouth bass (*Micropterus dolomieu*), walleye (*Sander vitreus*), yellow perch (*Perca flavescens*), and white perch (*Morone americana*). Data collected allow for evaluations of other population parameters including growth, age structure, year class strength, survival rates, and diet composition for some of the target species. This long-term dataset has been used to evaluate impacts of Double-crested cormorant predation on smallmouth bass and yellow perch populations in the eastern basin (O'Gorman and Burnett 2001, Lantry et al. 2002). This report focuses on 2012 abundance indices as they relate to previous years, and provides evaluations of the occurrence of round goby (*Neogobius melanostomus*) in predator diets, smallmouth bass age and growth trends, and age structure of walleye caught in 2012.

Methods

A standardized, stratified random design gillnetting assessment was conducted annually from 1976 through 2012 in the New York waters of Lake Ontario's eastern basin to assess the warmwater fish community. Sampling was initiated as early as July 29 and completed as late as August 25, typically occurring during the first two weeks of August. Since 1980, standardized net gangs (nine 50 ft panels, 8 ft deep, and stretch-mesh sizes ranging from 2-6 in by ½ in increments) were set overnight, on bottom and parallel to depth contours at predetermined, randomly selected sample locations. Detailed assessment methods and corrections for 1980, 1989, and 1993 survey and gear design changes were described previously (Eckert 1986, 1998, and 2006). A net set was deemed biased, and data from that set were excluded from analyses, when there was any indication of fouling or tampering. In 1993, gear changed from multifilament gill nets to monofilament gill nets and correction factors were determined, applied to multifilament catch data, and "monofilament equivalents" were calculated (Eckert 1998). The random survey design was stratified by three depth strata (Stratum 1: 12-30 ft; Stratum 2: 31-50 ft; Stratum 3: 51-100 ft) and five area strata (Grenadier Island, Chaumont Bay, Black River Bay, Henderson Bay, and Stony Island Areas; Figure 1). Area strata were used primarily to ensure that all major geographic areas within depth strata 1 and 2 were sampled each year in proportion to their surface areas. Each year 10 net sets were scheduled for depth stratum 3.

Prior to 1996 a net set was canceled and the catch of warmwater fish was assumed zero when the scheduled set location had stable water temperatures <50°F. Experience had shown that catches of warmwater fish were consistently zero in areas inundated by cold hypolimnetic waters (Eckert 2006). From 1996-2005 all scheduled net sets were completed regardless of temperature given the potential for a shift in fish depth distribution related to increased water clarity resulting from dreissenid mussel colonization. Similar shifts were observed with alewives, rainbow smelt and lake trout (e.g., O'Gorman et al. 2000). During that time period, 18 nets were set and pulled at temperatures <50°F. Sixteen out of 18 nets captured coldwater fish species (mean=10.5 coldwater fish per net, most of which were lake trout [*Salvelinus namaycush*]) and

only seven of those 16 captured warmwater species (mean=3.7 warmwater fish per net). Two of the 18 nets captured no fish. Beginning again in 2006, a net set was canceled and catch of warmwater fish was assumed zero when scheduled at a location with stable water temperatures <50°F for at least 9 ft off bottom.

In 2012, 29 randomly chosen netting locations were determined prior to initiation of the assessment on July 30. From July 30 through August 22, we completed 27 unbiased net sets and one additional net was canceled and catch of warmwater fish was assumed zero due to bottom water temperatures <50°F. One net set scheduled in depth stratum 3 (92-93' depth) was canceled due to logistical issues, however, zero warmwater fish catch could not be assumed due to water temperatures >50°F. Mean stratified catch-per-unit-effort (CPUE = fish per overnight net set) was calculated for the total warmwater fish catch and each fish species captured. The 95% confidence intervals were also determined for each mean stratified CPUE estimate. Relative standard error (RSE = 100% * [standard error/mean]) was calculated to examine variability in CPUE between years.

For fish collected, we determined species, length and weight, and when possible sex and maturity (with the exception of longnose gar [*Lepisosteus osseus*]). Stomach contents of all predators (i.e. smallmouth bass, walleye, northern pike [*Esox lucius*], and muskellunge [*Esox masquinongy*]) were identified each year beginning in 2000. For each assessment year, scales were collected from all species with the exception of ictalurids and longnose gar. We removed cleithra from all esocids and pectoral spines from all ictalurids. From 2003-2012 and in addition to scales, we collected otoliths from smallmouth bass >13.8 in, yellow perch >8.7 in, and all walleye and freshwater drum (*Aplodinotus grunniens*).

Species composition, depth stratum-specific species diversity and CPUE, and trends in abundance indices were described. Additional data analyses were completed for smallmouth bass including: 1) scales (1976-2003 and 2006-2009) and otoliths (2006-2009) were aged and mean length-at-age was determined; 2) for each sample year, condition (Fulton's K) was calculated for each inch increment (7-19 in); and 3) the age composition of bass fully vulnerable to our gill nets was determined (i.e. ≥12 in) for each year 1976-2003 and 2006-2009. Smallmouth bass samples collected in 2004-2005 and 2010-2012 were not aged. Also, otoliths from walleye collected in 2012 were aged.

Results and Discussion

2012 Water Temperature

In 2012, bottom temperatures for all nets set in depth strata 1 (12-30 ft) and 2 (31-50 ft) ranged from 74.5°F-76.8°F and 71.8°F-75.9°F, respectively. For nets set in stratum 3 (51-100 ft) bottom temperatures ranged from 53.2°F-76.6°F. Mid-70 degree water temperatures occurred as deep as approximately 70 ft during the 2012 survey. Four unbiased sets in depth stratum 3 may have experienced some periods of water temperatures <50°F, given that 20 coldwater fish (six species) were captured in those nets.

Species Composition

Since 1976, 44 fish species (33 warm and cool water species) were captured during the eastern basin gillnetting assessment (Table 1). In 2012, 1,014 fish were captured in unbiased net sets, representing 24 warm and cool water species (994 fish) and three coldwater species (20 fish). The greatest species diversity (16 species; CPUE=39.3) occurred in depth stratum 1, followed by depth strata 2 (12 species; CPUE=39.7) and 3 (7 species; CPUE=27.1). The lowest warm and cool water species diversity and catch typically occurs in depth stratum 3 (Eckert 2006).

Dominant species in the catch has changed over time. From 1976-1979 white perch, yellow perch and gizzard shad (*Dorosoma copedianum*) were the most commonly caught species and represented an average of 37.2%, 22.1% and 14.3% of the total catch, respectively (Table 1). Through the 1980s smallmouth bass (mean=25.2%), yellow perch (mean=25.0%) and white perch (mean=22.5%) dominated gillnet catches. Since 1990, smallmouth bass and yellow perch were the most common species, averaging 30.8% and 31.6% of the total

warmwater catch, respectively. From 1995-2007 catches of white perch remained low (mean=3.7%); however, each year 2008-2011 it was the third most commonly caught species and represented an average of 13.9% of the catch. In 2012, smallmouth bass (25.4%), yellow perch (46.8%), and walleye (7.5%) were the three most common species captured (Table 1).

Round goby is an invasive species first reported in southwestern Lake Ontario in 1998 and in the Bay of Quinte in 1999 (Mills et al. 2005). Gobies increased in distribution, abundance, and biomass throughout Lake Ontario, peaking in 2008, and remaining at a variable, lower level since (Walsh et al. 2007, Weidel et al. 2013). Although present in Lake Ontario for some time, gobies did not appear in this assessment until 2005 when two were captured. They have appeared in low numbers each year since (Table 1). This assessment will not provide an index of goby abundance due to their relatively small size and the size-selective nature of the assessment gill nets. We are, however, able to gain insight into the importance of gobies in predator diets during early August from examination of predator stomachs.

Occurrence of Round Goby in Predator Diets

Stomach contents from all predators captured were identified from 2000-2012. We first observed gobies in predator diets in 2005 (i.e. a total of 16 gobies observed in bass stomachs). The occurrence of gobies in smallmouth bass stomachs increased each year from 2005-2010. In 2010, 72.5% of non-empty stomachs contained gobies (mean=1.7 gobies/stomach). In 2011, gobies were present in 72.0% of the 168 non-empty smallmouth bass stomachs processed. Of the 170 non-empty bass stomachs processed in 2012, 78.8% had gobies (mean=2.0 gobies/stomach). Gobies were present in walleye diets each year from 2006-2010 and 2012 but none were observed in walleye diets during the 2011 assessment. Round gobies have also been observed in the diets of northern pike, brown trout (*Salmo trutta*), lake trout, and lake whitefish (*Coregonus clupeaformis*) caught in this survey. Although not quantified, round gobies were observed in stomachs of other fish species including rock bass (*Ambloplites rupestris*), yellow perch and white perch. Double-crested cormorants in the eastern basin are also consuming round goby. This species first appeared in cormorant diets at the Snake and Pigeon Island colonies in 2002 (Ross et al. 2003) and at the Little Galloo Island colony in 2004 (Johnson et al. 2005). Gobies were consumed each year since then and dominated cormorant diets by 2004 and 2005 at the Snake and Pigeon Island colonies, and Little Galloo Island colony, respectively (Ross et al. 2005, Johnson et al. 2006, Johnson et al. 2010, Johnson et al. 2012, Johnson et al. 2013).

Abundance Trends, 1976-2012

Total Warmwater Catch

The abundance index for warmwater fish in the New York waters of Lake Ontario's eastern basin was highest during the early years of the assessment (1976-1979 mean stratified CPUEs: 209-257) then declined (1984-1986 mean CPUE=68.7; Table 1, Figure 2). The decline in warmwater fish abundance was primarily due to declining indices for white perch (1976-1979 mean CPUE=90.1, 1984-1986 mean CPUE=15.7), yellow perch (1976-1979 mean CPUE=51.8, 1984-1986 mean CPUE=17.6), gizzard shad (1976-1979 mean CPUE=34.7, 1984-1986 mean CPUE=0.6), and rock bass (1976-1979 mean CPUE=13.5, 1984-1986 mean CPUE=6.2; Table 1, Figures 3-6). The mean stratified CPUE for all warmwater species reached a record low level in 1995 when CPUE was 14.9 and 94% lower than the 1976-1979 average (Table 1, Figure 2). Since 1996, mean stratified CPUE for total warmwater fish varied without trend averaging 26.6 and ranging between 14.9 (1995) and 44.4 (2008; Table 1, Figure 2). In 2012, the mean stratified CPUE of 32.0 was comparable to (-5.8%) the previous 5-year (2007-2011) average.

Alewife (*Alosa pseudoharengus*), walleye, and smallmouth bass also influenced trends in the total warmwater CPUE. Alewife was relatively common in the assessment and varied without trend through 1988 before declining to low levels (Table 1, Figure 7). Walleye catches increased from low levels observed prior to the mid-1980s (Figure 8). Smallmouth bass catches were relatively high and increased as strong year classes recruited into the gill nets (1980 CPUE=38.0; 1989 CPUE=39.1),

then declined to the lowest levels during 2000-2004 (average CPUE=4.2; Figure 9). Catches of other species (i.e. white sucker [*Catostomus commersonii*], brown bullhead [*Ameiurus nebulosus*], channel catfish [*Ictalurus punctatus*], pumpkinseed sunfish [*Lepomis gibbosus*], freshwater drum, northern pike, and common carp [*Cyprinus carpio*]) were low and variable across the entire data series (Table 1, Figures 10-16).

Lake Sturgeon

Lake Sturgeon (*Acipenser flavescens*) is designated as a threatened species in New York State. Prior to 1995, this species was extremely rare in this assessment, with only one lake sturgeon captured in 19 years (Table 1). From 1995-2007, at least one sturgeon was collected in 11 of the 13 years. Lake sturgeon remain rare in the survey (none caught in 2008, 2009, or 2012; Table 1).

White Perch

The most notable declines in species abundance between the late 1970s and mid 1980s occurred with white perch and gizzard shad, the two most abundant species in 1977 and 1978. White perch declined 83% between the 1976-1979 and 1984-1986 time periods (Table 1, Figure 3). Abundance indices declined further, reaching a low CPUE of 0.06 in 1995, and remained low through 2007. In 2008, white perch CPUE was 7.7, a more than 6-fold increase over the previous 5-year average and the highest observed since 1991. Each year from 2008-2011 white perch was the third most common species in the assessment, representing 9.6%-17.5% of the total warm water fish catch. The 2012 CPUE (1.0) was a 79.8% decrease compared to the 2008-2011 time period (Table 1, Figure 3).

Yellow Perch

Yellow perch were commonly caught since the assessment began in 1976, however, abundance declined significantly through the early to mid-1980s reaching a low CPUE of 2.2 in 1988 (Table 1, Figure 4). Subsequently, CPUE varied without trend and averaged 7.4 from 1989-2006 (range: 2.8 [1993] - 13.6 [1990]). Yellow perch CPUE increased in 2008 to the highest level (16.9) since 1984. The 2012 CPUE (15.0) was comparable to highs observed in recent years (i.e. +7.3% compared to the previous 5-year average). Variability of yellow perch catch in gill nets is relatively high (long-term average RSE=37.1%) when compared to another common species, smallmouth bass (long-term average RSE=21.2%), and is likely attributable to the schooling nature of perch. For 2012, yellow perch RSE (44.0%) was 19.2% above the long term average. Data collected during the Lake Ontario fishing boat survey corroborates continued, higher yellow perch abundance in recent years (Lantry and Eckert 2013).

As was documented for smallmouth bass (Chrisman and Eckert 1999, Lantry et al. 2002), the yellow perch population in the eastern basin was impacted by Double-crested cormorant predation (O'Gorman and Burnett 2001). Fall trawl sampling conducted in the eastern basin showed that relatively strong year classes of yellow perch were produced in the early 1990s, however, anticipated increases in assessment CPUE at older ages did not occur. Analyses indicated increased mortality of age 0-2 perch during that time period which was attributed, in part, to increased predation by Double-crested cormorants (O'Gorman and Burnett 2001). Since then, management of the Double-crested cormorant population reduced both the number of cormorant feeding days (the measure used to evaluate cormorant management efforts) and the number of fish consumed (Johnson et al. 2010). Over the same time period round goby abundance increased. Round goby is now the species most commonly consumed by cormorants, further reducing predation pressure on yellow perch in recent years (Johnson et al. 2013).

In 2012, yellow perch total lengths ranged between 5.2 in and 13.2 in, and averaged 9.0 in. Approximately 53% of perch captured were $\geq$ 9 in (Figure 17). Weights of yellow perch captured in 2012 ranged from 0.8 oz to 22.9 oz and averaged 5.8 oz.

Gizzard Shad

Gizzard shad was one of the most abundant species at the start of the warmwater assessment program (Table 1, Figure 5). Abundance declined 98% from the 1976-1979 (mean CPUE=34.7) to 1984-1986 (mean CPUE=0.6) time periods. Since then, gizzard

shad abundance remained low, with CPUEs of zero or <1 in 22 of the last 25 years (Table 1). In 2012, gizzard shad CPUE (0.19) was the highest since 1992 (CPUE=1.8).

Rock Bass

Rock bass CPUE peaked in 1978 at 22.1, declined through the early 1980s, varied without trend through the early 1990s, then declined again to a relatively stable level through 2012 (Figure 6). In 2012, the rock bass CPUE (0.8) was a 59.8% decrease compared to the previous 5-year average.

Alewife

Alewife CPUE varied without trend through 1988, averaging 9.0 (Figure 7). CPUE subsequently declined and was ≤1 each year 1993-2008. In 2009, alewife CPUE (1.2) was the highest observed since 1992, but well below levels observed through the 1970s and 1980s. No alewives were caught during the 2010 assessment. Alewife CPUE in 2012 was 0.46. Although alewife is not fully vulnerable to our gear, the trends we observed were similar to those in Lake Ontario bottom trawl surveys (O'Gorman et al. 2000, Walsh et al. 2010). The declining trends in alewife abundance and a shift in distribution temporally were particularly evident in the eastern basin (O'Gorman et al. 2000, O'Gorman et al. 2005).

Walleye

Walleye is the only relatively common species that increased in abundance since the assessment was initiated in 1976 (Figure 8). Catches were lowest from the late 1970s through the mid-1980s (mean CPUE 1976-1986=0.2) and increased through the early 1990s with a peak CPUE of 3.8 in 1993 (Table 1). Subsequently, CPUE declined through the late 1990s, and has fluctuated without trend (Figure 8). The 2012 CPUE of 2.4 was a 22.9% increase compared to the previous 10-year average. Variability of gillnet catches was highest when CPUE was low (Figure 8) with RSE averaging 44.6% during the 1980-1989 time period. RSE fluctuated at a lower level without trend from 1990-2012 (average RSE=26.9%).

Catches of age-1 walleye were rare in this assessment (n=17 during 1976-2003) until 2004 when the strong 2003 year class represented 25.9% (n=21 age-1 fish; record-high) of the walleye catch (Eckert 2005). Assessments in Canadian waters of Lake Ontario and New York waters of Lake Erie also identified a strong 2003 walleye year class (Einhouse et al. 2010, Ontario Ministry of Natural Resources 2011a and 2011b).

Small walleye (<13.5 in and likely age-1 fish) continued to appear in this assessment at levels higher than those observed prior to 2004. The increased catches of age-1 walleye in recent years (Eckert 2005 and 2006) may be due, in part, to improved growth or to increased natural reproduction in New York waters of the eastern basin.

In 2009, a relatively high catch of age-1 walleye (confirmed with ageing) suggested a potentially strong 2008 year class. Fall 2008 bottom trawling conducted by Ontario Ministry of Natural Resources staff indicated that a potentially strong 2008 year class was produced in the Bay of Quite (Ontario Ministry of Natural Resources 2009). Otoliths collected from walleye during this 2012 survey were aged. The 2003, 2005, and 2008 year classes dominated the catch (18.8%, 18.8%, and 21.8% of the catch, respectively; Figure 18).

In 2012, walleye total lengths ranged between 16.0 in (407mm) and 29.7 in (755mm), and averaged 24.3 in (617.1mm; Figure 17). Walleye weights ranged from 1.4 lb (614g) to 10.5 lb (4,756g) and averaged 6.0 lb (2,731.5g).

Smallmouth Bass

Smallmouth bass have provided an important sport fishery in Lake Ontario's eastern basin for decades (Jolliff and LeTendre 1967, Panek 1981, NYDEC 1984, McCullough and Einhouse 1999). It has always been a relatively common species in the warmwater assessment and has been the most commonly or second most commonly captured species in the assessment since 1986 (Table 1). This is primarily due to significant declines of previously dominant species, particularly white perch and gizzard shad. In 2012, smallmouth bass was the second most commonly captured species, representing 25.4% of the total catch.

Smallmouth bass CPUE trends varied over time, peaking during the 1979-1980 and 1989-1991 periods (Table 1, Figure 9), attributable to strong 1973 and 1983 year classes, respectively (Chrisman and Eckert 1999). Data from young fish indicated that strong year classes were also produced in 1987, 1988, 1995, and 1997 (Chrisman and Eckert 1999, Eckert 2000, Casselman et al. 2002); however, subsequent increased CPUE at older ages was not evident in the assessment (Figure 9). Further analyses indicated increased mortality of age-3 to age-6 bass through the 1990s (Chrisman and Eckert 1999, Lantry et al. 2002), which coincided with documented increases in the number of Double-crested cormorants as well as cormorant diet data corroborating substantial predation on smallmouth bass (Johnson et al. 1999, Johnson et al. 2000). With the exception of an increase in abundance in the late 1990s, CPUEs remained low and declined to record and near record lows during 2000-2004 (mean CPUE=4.2). Smallmouth bass CPUE increased substantially in 2005 to 11.3 and has remained relatively stable since (Table 1). The CPUE in 2012 was 8.1, comparable to (+2.9%) the previous 5 year average and well above lows observed 2000-2004. The 2005-2012 CPUE is, however, 59.8% below the levels observed before cormorant impacts (1976-1994; Figure 9).

During the entire time series smallmouth bass RSE fluctuated without trend, ranging from 13.2% (2005) to 29.0% (1989). RSE was 21.0% in 2012, comparable to the long-term average RSE (21.2%).

Improved smallmouth bass CPUEs relative to 2000-2004 levels may be due to several factors including reduced predation by Double-crested cormorants and improved catchability in the gill nets. Smallmouth bass mean length-at-age began increasing in the mid-1990s (see "Growth and Condition" section), resulting in increased catchability of the more abundant, younger ages (i.e. younger ages were more vulnerable to being caught in recent years relative to the mid-1990s). Prior to 1994, gillnet catches were dominated by age-5 and older bass (1976-1993 average percent contribution: ages 5+ = 73.6%, and < age 5 = 26.4%); now younger bass dominate catches (2006-2009 average percent contribution: ages 5+ = 45.1%, and < age 5 = 54.9%). Currently there is no evidence of a strong year class recruiting to older ages (i.e. ages 5+) since the 1983 year class.

Reduced predation pressure by Double-crested cormorants likely also contributed to improved bass abundance in the Eastern Basin. Ongoing cormorant population management in the New York waters of the eastern basin has effectively reduced cormorant numbers and, since 2006, has maintained the number of cormorant feeding days to near target level (McCullough et al. 2013, Johnson et al. 2013). The decline in number of cormorant feeding days combined with their dietary shift to round goby (Johnson et al. 2013) appear to have reduced predation pressure on smallmouth bass.

Growth and Condition

By the 1997 assessment, smallmouth bass mean length-at-age was increasing for all ages caught (Figure 19). This is prior to first reports of round goby in Lake Ontario which occurred in 1998 (southwestern area) and 1999 (Bay of Quinte). The increase in mean length-at-age began prior to 1997 for bass ages 8 and older. Increased growth may be due to system changes associated with dreissenid mussel proliferation or compensatory growth associated with a declining bass population through the early 1990s due to cormorant predation (Figure 9). Mean lengths of smallmouth bass have fluctuated over the data series and, since the mid to late 1990s, have generally been above age-specific long term means for all ages (2-13) (Figure 19). In 2009, mean length-at-age remained at or near record high for all ages 2-10 (Figure 20).

Age-1 bass first appeared in the assessment in 1994 and appeared in low numbers during the 1995, 1997-2000, 2002, and 2006-2008 sample years. Scale aging is incomplete, so it is not currently known if age-1 bass were captured in 2004-2005 or 2010-2012.

In 2012, 14.3% and 3.1% of all bass caught (n=294) were $\geq$ 4 lbs and $\geq$ 5 lbs, respectively, the highest proportions of "heavy" bass recorded. In 2012, smallmouth bass total lengths ranged between 6.9 in (176mm) and 20.7 in (527mm), and averaged 14.7 in (373.7mm) (Figure 17). Bass weights ranged from 0.18 lb (80g) to 6.1 lb (2,756g) and averaged

2.4 lb (1,094.1g).

Age composition of bass fully vulnerable to our gear and of legally harvestable size (i.e. ≥ 12 in) changed as mean length-at-age increased (Figures 19-20). For years prior to 1997, 98.1% (1976-1996 mean) of bass ≥ 12 in were age 5 and older and only 1.9% were ages 3 or 4. Age-3 bass ≥ 12 in were very rare in the assessment through that time period. Since 1997, mean length-at-age was above the long term average for all age-3 and older bass (Figure 20). From 1997 through 2003, age-3 and age-4 bass ≥ 12 in appeared in greater frequency, and represented an average of 19.7% of bass ≥ 12 in (Figure 20). During that time period, age 5 and older bass comprised 80.3% of the catches. In 2009, 49.5% of bass ≥ 12 in were age 3 and age 4, and 50.5% were age 5 and older (Figure 20). Samples collected from bass in 2004-2005 and 2010-2012 are not yet aged. Given the improved growth and increased proportion of younger bass recruiting to the gill nets, further analyses are needed to determine how improved catchability of younger bass impacts our ability to evaluate year class strength and population trends.

Recent smallmouth diet data indicate a shift from crayfish dominance and no gobies to one clearly dominated by round goby and very low occurrence of crayfish. This dietary shift coincides with recent improved condition of smallmouth bass in the eastern basin. Smallmouth bass condition varied about the long term mean from 1976-2005, then increased for each length group from 7-12 in (Figure 21). Condition of the 16-18 in length groups has trended upward since the early to mid 1990s. In 2012, condition remained at or near the highest levels observed in the survey for the 12-18 in length groups. Condition of smaller bass (9-11 in) remained above the long term average (Figure 21).

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Table 1. Stratified mean catch per unit effort data from the 1976-2012 warmwater assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

	Stratified Mean Catch per 450 ft Monofilament Gill Net Gang											
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Lake Sturgeon	0	0	0	0	0	0.02	0	0	0	0	0	0
Longnose Gar	0	0	0	0	0.04	0	0	0.04	0	1.19	0.04	0
Bowfin	0	0	0	0	0.02	0.02	0	0	0	0	0	0
American Eel	0	0	0.06	0.03	0	0	0	0	0	0	0	0
Alewife	20.96	2.07	14.83	11.57	4.30	8.18	7.53	6.90	17.65	3.35	7.61	2.32
Gizzard Shad	17.82	53.45	47.38	19.95	4.52	2.78	0.10	0.29	0.87	0.50	0.48	0.44
Northern Pike	0.83	1.04	0.93	0.16	0.08	0.02	0.04	0.06	0.02	0.17	0.17	0.08
Muskellunge	0	0	0	0	0	0	0	0	0	0	0	0
Goldfish X Carp	0	0	0	0.17	0	0	0	0	0	0	0	0
Common Carp	0.25	0.55	0.33	0.45	0.17	0.10	0.35	0.21	0.17	0.17	0.10	0.20
Golden Shiner	0	0	0	0	0.02	0	0	0	0.04	0.02	0	0
Spottail Shiner	0	0	0	0	0	0	0	0.15	0	0	0	0
Quillback	0	0	0	0.31	0.04	0.06	0	0.04	0	0	0.02	0
Longnose Sucker	0	0	0	0	0.02	0	0	0	0	0	0	0
White Sucker	4.04	0.63	2.90	3.11	1.84	1.42	4.34	1.40	1.58	0.93	2.47	1.49
Silver Redhorse	0.06	0.05	0.20	0.43	0.04	0.10	0.15	0.38	0.06	0	0.02	0.02
Shorthead Redhorse	0	0	0	0	0	0	0	0	0	0	0	0
Brown Bullhead	1.12	0.2	1.41	4.17	0.66	0.23	1.29	0.76	0.86	1.70	2.14	1.96
Channel Catfish	0.41	1.03	1.75	3.64	0.6	0.56	1.27	0.86	0.29	0.63	1.25	0.77
Stonecat	0	0.04	0.26	0.08	0	0.23	0.30	0.02	0.04	0.06	0.04	0
Trout-perch	0	0	0	0	0	0.15	0.15	0	0.08	0	0	0.08
White Perch	63	136.42	74.11	86.98	26.2	44.53	25.98	34.02	20.78	12.23	13.94	11.14
White Bass	0	0	0.13	0	0.02	0.06	0.26	0	0.06	0.02	0.06	0.06
Rock Bass	7.10	10.75	22.13	13.94	14.69	10.09	7.06	4.69	6.99	3.96	7.58	4.76
Pumpkinseed	0	0.44	0.06	3.06	0.14	0.32	0.73	0.43	0.09	0.59	0.57	0.40
Bluegill	0	0	0	0	0	0	0.04	0	0	0	0	0
Smallmouth Bass	24.51	24.05	26.04	35.74	38.02	23.47	14.55	14.96	12.44	9.76	18.14	10.89
Largemouth Bass	0	0	0	0	0	0	0	0	0	0	0	0
Black Crappie	0	0	0	0.04	0.02	0.02	0.02	0.06	0.02	0.1	0	0
Yellow Perch	69.09	26.20	44.44	67.32	27.63	43.81	36.07	50.85	24.02	15.35	13.32	8.36
Walleye	0.05	0.20	0.12	0.27	0.28	0.12	0.59	0.09	0.09	0.41	0.19	0.75
Freshwater Drum	0.19	0	0.74	1.43	0.34	0.09	0.34	0.59	0.31	0.25	0.16	0.25
Round Goby	0	0	0	0	0	0	0	0	0	0	0	0
Total	209.4	257.13	237.8	252.8	119.7	136.4	101.2	116.8	86.50	51.38	68.30	43.98

Table 1 (continued). Stratified mean catch per unit effort data from the 1976-2012 warmwater assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

	Stratified Mean Catch per 450 ft Monofilament Gill Net Gang											
	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Lake Sturgeon	0	0	0	0	0	0	0	0.02	0	0.02	0.06	0.04
Longnose Gar	0	0	0.08	0	0	0.48	0.35	0	0	0.02	0.02	0.08
Bowfin	0	0	0	0	0.02	0	0	0	0	0	0	0
American Eel	0	0	0.02	0	0	0	0	0	0	0	0	0
Alewife	9.64	0.59	1.29	1.27	2.26	0.18	0	0.48	0.92	0	0.06	0.12
Gizzard Shad	0.24	0.69	1.26	1.39	1.79	0.12	0.06	0	0	0	0.08	0.08
Northern Pike	0	0.02	0	0.15	0.04	0.10	0.06	0.04	0.04	0.08	0.06	0.06
Muskellunge	0	0	0	0	0	0	0	0	0	0	0	0
Goldfish X Carp	0	0	0	0	0	0	0	0	0	0	0	0
Common Carp	0.23	0.37	0.35	0.29	0.33	0.35	0.06	0.10	0.15	0.12	0.10	0.33
Golden Shiner	0	0	0	0	0	0	0	0	0	0	0	0
Spottail Shiner	0	0	0	0	0.06	0	0	0	0	0	0	0
Quillback	0.02	0.04	0.04	0.08	0	0.04	0	0	0.04	0	0.04	0
Longnose Sucker	0	0	0	0	0	0	0	0	0	0	0	0
White Sucker	0.91	0.75	3.47	0.41	0.88	1.18	0.81	1.13	2.01	1.31	1.02	1.02
Silver Redhorse	0.07	0.17	0.29	0.22	0.18	0	0.08	0.12	0.02	0.13	0.12	0.10
Shorthead Redhorse	0	0	0	0	0	0	0.02	0	0	0.02	0	0
Brown Bullhead	0.61	0.84	0.66	0.86	0.87	0.35	0.35	0.06	0	0.83	0.06	0.21
Channel Catfish	0.97	2.40	3.34	1.20	1.35	1.12	0.35	0.19	0.47	1.42	0.75	0.68
Stonecat	0	0.02	0	0.02	0	0	0	0	0	0	0	0
Trout-perch	0.15	0	0	0.12	0	0	0	0	0	0	0	0
White Perch	4.87	7.95	4.36	7.83	5.49	5.04	6.01	0.06	0.31	0.48	0.29	1.36
White Bass	0.13	0.08	0	0.10	0	0.02	0	0	0	0	0.04	0
Rock Bass	4.94	7.53	8.08	6.86	3.09	6.99	3.99	1.41	3.79	2.33	2.13	3.08
Pumpkinseed	0.25	0.64	0.78	0.14	0.34	0.23	0.04	0.06	0.04	0.08	0.29	0.27
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0
Smallmouth Bass	15.92	39.05	21.72	29.4	19.13	19.91	11.99	5.01	6.98	6.03	9.36	10.68
Largemouth Bass	0	0	0	0	0	0	0	0	0	0	0.02	0
Black Crappie	0.02	0.02	0.06	0	0	0.04	0	0	0	0	0.02	0
Yellow Perch	2.19	10.06	13.61	6.97	6.72	2.78	5.87	3.68	8.76	5.53	5.01	4.47
Walleye	0.80	0.96	1.31	1.68	1.59	3.84	3.29	1.91	2.97	1.76	2.13	1.32
Freshwater Drum	0.45	0.53	0.62	0.34	0.43	0.52	0.74	0.63	0.23	0.41	0.25	0.50
Round Goby	0	0	0	0	0	0	0	0	0	0	0	0
Total	42.42	72.71	61.35	59.34	44.57	43.32	34.08	14.91	26.73	20.58	21.94	24.40

Table 1 (continued). Stratified mean catch per unit effort data from the 1976-2012 warmwater assessment netting conducted late July through mid August in New York waters of Lake Ontario's eastern basin.

	Stratified Mean Catch per 450 ft Monofilament Gill Net Gang												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Lake Sturgeon	0.10	0.02	0	0.04	0.02	0.02	0.09	0.10	0	0	0.08	0.02	0
Longnose Gar	0	0.02	0	0	0.06	0.17	0.12	0.08	0.10	0.21	0.75	0.62	0.02
Bowfin	0	0	0	0	0	0	0	0	0	0	0	0	0
American Eel	0	0	0	0	0	0	0	0	0	0	0	0	0
Alewife	0.26	0.95	0.02	0.08	0	0	0.07	0.14	0.19	1.19	0	0.16	0.46
Gizzard Shad	0.13	0	0.06	0	0	0	0	0	0	0.10	0	0.12	0.19
Northern Pike	0.08	0.07	0.19	0.15	0.17	0.19	0.08	0.06	0.23	0.09	0.10	0.02	0.02
Muskellunge	0	0	0	0	0.02	0.02	0	0	0	0	0	0	0
Goldfish X Carp	0	0	0	0	0	0	0	0	0	0	0	0	0
Common Carp	0.04	0	0	0.02	0.15	0.14	0.11	0.02	0.05	0.10	0.02	0.02	0
Golden Shiner	0	0	0	0	0	0	0	0	0	0	0	0	0
Spottail Shiner	0	0	0	0	0	0	0	0	0	0	0	0	0
Quillback	0	0	0	0	0	0	0	0	0	0	0	0	0
Longnose Sucker	0	0	0	0	0	0	0	0	0	0	0	0	0
White Sucker	0.35	0.38	0.78	1.66	0.41	1.03	0.72	0.573	0.65	1.31	0.48	0.25	2.35
Silver Redhorse	0.12	0.05	0.17	0.10	0.42	0.33	0.02	0.02	0.08	0.07	0.04	0	0.06
Shorthead Redhorse	0	0.02	0	0	0	0	0	0	0	0	0	0	0
Brown Bullhead	0.21	0.32	0.21	0.40	0.35	0.48	0.31	0.54	2.12	0.81	1.48	0.42	0.82
Channel Catfish	0.54	0.09	0.21	0.12	0.79	0.81	0.15	0.12	0.57	0.54	0.42	0.17	0.21
Stonecat	0	0	0	0	0	0.06	0.02	0	0	0	0.04	0.02	0.02
Trout-perch	0	0	0	0	0	0	0	0	0	0	0	0	0
White Perch	0.92	1.04	1.09	0.42	1.18	1.94	0.92	0.81	7.75	3.02	6.22	3.72	1.04
White Bass	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock Bass	1.47	1.22	1.10	1.84	2.09	2.70	2.43	0.70	3.27	2.52	1.54	1.31	0.75
Pumpkinseed	0.31	0.28	0.46	0.46	0.52	0.50	1.15	0.21	0.10	0.28	0.04	0.21	0.29
Bluegill	0	0	0	0	0	0	0	0	0	0	0	0	0
Smallmouth Bass	5.01	2.99	3.76	5.43	3.84	11.33	10.45	6.39	9.27	9.81	7.90	6.09	8.12
Largemouth Bass	0	0	0	0	0.02	0.02	0.02	0	0	0.03	0.02	0	0
Black Crappie	0	0	0.06	0	0.02	0.06	0	0.04	0.05	0.03	0.04	0.04	0.02
Yellow Perch	8.58	6.37	9.65	9.82	6.74	8.93	9.13	13.95	16.91	7.37	16.31	15.29	14.99
Walleye	1.53	1.70	1.08	2.12	1.69	2.38	1.94	1.33	2.33	2.65	1.91	1.97	2.38
Freshwater Drum	0.25	0.20	0.23	0.27	0.60	0.19	0.32	0.23	0.26	0.36	0.08	0.19	0.19
Round Goby	0	0	0	0	0	0.04	0.10	0.26	0.42	0.95	0.36	0.08	0.07
Total	19.92	15.73	19.06	22.92	19.1	31.36	28.16	25.6	44.36	31.44	37.84	30.73	32.02

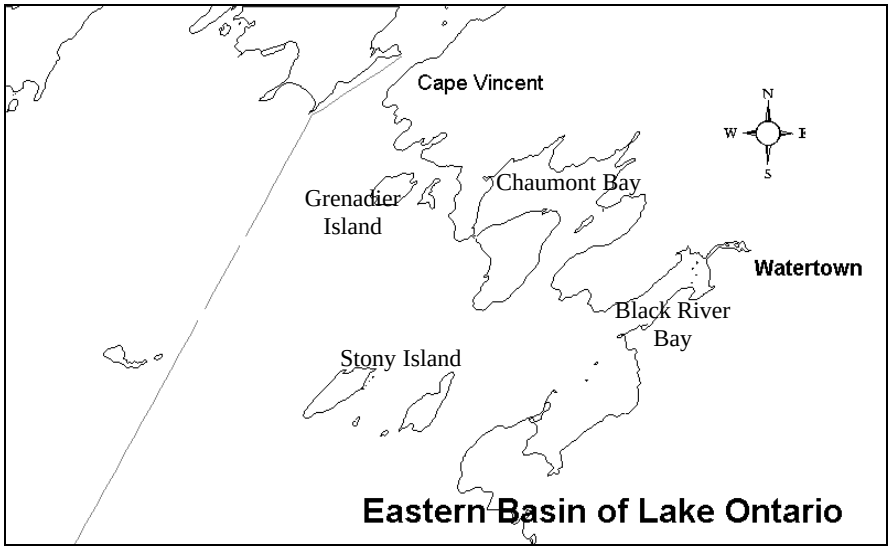

Figure 1. Map of New York waters of Lake Ontario's eastern basin showing five area strata used in the 1980-2012 warmwater assessment.

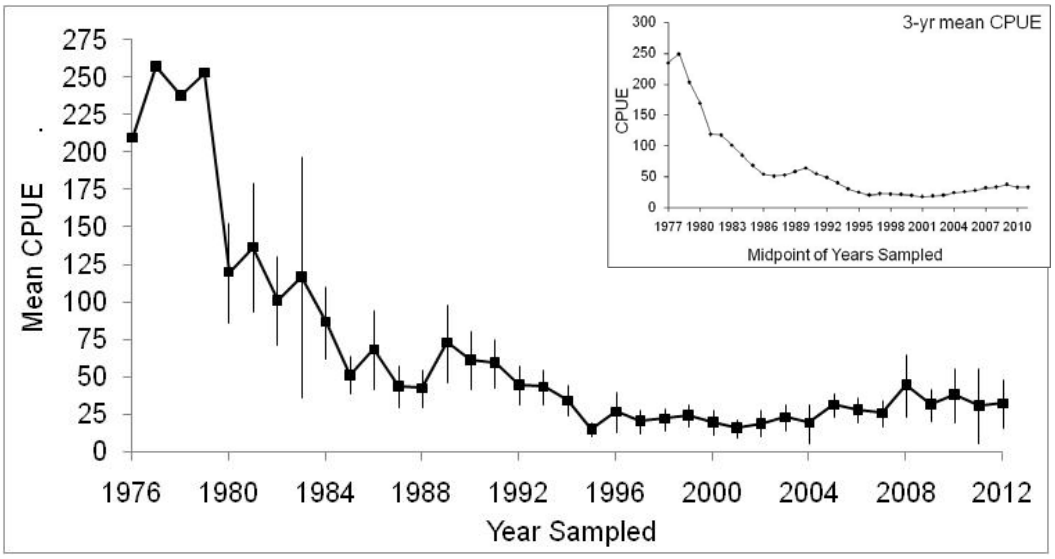

Figure 2. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for all warmwater fish from the 1976-2012 assessments.

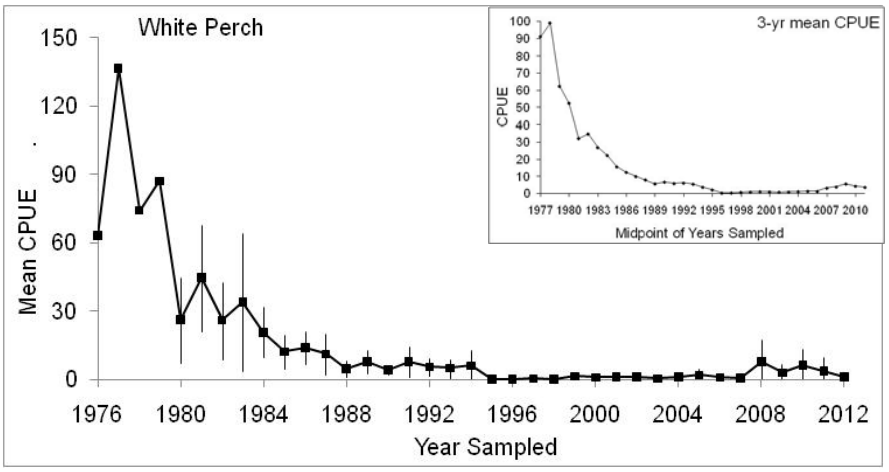

Figure 3. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for white perch, 1976-2012.

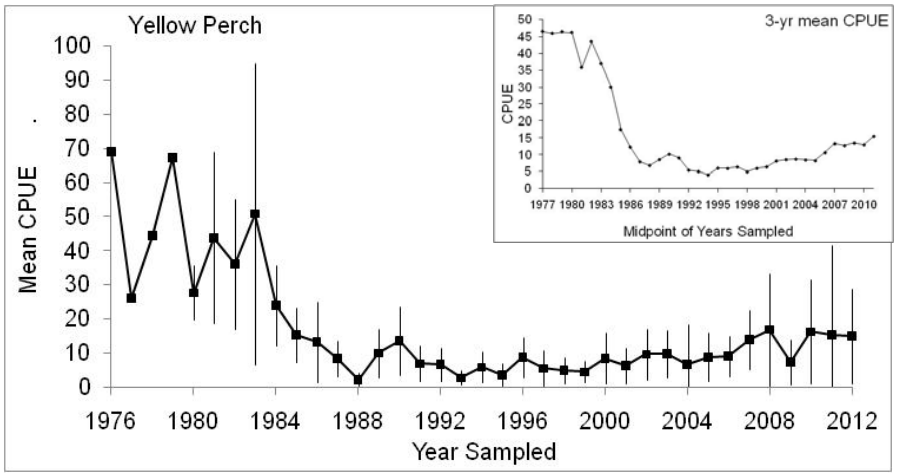

Figure 4. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for yellow perch, 1976-2012.

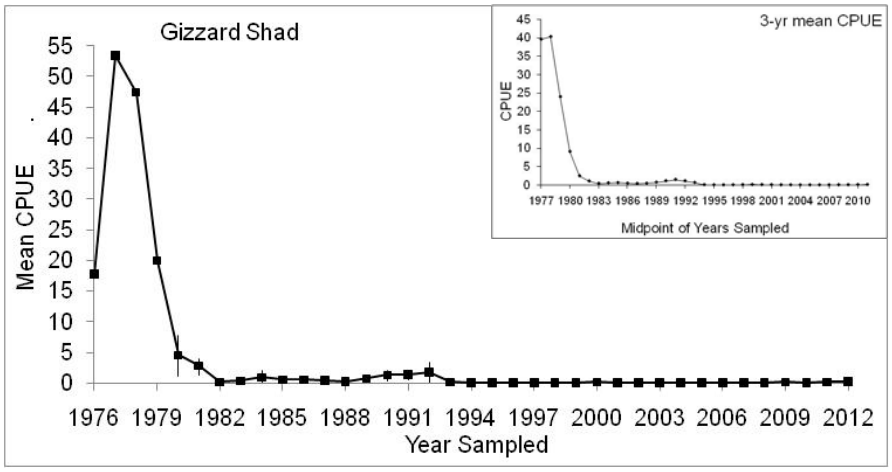

Figure 5. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for gizzard shad, 1976-2012.

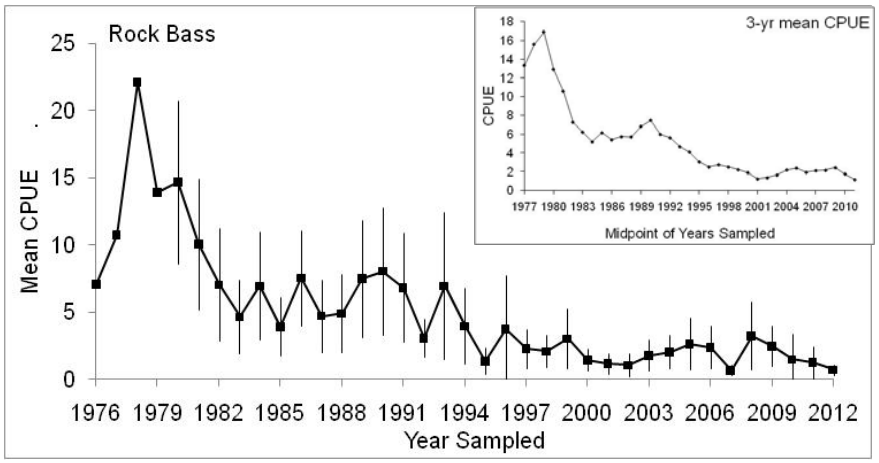

Figure 6. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for rock bass, 1976-2012.

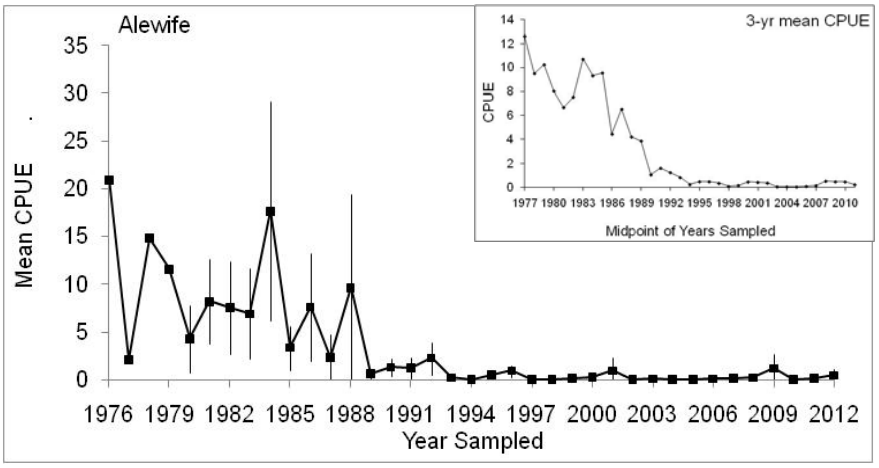

Figure 7. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for alewife, 1976-2012.

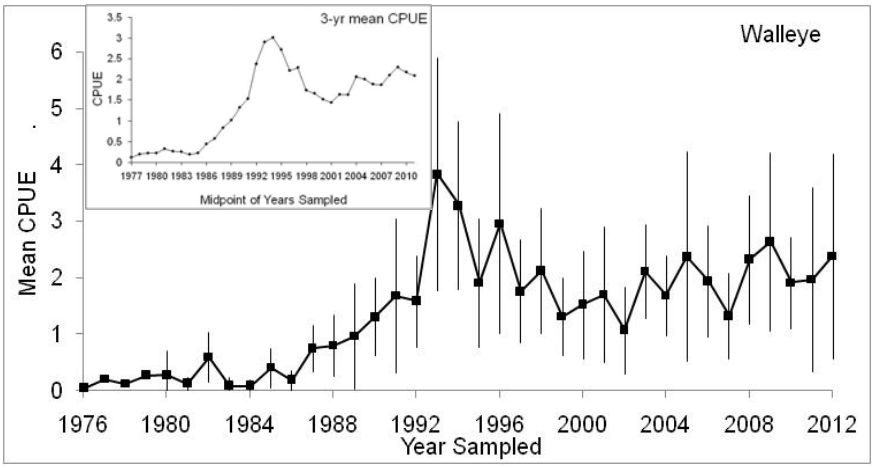

Figure 8. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for walleye, 1976-2012.

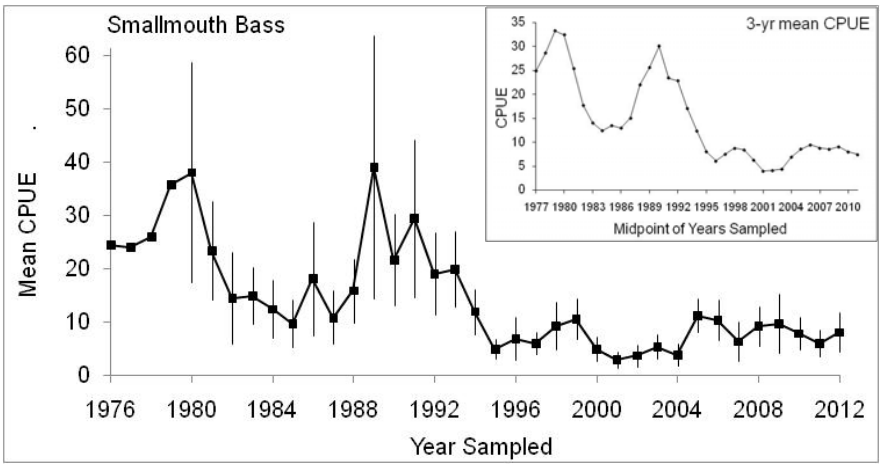

Figure 9. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for smallmouth bass, 1976-2012.

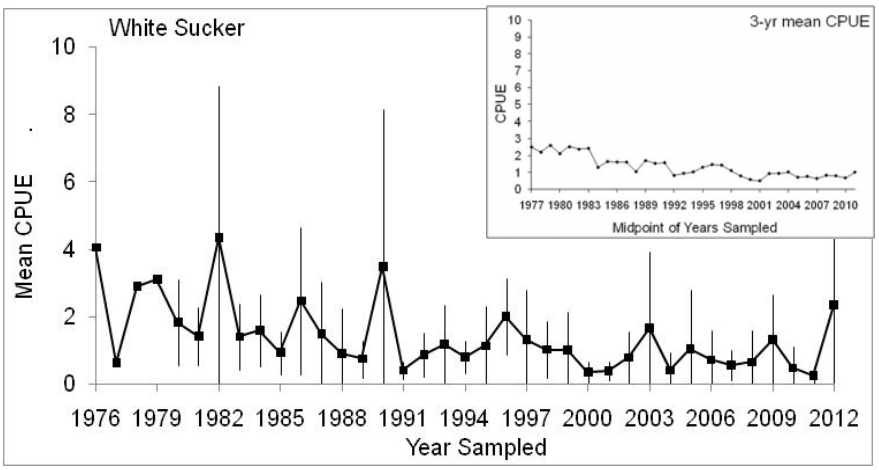

Figure 10. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for white sucker, 1976-2012.

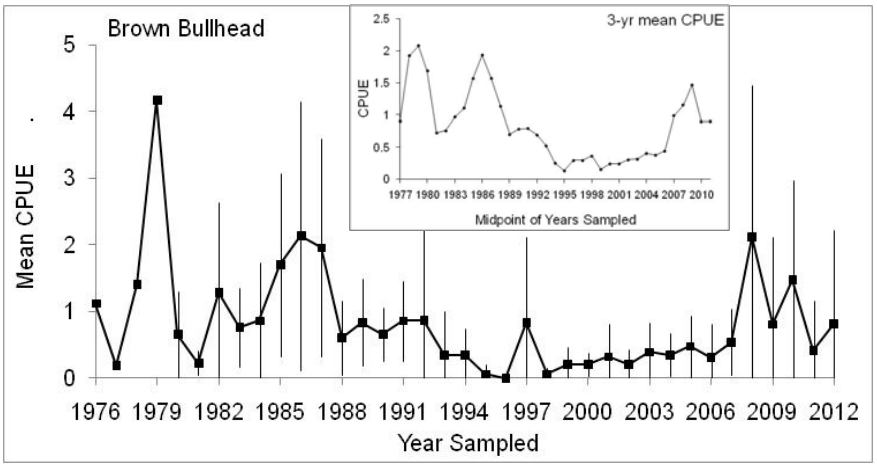

Figure 11. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for brown bullhead, 1976-2012.

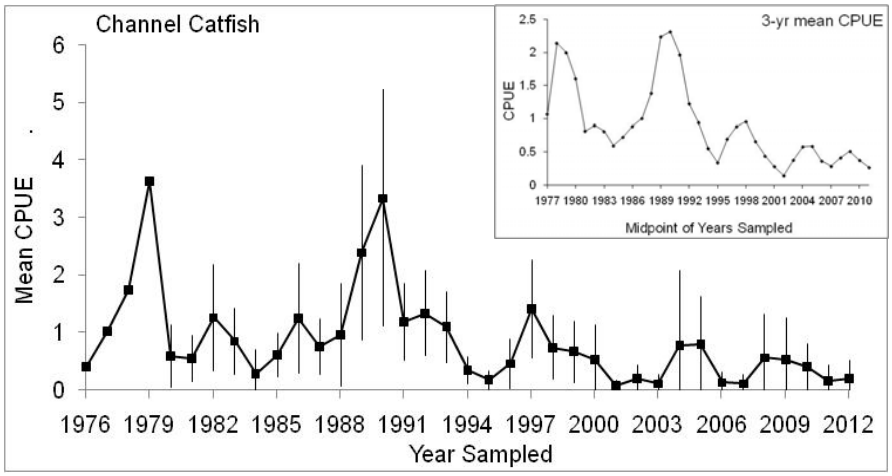

Figure 12. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for channel catfish, 1976-2012.

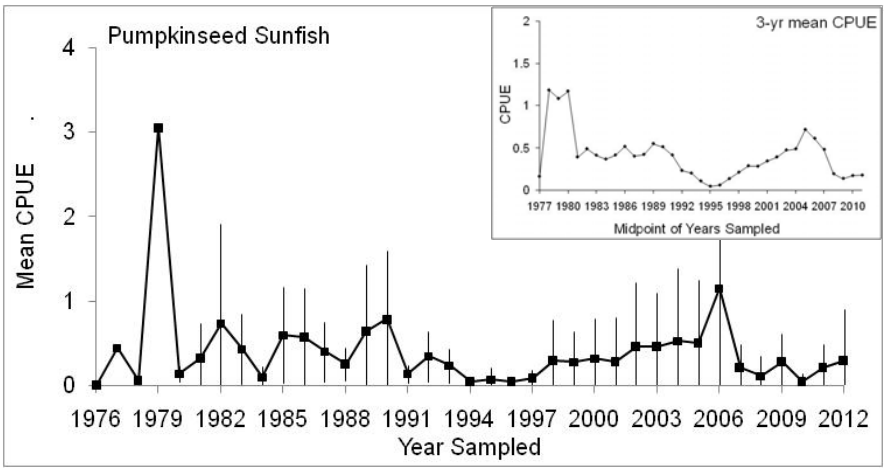

Figure 13. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for pumpkinseed sunfish, 1976-2012.

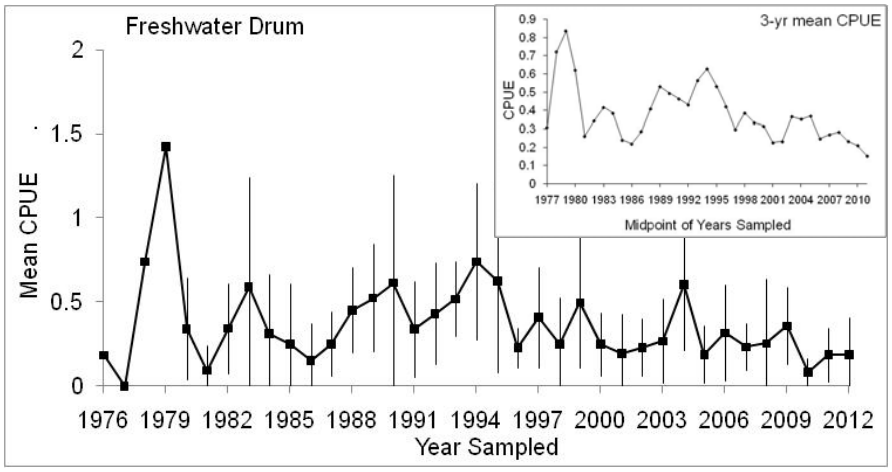

Figure 14. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for freshwater drum, 1976-2012.

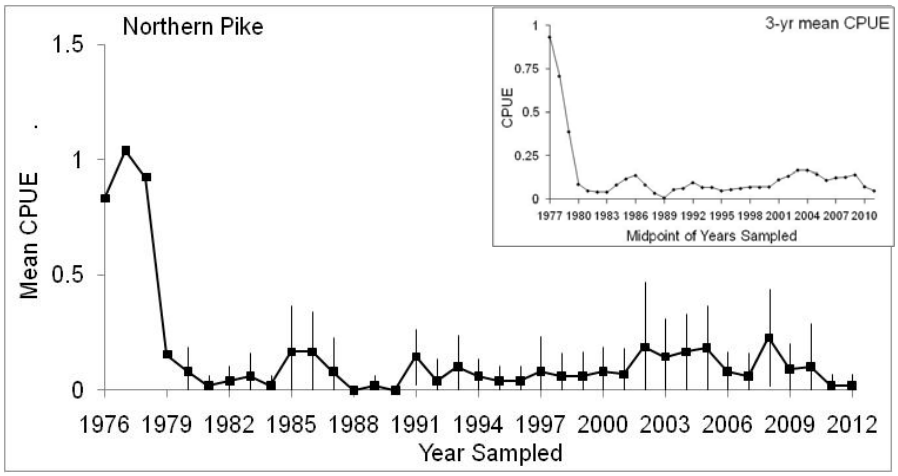

Figure 15. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for northern pike, 1976-2012.

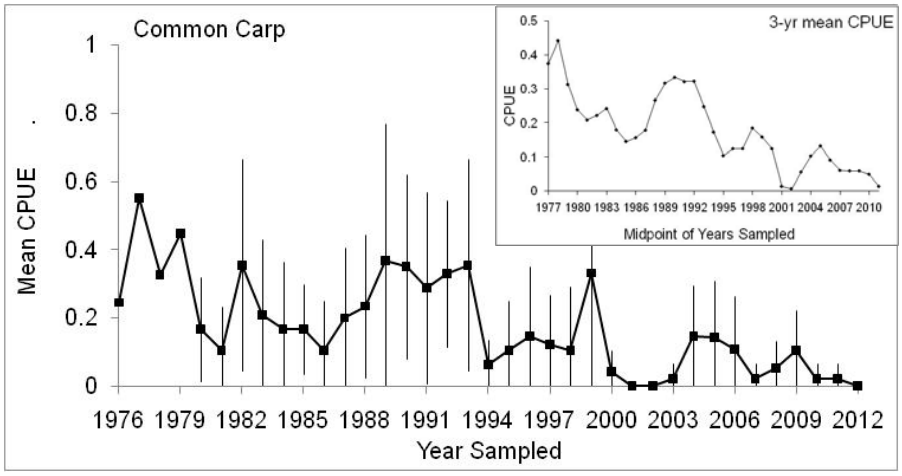

Figure 16. Stratified mean catch per 450 ft gill net gang and 95% confidence intervals for common carp, 1976-2012.

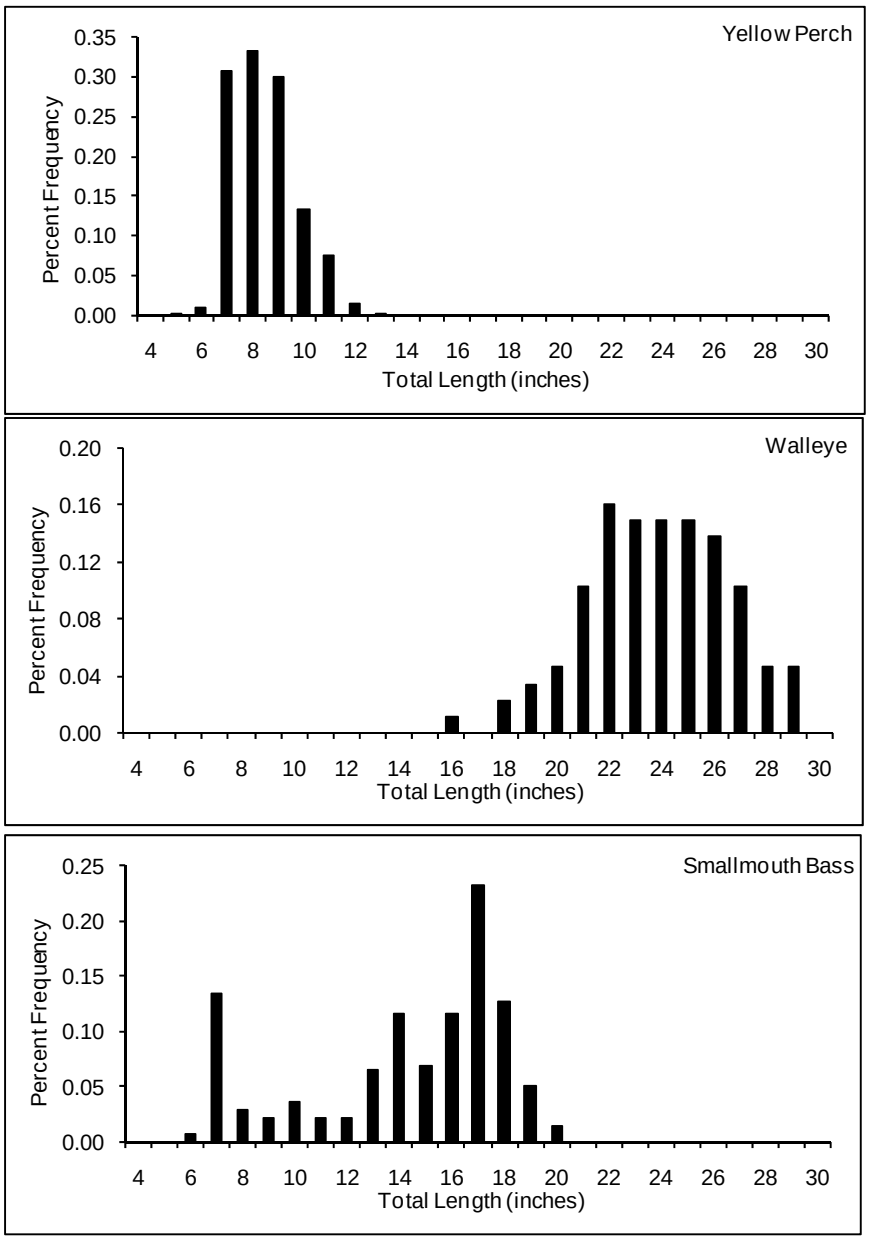

Figure 17. Length frequency distribution of yellow perch, walleye, and smallmouth bass collected during the warmwater assessment in 2012.

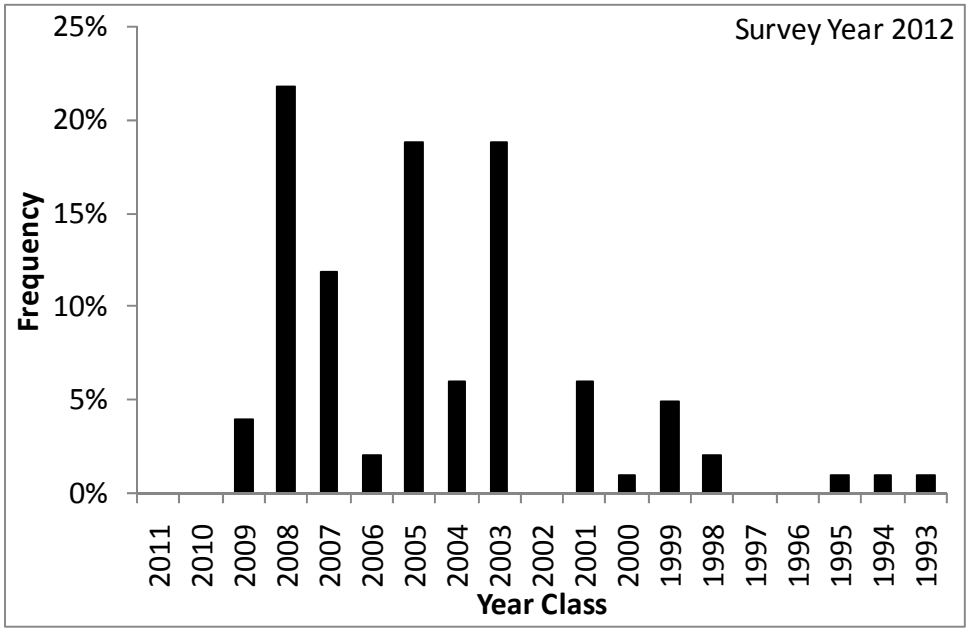

Figure 18. Year class frequency distribution of walleye collected during the warmwater assessment in 2012.

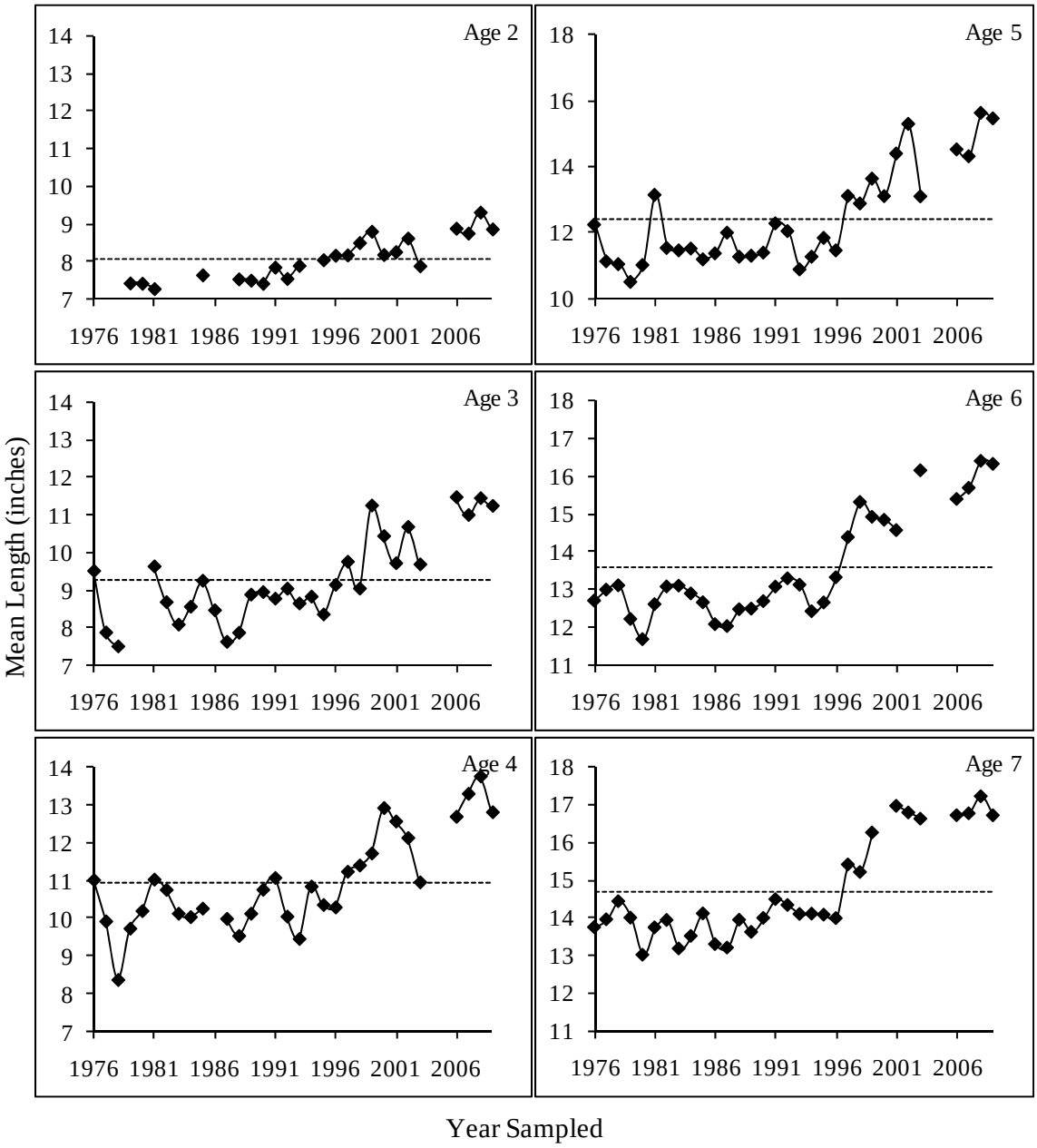

Figure 19. Mean length at age (age 2-13) by year sampled (1976-2003 and 2006-2009) for smallmouth bass collected during the warmwater assessment (continued on next page). Samples collected in 2004-2005 and 2010-2012 were not aged.

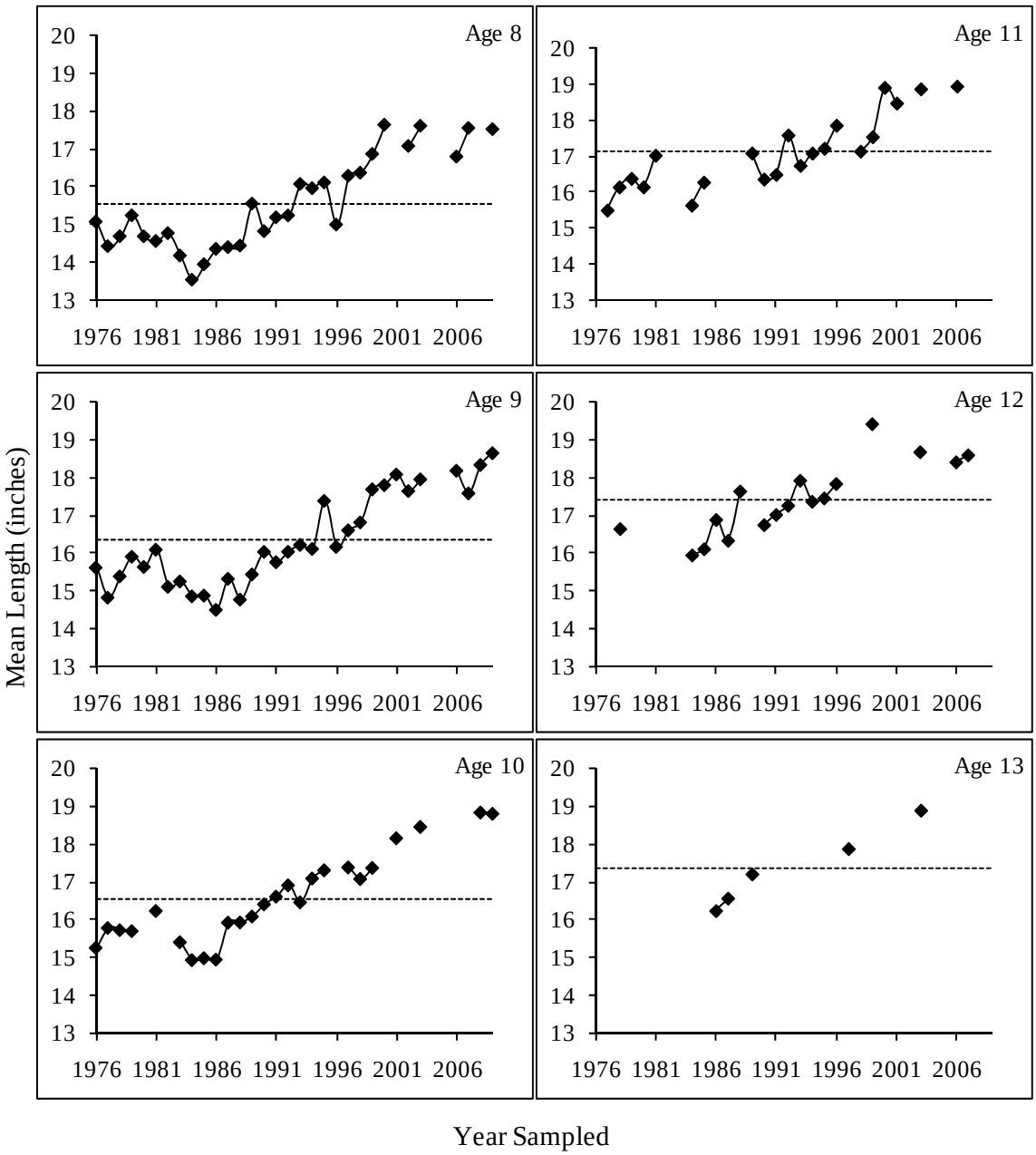

Figure 19 (continued). Mean length at age (age 2-13) by year sampled (1976-2003 and 2006-2009) for smallmouth bass collected during the warmwater assessment. Samples collected in 2004-2005 and 2010-2012 were not aged.

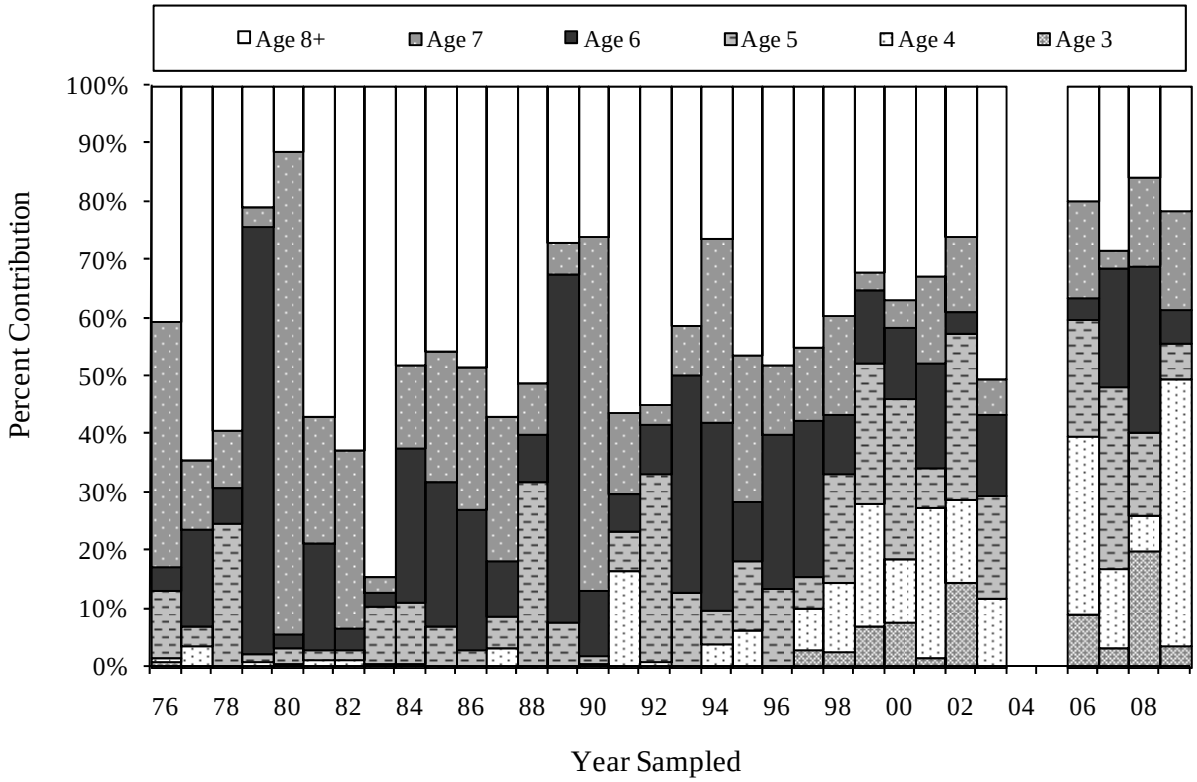

Figure 20. Age composition of smallmouth bass ≥ 12 inches in the warmwater assessment (1976-2003 and 2006-2009). Samples collected in 2004-2005 and 2010-2012 were not aged.

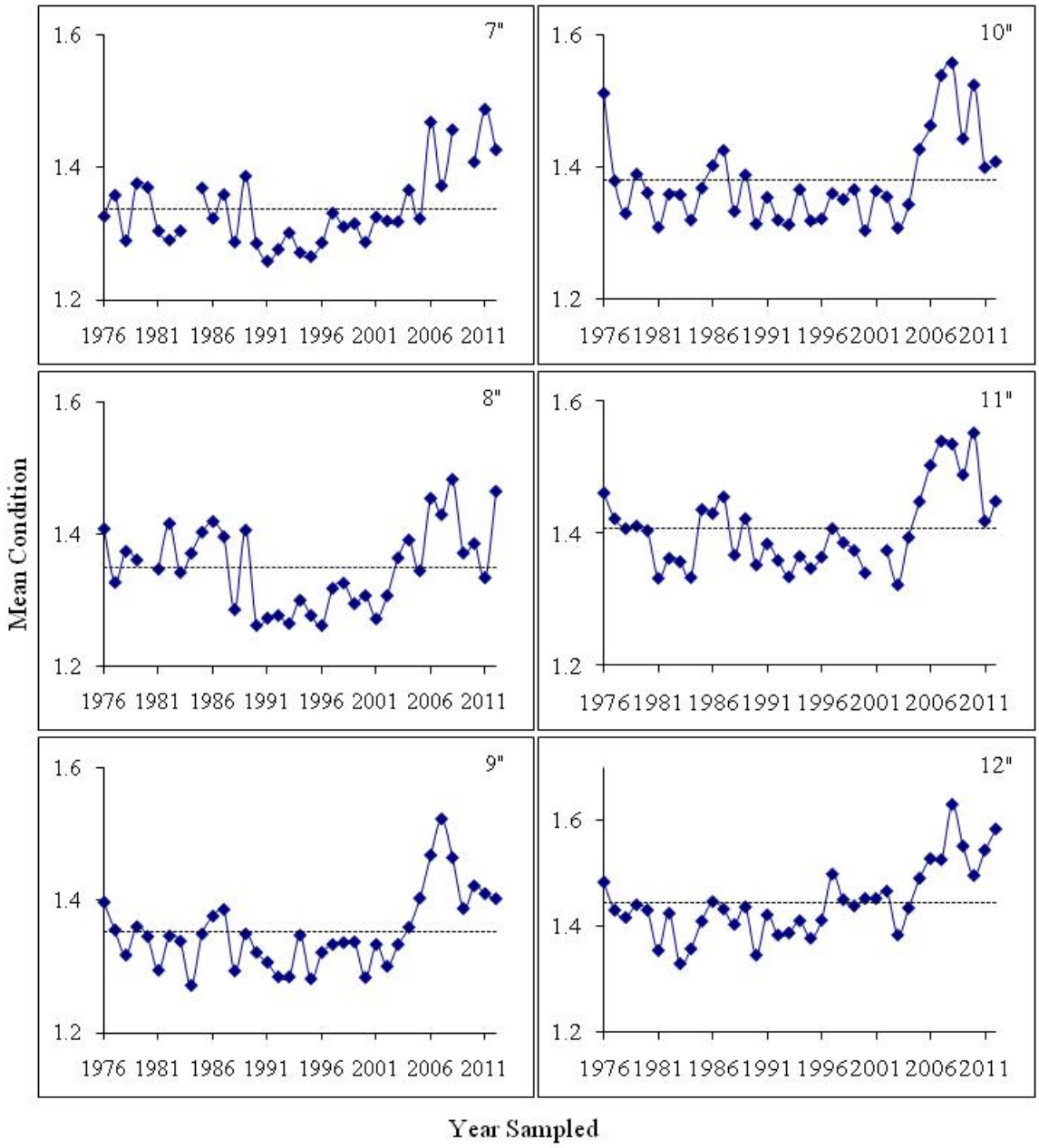

Figure 21. Mean condition (7-18 inch increments) by year sampled (1976-2012) for smallmouth bass collected during the warmwater assessment (continued on next page).

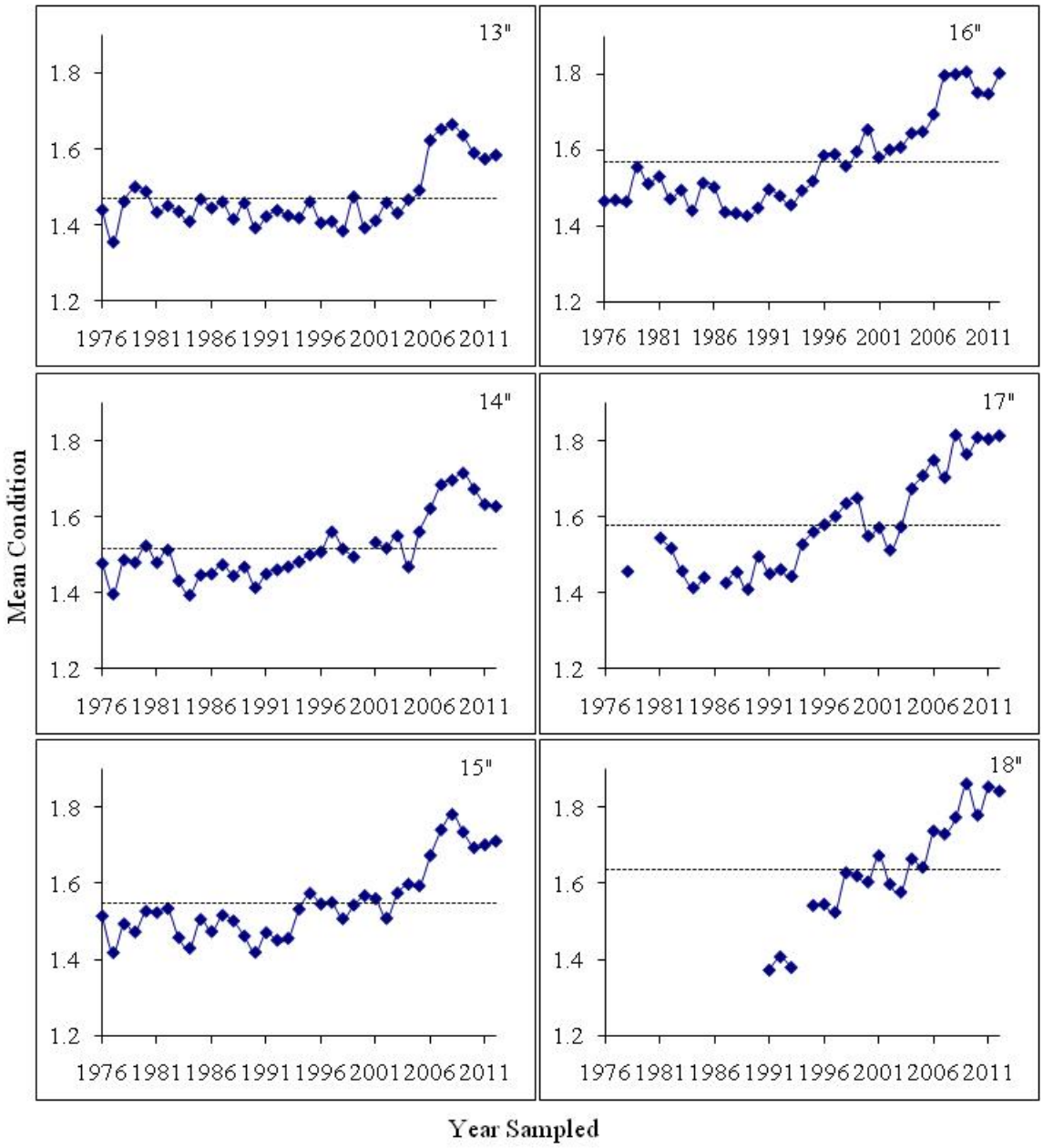

Figure 21 (continued). Mean condition (7-18 inch increments) by year sampled (1976-2012) for smallmouth bass collected during the warmwater assessment.

Lake Trout Rehabilitation in Lake Ontario, 2012

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Abstract

Each year we report on the progress toward rehabilitation of the Lake Ontario lake trout (Salvelinus namaycush) *population, including the results of stocking, annual assessment surveys, creel surveys, and evidence of natural reproduction observed from all standard surveys performed by USGS and NYSDEC. No lake trout from the 2011 year class were stocked into Lake Ontario during October 2011 or May 2012. The adjusted catch of age-2 lake trout with bottom trawls during the 2012 juvenile lake trout survey was the highest recorded since the 1990 year class was sampled in 1992. Adult lake trout catch per unit effort from the gill net survey recovered from historic lows observed during 2005-2007 and seemed to stabilize during 2010-2011 at a level slightly below the 1999-2004 mean. Adult abundance again rose in 2012 reaching a level equivalent to the 1999-2004 mean. The rate of wounding by sea lamprey* (Petromyzon marinus) *on lake trout caught in gill nets was 2.41 fresh (A1) wounds per 100 lake trout and was slightly above target (2 wounds per 100 lake trout). Estimates from the NYSDEC fishing boat survey indicated 2012 angler catch, harvest, and catch and harvest rates remained at levels comparable to 2011, which were the highest estimated since 2002. Condition of adult lake trout (indexed from annual length–weight regressions) in 2007-2009 increased from relatively low values observed during 2000-2006 and remained nearly constant during 2010-2012 at the highest values observed for the 30 year time-series. The low condition values observed for juvenile lake trout during 2010 continued during 2012. Reproductive potential for the adult stock, determined from the annual egg deposition index, rebounded from the 2007-2008 values that were the lowest observed since 1985 and seems to have stabilized during 2009-2012 at a mean value of 19.7. In 2012 one age-1 and four age-2 naturally produced lake trout were collected from trawl survey catches providing first evidence of a 2011 year class and continued evidence of a 2010 year class.*

Introduction

Restoration of a naturally reproducing population of lake trout (*Salvelinus namaycush*) is the focus of a major international effort in Lake Ontario. Coordinated through the Lake Ontario Committee of the Great Lakes Fishery Commission, representatives from cooperating agencies (New York State Department of Environmental Conservation [NYSDEC], United States Geological Survey [USGS], United States Fish and Wildlife Service [USFWS], and Ontario Ministry of Natural Resources [OMNR]) developed the Joint Plan for Rehabilitation of Lake Trout in Lake Ontario (Schneider et al. 1983, 1997), identifying a goal, interim objectives, and strategies. The present report documents progress towards restoration through 2012.

Methods

Adult Gill Net Survey

During September 1983-2012, adult lake trout were collected with gill nets at random transects within 14 to 17 geographic areas distributed uniformly within U.S. waters of Lake Ontario. Survey design (size of geographic areas) and gill net construction (multi- vs. mono-filament netting) has changed through the years. For a

description of survey history including gear changes and corrections see Elrod et al. (1995).
During September 2012, USGS R/V *Kaho* and NYSDEC R/V *Seth Green* fished standard gill nets for adult lake trout at 14 geographic locations encompassing the entire U.S. shore in Lake Ontario. Survey gill nets consisted of nine, 15.2- x 2.4-m (50 x 8 ft) panels of 51- to 151-mm (2- to 6-in stretched measure) mesh in 12.5-mm (0.5 in) increments. At 12 sites in the lake's main basin, four survey nets were fished along randomly chosen transects, parallel to contours beginning at the 10ºC (50ºF) isotherm and proceeding deeper in 10-m (32.8-ft) increments. At each of two sites in the eastern basin, two nets were fished in waters from 35 to 45 m due to an unusually deep thermocline.

For all lake trout captured, total lengths and weights were measured, body cavities were opened and prey items were removed from stomachs and enumerated. Presence and types of fin clips were recorded, and when present, coded wire tags (CWTs) were removed. Sex and maturity of lake trout were determined by visual inspection of gonads. Sea lamprey (*Petromyzon marinus*) wounds on lake trout were counted and graded according to King and Edsall (1979) and Ebener et al. (2006).

A stratified catch per unit effort (CPUE) was calculated using four strata based on net position from shallowest to deepest. The unit of effort was one overnight set of one net. Depth stratification was used because effort was not equal among years and catch per net decreased uniformly with increasing depth below the thermocline. To examine variability in CPUE between years, the relative standard error was calculated (RSE = 100 * {standard error / mean}).

Survival of various year classes and strains was estimated by taking the antilog of the slope of the regression of ln(CPUE) on age for fish ages 7 to 11 that received coded wire tags. Catches of age-12 and older lake trout were not used in calculations because survival often seemed to greatly increase after age 11 and catch rates were too low to have confidence in estimates using those ages (Lantry et al. 2006).

Adult condition was indexed from both the predicted weights of a 700-mm fish calculated from annual length-weight regressions based on all lake trout caught that were not deformed, and from Fulton's *K* (Ricker 1975, Nash et al. 2006) for age-6 males:

$K = (WT/ TL^3)*100{,}000;$

where WT is weight (g) and TL is total length (mm). We grouped data across strains because Elrod et al. (1996) found no difference between strains in the slopes or intercepts of annual length-weight regressions in 172 of 176 comparisons for the 1978 through 1993 surveys.

Lake trout fecundity changes with age and length (O'Gorman et al. 1998), both mean age and mean length increased after effective control of sea lamprey (achieved during the mid-1980s) reduced size-selective mortality on lake trout. Also, sea lampreys kill mature lake trout each fall, mostly between our September assessment and November spawning (Bergstedt and Schneider 1988, Elrod et al. 1995). The numbers of lake trout killed have varied through time, and not all strains of lake trout are equally vulnerable to attack by sea lampreys or are as likely to succumb to an attack (Schneider et al. 1996). Thus, change in age and strain composition of mature females has to be considered when judging reproductive potential from September gill net catches.

Population reproductive potential was estimated by calculating annual egg deposition indices (O'Gorman et al. 1998) from catches of mature females in September gill nets, length/age-fecundity relationships, and observed differences in mortality rates among strains. Length-fecundity relationships were determined from the fecundity of individual lake trout collected with gill nets in September and early October each year during 1977-1981 and in September 1994 (O'Gorman et al. 1998). During 1977-1981, fecundity-length relationships were not different among fish of various ages but in 1994, age-5 and age-6 fish had fewer eggs per unit length ($P<0.003$) than age-7 fish, and age-7 fish had fewer eggs per unit length ($p<0.003$) than fish of ages 8, 9, or 10. This suggests that at some point between the early 1980s and the mid 1990s, age-related factors began to influence fecundity. The lake trout population in the

earlier period was small with few mature fish whereas the population in the 1990s was relatively large with many mature fish (Elrod et al. 1995).

Elrod et al. (1996) demonstrated that the weight of a 700-mm mature female lake trout was much greater during 1978-1981 than during 1982-1993. They attributed the better condition during 1978-1981 to a lack of competition for food or space at low population levels. Therefore, we used the fecundity-length regression for 1977-1981 to calculate indices of egg deposition during 1980-1981 and the fecundity-length regressions for 1994 to calculate indices of age and size related egg deposition during 1982-2012. To account for sea lamprey-induced mortality that occurred between September gill net sampling and November spawning, we reduced catches of mature females by factors representing strain related differences in susceptibility to sea lamprey predation developed in O'Gorman et al. (1998).

Creel Survey

Catch and harvest by anglers fishing from boats is measured by a direct-contact creel survey, which covers the open-lake fishery from the Niagara River in the western end of the lake to Association Island near Henderson in the eastern basin (Lantry and Eckert 2013). The survey uses boat trips as the primary unit of effort. Boat counts are made at boat access locations and interviews are based on completed trips. During 1985-2009 survey estimates were based on a 6 month sampling interval from April 1-September 30. In 2010 the sampling interval was officially reduced to 5.5 months (April 15 – September 30). In previous reports, results were based on the 6 month sampling interval. In this and future reports, results from all survey years will reflect an April 15 – September 30 sampling interval. For detailed description on how survey results were adjusted to the 5.5 month interval, see Lantry and Eckert (2013).

Juvenile Trawl Survey

From mid-July to early-August 1980-2012, crews from USGS and NYSDEC used the R/V *Kaho* and the R/V *Seth Green* to capture juvenile lake trout (targeting age-2 fish) with bottom trawls. Trawling was conducted at 14 locations in U.S. waters distributed evenly along the southern shore and within the eastern basin, and at one location in Canadian waters off the mouth of the Niagara River. A standard tow was 10 min long. From 1980 to 1996, trawling was conducted with a 12-m (39.4-ft, headrope) trawl at 5-m (16.4-ft) depth intervals, beginning at the metalimnion (15°C, 59°F isotherm) and progressing into deeper water until few or no lake trout were captured. Because of an abrupt shift in the depth distribution of juvenile lake trout to deeper waters in 1993 (O'Gorman et al. 2000) and fouling of the gear by dreissenid mussels in 1996, the sampling scheme and gear were changed. In 1997 the 12-m (39.4-ft) trawl was replaced with a 3-in-1 trawl (18-m or 59-ft headrope, 7.6-m or 24.9-ft spread) equipped with roller gear along the footrope. In addition, effort was decreased at depths < 55 m (180.4 ft) and increased at depths > 70 m (229.6 ft). For years after 1997, the sampling protocol was modified by alternating between odd and even depths (5-m or 16.4-ft increments) between adjacent sites and adjacent years. At four sites where depth did not exceed 75 m (246.1 ft), all 5-m (16.4-ft) contours at and below the 15°C (59°F) isotherm were fished. During July 2-30, 2012, trawling was conducted at all 14 locations. Data collection from trawl-captured lake trout was the same as that described above for fish captured with gill nets.

Survival indices were calculated from catches of age-2 lake trout that were stocked in U.S. waters and caught in the bottom trawl survey. Survival was assessed at age-2 because the trends in adjusted catch were similar for age-2 lake trout caught in this survey and age-3 lake trout from the same year class caught in the gill net survey. This indicated that recruitment of hatchery fish to the population was governed by survival during their first year in Lake Ontario. For 1981 to 1996 (1979-1994 year classes), survival indices were calculated by adjusting total catch for strain, stocking location, and to reflect a total of 500,000 spring yearlings stocked (total catch * 500,000 / the number stocked). Data obtained on the 1995 year class were not adjusted for strain or stocking location because of poor retention rates of CWTs. Among the age-2 lake trout caught in trawls in 1997, 36% of adipose-fin clipped individuals did not have tags. Data for year classes stocked since 1997 were not

adjusted for strain or stocking location because from 36% to 84% of fish stocked during 1997-2003 did not receive CWTs and stockings thereafter did not include strains or locations that required adjustments. Catches of the 1995 through 2010 year classes were, however, adjusted for numbers stocked. Most untagged fish stocked since 1997 received paired fin clips that facilitated year class identification through at least age 4. The ages of unmarked fish and fish with poor clips were estimated with age-length plots developed from CWT tagged fish.

To assess the condition of juvenile lake trout, we used the predicted weight of a 400-mm (15.8 in) fish. A 400-mm fish would be age 2 or age 3. Weights were estimated each year from length-weight regressions calculated from annual trawl catches of lake trout ranging in total length from 250 mm to 500 mm (9.8 in to 19.7 in).

Results and Discussion

Stocking

From 1973 to 1977 lake trout stocked in Lake Ontario were raised at several NYSDEC and USFWS (Michigan and Pennsylvania) hatcheries with annual releases ranging from 0.07 million for the 1973 year class to 0.28 million for the 1975 year class (Figure 1). By 1978 (1977 year class) the USFWS Alleghany National Fish Hatchery (Pennsylvania) was raising all lake trout stocked in U.S. waters of Lake Ontario and annual releases exceeded 0.60 million fish. In 1983, the first official Lake Ontario lake trout rehabilitation plan (Schneider et al. 1983) was formalized and it called for a target of 1.25 million yearlings to be stocked annually in U.S. waters. The stockings of the 1979-1986 year classes approached that level, averaging about 1.07 million annually. The number of yearling equivalents released declined by about 22% between the stockings of the 1981 and 1988 year classes. Stocking declined by 47% in 1992 (1991 year class) due to problems encountered at the hatchery. In 1993, because of a predator-prey imbalance in Lake Ontario, and following recommendations from an international panel of scientists and extensive public review, managers reduced the lake trout stocking target to the current level of 500,000 yearlings. In the 20 years since the stocking cuts

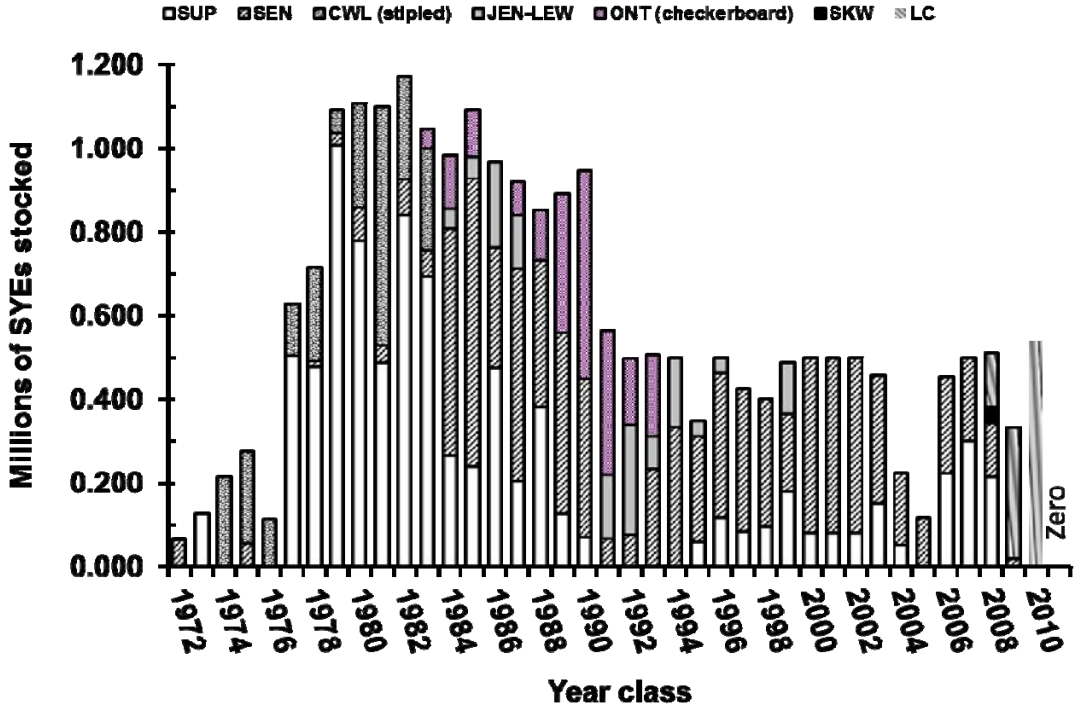

Figure 1. Total spring yearling equivalents (SYE) for lake trout strains (strain descriptions for ONT, JEN-LEW, CWL, SEN, LC, SUP, and SKW appear in Appendix 1) stocked in U.S. waters of Lake Ontario for the 1972 – 2011 year classes. MIX were unknowns. SYE = 1 spring yearling or 2.4 fall fingerlings (Elrod et al. 1988). No lake trout from the 2011 year class were stocked in 2012.

(1992-2011 year classes), the annual stockings were near the target level in only thirteen years (Figure 1). The USFWS Alleghany National Fish Hatchery (ANFH) was closed in 2005 due to an outbreak of infectious pancreatic necrosis and remained closed for fish production through summer 2011. Completion of disinfection, renovation and disease trials permitted fish production to resume at ANFH in fall 2011. Lake trout stocked in 2006 were raised at the NYSDEC Bath Fish Hatchery. Lake trout for 2007 and 2008 stockings were raised at the USFWS Pittsford (the name was changed in 2009 to: Eisenhower (ENFH)) and White River National Fish Hatcheries in Vermont. In 2010, 94% of the stocked lake trout were raised at White River and 6% were raised at NYSDEC Bath Fish Hatchery. All lake trout from stockings in 2009 and 2011 were raised at the USFWS White River National Fish Hatchery. Detailed stocking information appears in Connerton (2013). In late August 2011, flooding of the White River Hatchery during tropical storm Irene led to the USFWS decision to depopulate the hatchery over serious concerns of contamination of raceway water with didymo (*Didymosphenia geminate*) from the adjacent White River. As a result, no lake trout from the 2011 year class were stocked into Lake Ontario in May 2012. Currently, combined production at ANFH and ENFH are on target to meet the 2013 Lake Ontario stocking goals.

Survival to age-2

First-year survival was relatively high for the 1979-1982 year classes but then declined by about 32% and fluctuated without trend for the 1983-1989 year-classes (Figure 2). First-year survival declined further for the 1990 year class and continued to decline for the 1991-1996 year classes. The average survival of the 1994-1996 year classes at age 2 was only 6% of the average for the 1979-1982 year classes and only 9% of the average for the 1983-1989 year classes. The survival index was quite variable during 1995 to 2011 (1993 – 2009 year classes) fluctuating by greater than 40-fold with no general trend apparent. The survival index for the 2010 year class sampled in 2012 was greatest observed since the 1990 year-class was sampled in 1992.

Abundance of age-3 and older Lake Trout

A total of 724 lake trout were captured in the September 2012 gill net survey resulting in a total CPUE of mature adults of 11.1 (Figure 3). Catches of lake trout among sample locations were similar within years with the RSE for the CPUE of adult males and females (generally ages 5 and older) averaging only about 9.2% and 10.9%, respectively, for the entire data series (Figure 4). 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 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 2005-2007 CPUEs of mature lake trout were similar to the 1983-1984 values which pre-dated effective sea lamprey control. The CPUE of mature lake trout, however, increased during 2007-2010 and appeared to stabilize during 2010-2011 at a mean (CPUE: 8.8) which approached the 1999-2004 mean (CPUE: 11.0) that pre-dated the most recent declines. Adult abundance rose somewhat (CPUE: 11.1) in 2012 due mostly to a 26% increase from 2011 to 2012 in the CPUE of mature males. Similar to age-2 survival calculated from bottom trawls, the CPUE for immature lake trout captured in gill nets (generally ages 2 to 5) declined by 64% between the 1989-1993 (CPUE: 8.0) and the 1995-2004 intervals (CPUE: 2.9). Low CPUEs continued in 2012 (CPUE: 2.6), relative to years prior to 1994, and the current value was 30% below those observed during 2009-2011.

Schneider et al. (1983, 1997) established a target gillnet CPUE of 2.0 for sexually mature female trout ≥ 4,000 g reflecting the level of abundance at which successful reproduction became detectable in the early 1990s. The CPUE for mature females reached the target value in 1989 and fluctuated about the value until 1992 (Figure 5). From 1992 until 2004, the CPUE exceeded the target, but fell below target during 2005 to 2009, coincident with the decline of the entire adult population. During 2010-2011 the CPUE once rose above the target, but declined back just below target in 2012 (1.94).

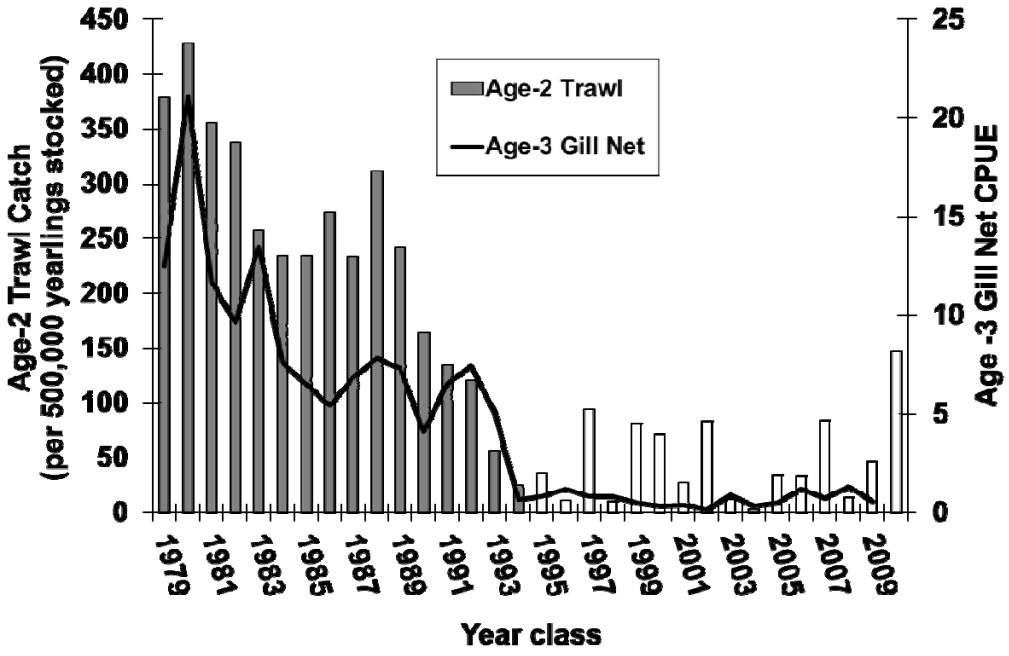

Figure 2. Survival indices for age-2 lake trout stocked in U.S. waters of Lake Ontario in 1980 – 2011. Survival was indexed at age 2 as the total catch from bottom trawls (BTR) fished in July-August per 500,000 fish stocked (Note: White bars represent data collected with a new trawl configuration which employed roller gear on the footrope and did not fish as hard on the lake bottom as the old trawl).

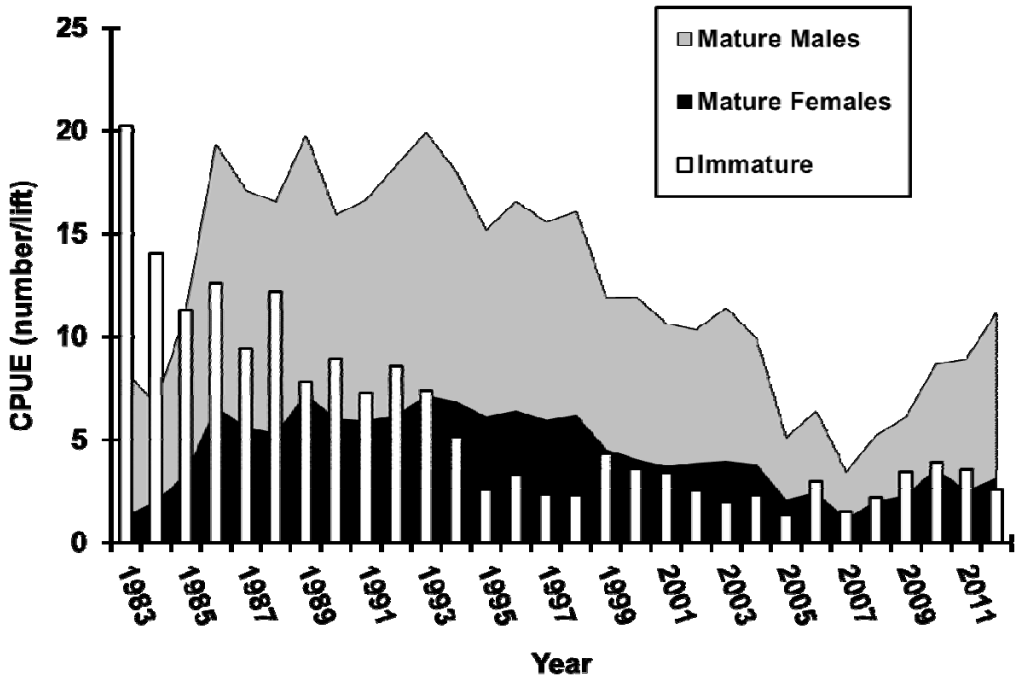

Figure 3. Abundance of mature and immature (sexes combined) lake trout calculated from catches made with gill nets set in U.S. waters of Lake Ontario, during September 1983-2012. CPUE (number/lift) was calculated based on four strata representing net position in relation to depth of the sets.

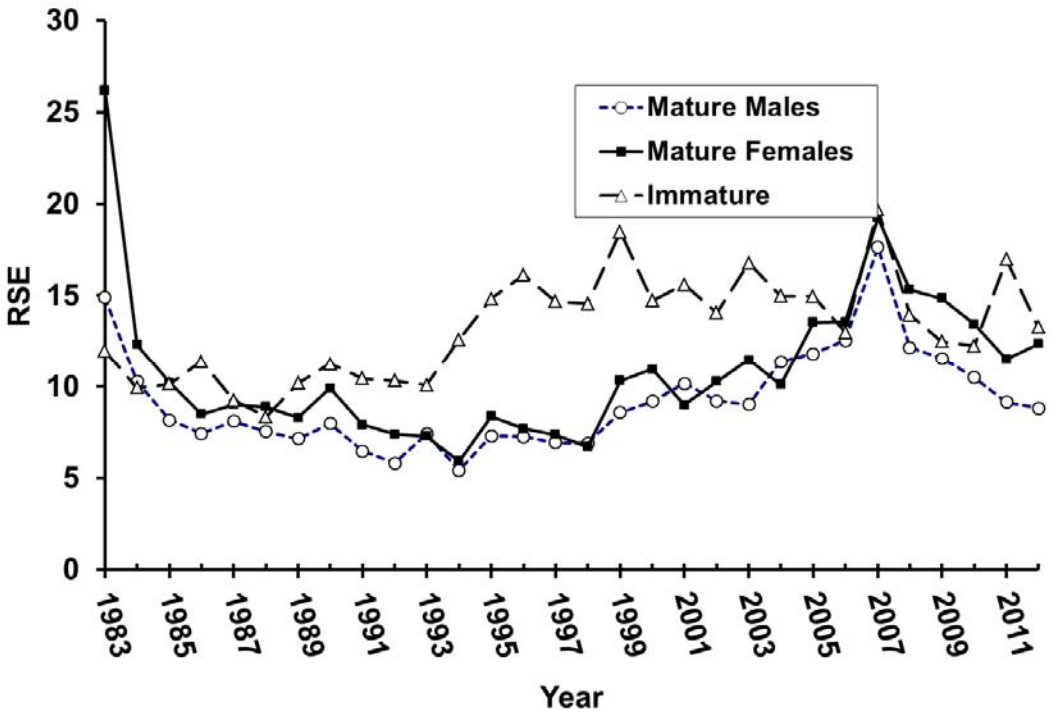

*Figure 4. Relative standard error (RSE = {SE / Mean}*100) of the annual CPUE for mature and immature (sexes combined) lake trout caught with gill nets set in U.S. waters of Lake Ontario, during September 1983 – 2012.*

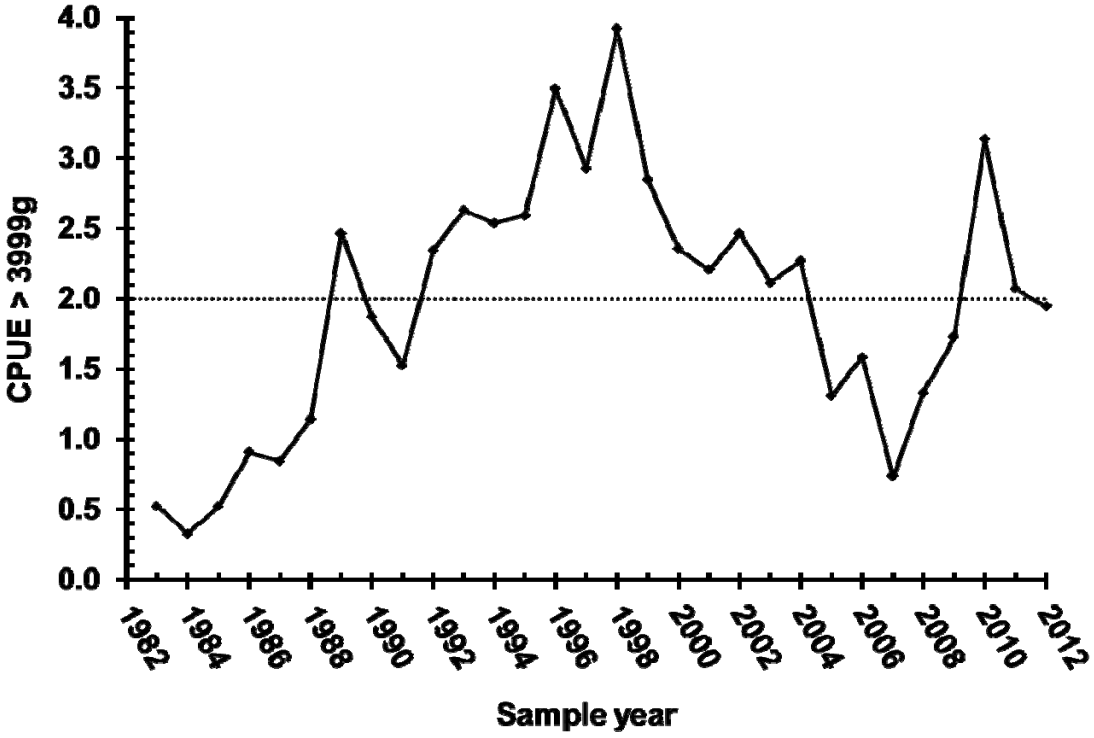

Figure 5 Abundance of mature female lake trout >3999g calculated from catches made with gill nets set in U.S. waters of Lake Ontario, during September 1983-2012. The dashed line represents the target CPUE from Schneider et al. (1997).

Angler Catch and Harvest

Angler catch rates of lake trout in U.S. waters of Lake Ontario declined from the early to mid-2000s, coinciding with the lake trout population decline and good fishing quality for other salmonids (i.e., anglers targeted other salmonids more frequently because of their relatively high catch rates; Lantry and Eckert 2013). In 2007, catch and harvest rates (0.12 and 0.05 lake trout per boat trip, respectively) and total harvest (2,570 fish) reached the lowest levels in the NYSDEC Fishing Boat Survey data series (Lantry and Eckert 2013). Harvest at that time was 92% below 1990s levels. Since then, catch and harvest rates increased for four consecutive years. In 2012, angler catch (22,206 fish), harvest (7,829 fish), and catch and harvest rates (0.48 and 0.17 lake trout per boat trip, respectively) were similar to values from 2011 and both were higher than any estimated since 2002. The 2011-2012 catch and harvest rates were more than three times higher than the lows observed in 2007 (Lantry and Eckert 2013). This increase was due, in part, to an increased number of young fish recruiting into the fishery in recent years (Figure 3), and a fishing regulation change. Prior to October 2006, anglers were permitted to harvest three lake trout outside of a protected length interval of 635 to 762 mm (25 to 30 in). The October 2006 regulation change reduced the creel limit to two fish per angler, but allowed for one of those fish to be within the 635 to 762 mm slot.

Sea Lamprey Predation

Percentage of fresh (A1) sea lamprey marks on lake trout has remained low since the mid-1980s, however, wounding rates (Figure 7) in 9 out of 11 years between 1997 and 2007 were above the target level of 2 wounds per 100 fish ≥433 mm (17.1 in). Wounding rate rose above target in 2005, reaching a maximum of 4.7 wounds in 2007 which was 2.35 times the target level. Rates fell below target again in 2008 (1.47) and remained there through 2011 (0.62). However, the rate rose above target again in 2012 rate (2.41).

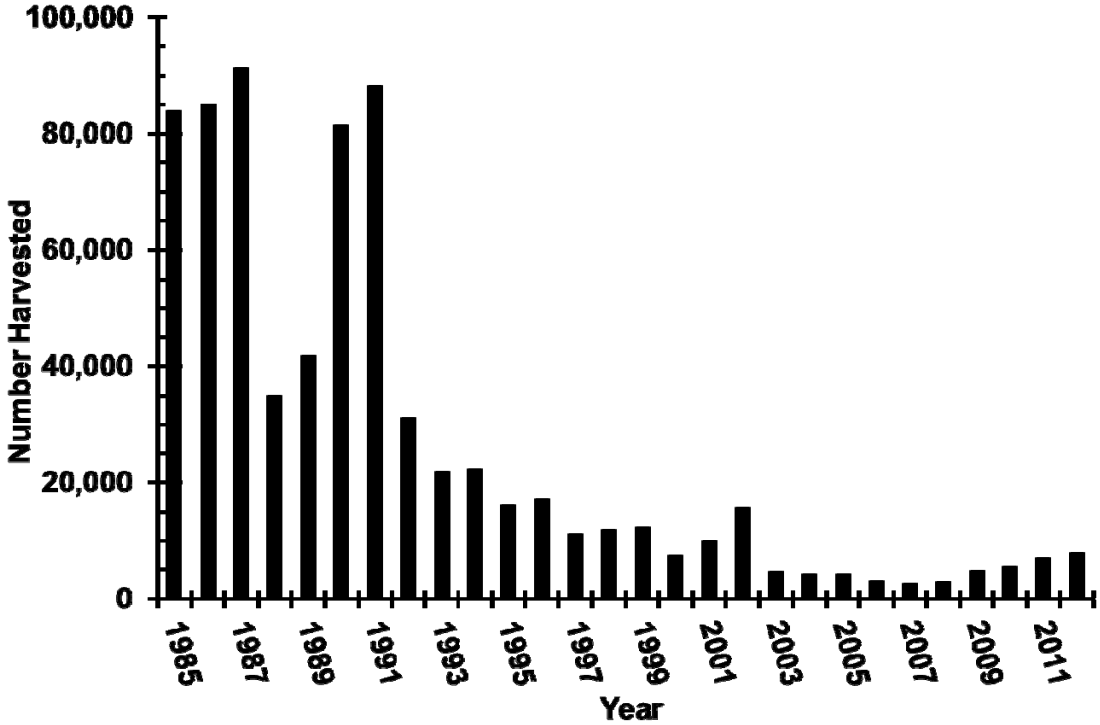

Figure 6. Estimated numbers of lake trout harvested by boat anglers from U.S. waters of Lake Ontario, during April 15 – September 30, 1985 – 2012 (Lantry and Eckert 2013). In this 2012 report, all harvest values have been adjusted to reflect a 5.5 month sampling interval. Prior reports were based on a 6 month sampling interval (April 1 – September 30).

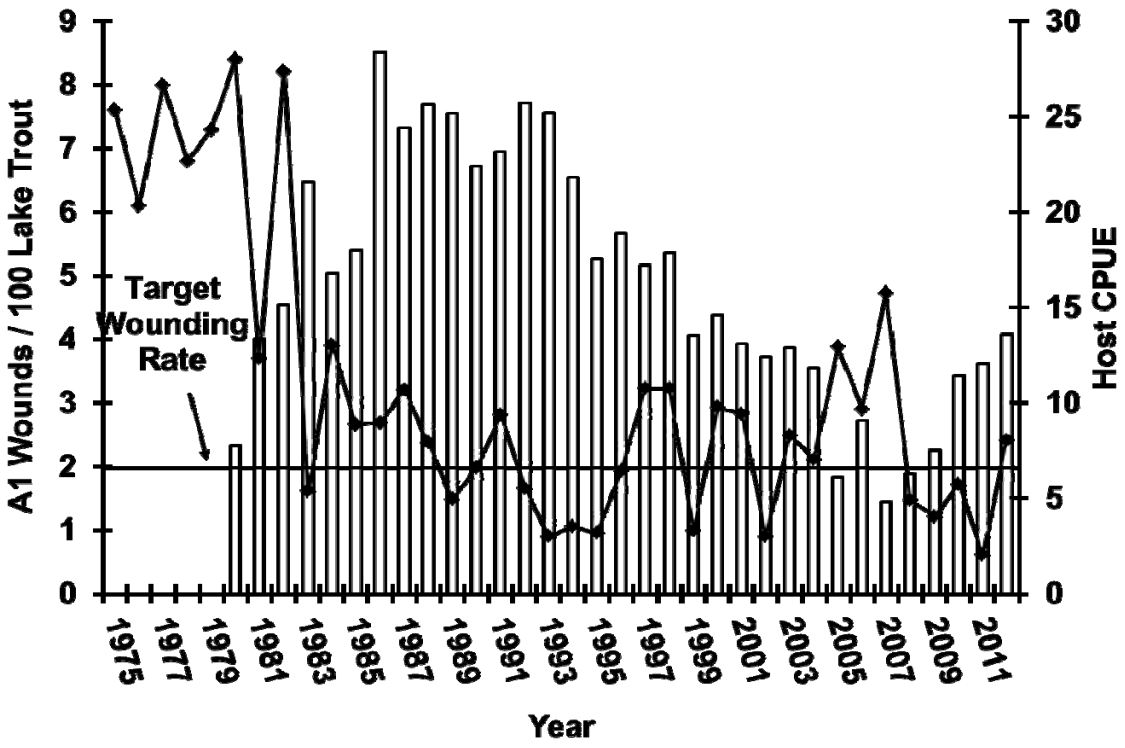

Figure 7. Wounding rates (A1 wounds per 100 lake trout, line) inflicted by sea lamprey on lake trout ≥ 433 mm (17.1 in) TL and the gill net CPUE of lake trout hosts (≥ 433 mm TL, bars) collected from Lake Ontario in fall, 1975 – 2012.

Adult Survival

Survival of Seneca strain lake trout (ages 7 to 11) had been consistently greater (20-51%) than that of the Superior strain for the 1980-1995 year classes (Table 1). Lower survival of SUP strain lake trout was likely due to higher mortality from sea lampreys (Schneider et al. 1996). Survival of both JEN and LEW strains was similar to the SUP strain, suggesting that those strains may also be highly vulnerable to sea lampreys. Ontario strain (ONT) lake trout were progeny of SEN and SUP strains (Appendix 1) and their survival was intermediate to that of their parent strains.

Survival for all strains combined (hereafter referred to as population survival) was based on all fish captured for the 1983 – 1995 cohorts as all fish stocked during that period received coded wire tags. Population survival was not calculated for the 1978-1982 and 1995-2002 cohorts because only a portion of those stockings received coded wire tags. Population survival generally increased with successive cohorts through the 1985 year class, exceeded the restoration plan target value of 0.60 beginning with the 1984 year class, and remained above the target for most year classes thereafter. The population survival of the 2003 year class is currently based only on ages 7-9 fish from stockings of 67% SEN and 33% SUP strains.

Growth and Condition

The predicted weight of a 700-mm lake trout (from length-weight regressions) decreased during 1983 to 1986, but increased irregularly from 1986 to 1996 and remained relatively constant through 1999 (Figure 8). Predicted mean weight declined by 158.8 g (5.6 oz) between 1999 and 2006, but increased again in 2007 and was relatively stable through the 2009 value of 3647.1 g (8.0 lb.). The 2007-2009 mean (3653.4 g, 8.0 lb.) was similar to the 1996-1999 mean (3679.6 g, 8.1 lb). Predicted mean weight rose sharply after 2009, and remained nearly constant during 2010-2012 at highest values observed for the time series (2010-2012 mean =3734.0 g).

Table 1. Annual survival of various strains (strain descriptions appear in Appendix 1) of lake trout, U.S. waters of Lake Ontario, 1985-2012. Dashes represent missing values due to no or low numbers of tagged lake trout stocked for those strains. ALL is population survival of all strains combined using only coded wire tagged fish.

YEAR		STRAIN					
CLASS	AGES	SEN	ONT	SUP	JEN	LEW	ALL
1978	7-10	-	-	0.40	-	-	
1979	7-11	-	-	0.52	-	-	
1980	7-11	0.85	-	0.54	-	-	
1981	7-11	0.92	-	0.45	-	-	
1982	7-11	0.82	-	0.44	-	-	
1983	7-11	0.90	0.61	0.54	-	-	0.57
1984	7-11	0.70	0.61	0.48	0.39	-	0.65
1985	7-11	0.77	0.80	0.47	-	-	0.73
1986	7-11	0.81	-	0.43	0.57	-	0.62
1987	7-11	0.80	-	0.50	0.50	-	0.73
1988	7-11	0.73	0.77	0.61	-	-	0.68
1989	7-11	0.86	0.78	0.59	-	-	0.81
1990	7-11	0.75	0.64	0.60	-	-	0.68
1991	7-11	0.70	0.62	-	-	0.56	0.70
1992	7-11	0.81	-	-	-	0.51	0.60
1993	7-11	0.72	-	-	-	0.64	0.71
1994	7-11	0.45	-	-	-	0.73	0.56
1995	7-11	0.76	-	-	-	0.50	0.72
1996	7-10	-	-	0.43	-	-	
1999	7-11	0.60	-	-	-	-	
2000	7-11	0.60	-	-	-	-	
2001	7-11	0.58	-	-	-	-	
2002	7-10	-	-	0.77	-	-	
2003	7-9	0.58	-	-	-	-	0.58

The trend of improving condition through 1996 corresponded to increased abundance of older lake trout in the population. Our data suggested that for lake trout of similar length, older fish were heavier. To examine condition while removing the effects of age and sex, we calculated annual means for Fulton's *K* for age-6 mature male lake trout (Figure 8). Values of *K* for age-6 males followed a similar trend as predicted weights, which were calculated using data from all fish captured and indicated that age alone was not the determinant of condition for this population.

Predicted weights of 400-mm lake trout, based on bottom trawl catches of 250-500 mm fish, (Figure 9) were inversely related to both total numbers stocked and the CPUE of immature fish captured with gill nets in September (Figures 1 and 3). Early stockings during 1973-1979 ranged from 66,000 to 728,240 yearling equivalents (Figure 1) and immature lake trout condition was high during 1979-1981. Stocking first exceeded 1,000,000 yearling equivalents in 1980 and between 1980 and 1981 the CPUE of immature lake trout from gill net catches doubled. From 1981 to 1983 predicted weight fell by 69 g (2.4 oz) and remained relatively constant (mean = 576 g, 1.3 lb) through 1992. Stocking rate remained at a relatively constant level from 1980 to 1991 (846,260 to 1,165,530 fish) and then declined to its' current target level (500,000 fish) in 1992. Predicted weight rose in 1993 and the 1993-1998 mean was 4% (22 g, 0.8 oz) higher than the mean for 1983-1992. Increased condition of young lake trout during 1993 - 1998 occurred after stocking was reduced and immature abundance declined in both bottom trawl and gillnet catches. During 1999-2005, condition declined to a level similar to the mid-1980's without associated changes in stocking or abundance, but paralleling declines in native benthic prey resources (Weidel et al. 2013). Predicted weight increased during 2005-2008 paralleling increases in round goby (*Neogobius melanostomus)* abundance (Weidel et al. 2013) which are now common in lake trout diets. Condition of immature fish fell again in 2009 (591.3 g, 1.3 lb.) to a level near the long term mean for the data series, but condition during 2010 - 2012 (2010-2012 mean = 555.43 g or 1.22 lb) was among the lowest recorded for the data series.

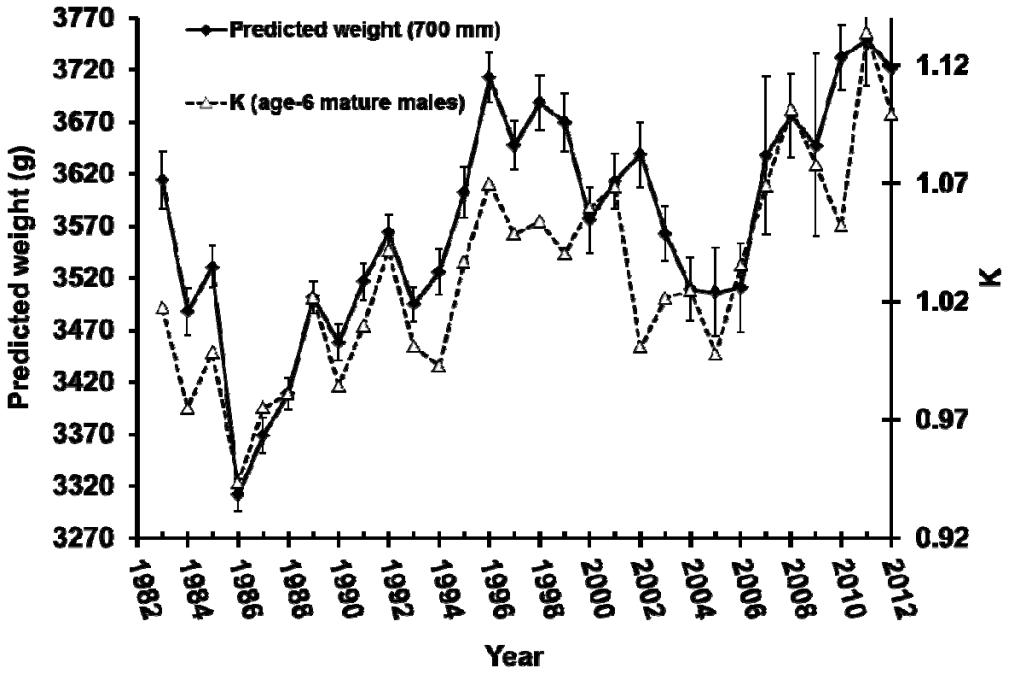

Figure 8. Lake Ontario lake trout condition (K) for age-6 mature males and predicted weight at 700-mm (27.6 in) TL from weight-length regressions calculated from all fish collected during each annual gill net survey, September 1983 – 2012. Error bars represent the regression confidence limits for each annual value.

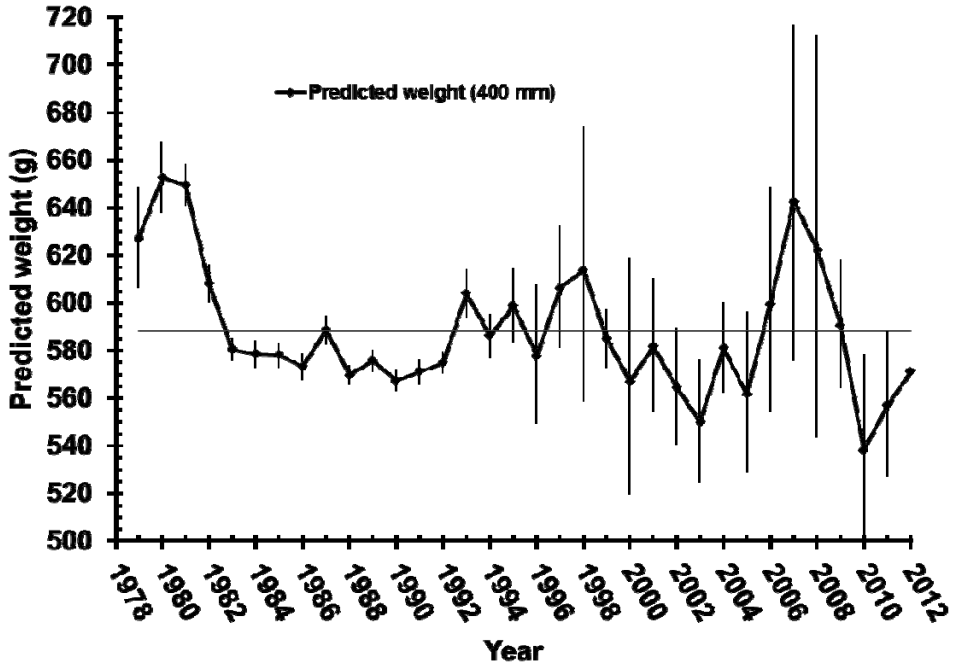

Figure 9. Lake Ontario lake trout predicted weight at 400-mm (15.8 in) TL from annual weight-length regressions calculated from fish 250 mm-500 mm (9.8 to 19.7 in). All lake trout were sampled from bottom trawls, July -August 1978 – 2012. The horizontal line represents the mean predicted weight across all years. Sample sizes for regressions were ≥ 39 except for 1997, 2000, 2005, 2006, 2007 and 2008 (n = 13, 15, 19, 11, 14 and 20, respectively). Error bars represent the regression confidence limits for each annual value.

Reproductive Potential

Temporal changes in lake trout reproductive potential measured by the egg deposition index (Figure 10) differed considerably from those measured by the CPUE of mature females (Figures 3 and 5). The CPUE of mature females suggested that reproductive potential quadrupled from 1983 to 1986 and then fluctuated around a high level through 1998. In contrast, the egg index suggested that reproductive potential quadrupled from 1985 to 1993 and then remained high through 1999. The CPUE of mature females declined by 31% between 1998 and 1999, yet a change in reproductive potential was delayed by one year, dropping by 27% between 1999 and 2000. Strain composition of the eggs was mostly SUP during 1983-1990 and mostly SEN during 1991-2002. After 2002, it became increasingly difficult to assess strain-specific contribution to the egg deposition index because many fish stocked since 1997 were not marked with coded wire tags. In most recent years SEN strain dominated stockings and we assumed that they continued to contribute the greatest proportion to the egg index. The first predominantly untagged cohort since 1983 was stocked as spring yearlings in 1997 and was first captured in substantial numbers as mature females at age 5 in 2001. For 2001 and later indices, we calculated size and age-specific fecundities for untagged fish with paired fin clips that facilitated age estimation. We then applied strain-specific mortality correction factors to fecundity estimates of untagged fish and weighted them based on strain composition for specific cohorts at stocking.

The egg deposition index changed little between 2001 and 2004 and the average for those years was 42% lower than the average for 1993 to 1999. In 2005, the index dropped by 40% below the 2001-2004 mean and during 2007-2008 values dropped to the lowest observed since 1985. The index value increased in 2009 and remained relatively constant through 2012. The 2009 – 2012 mean was 25% below the mean for 2001-2004.

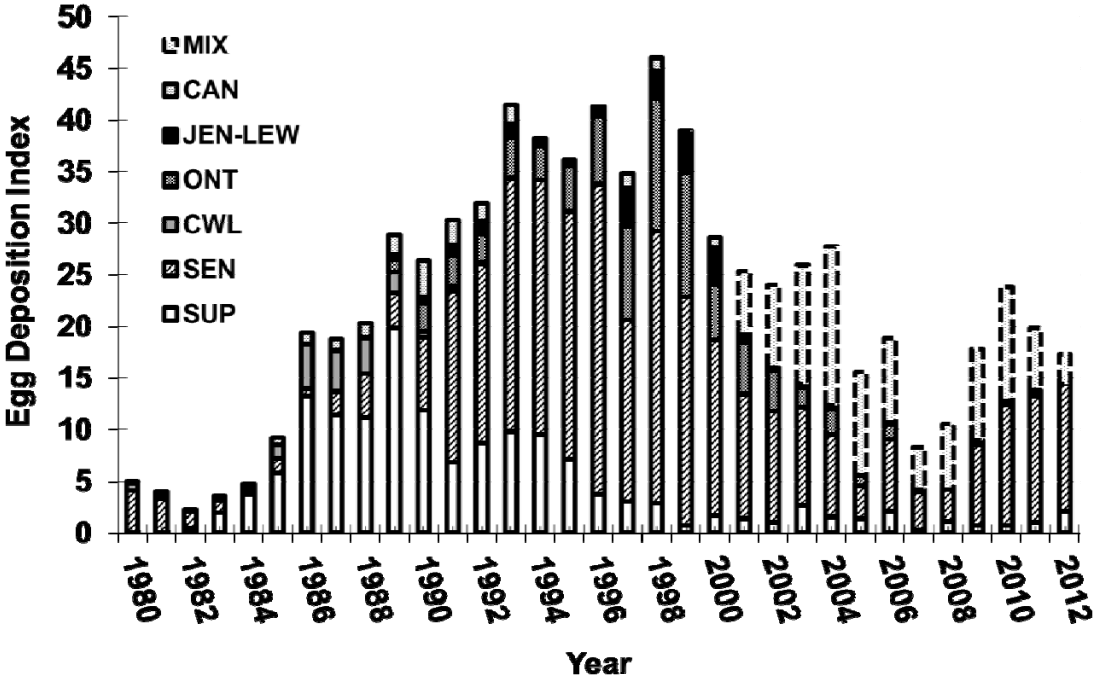

Figure 10. Egg deposition indices by strain (strain descriptions for ONT, JEN-LEW, CWL, SEN, and SUP appear in Appendix 1) for lake trout in U.S. waters of Lake Ontario during 1980-2012. CAN represents a mix of the strains stocked by OMNR and MIX represents values for untagged females stocked since 1997 for which strain could not be determined.

Natural Reproduction

In 2012, one age-1 (100 mm, 3.49in) and four age-2 naturally produced (wild) lake trout (187 – 259mm, 7.4 -10.2in) were caught bottom trawling. Survival of naturally produced lake trout past the fingerling stage in summer and fall occurred each year during 1993-2011 (Figure 11) except 2008, representing production of 18 year classes, however no wild lake trout were caught as of yet from the 2008 year class. The wild yearlings captured in 2010 - 2012 were the first wild yearlings caught since 2005. Low numbers of small (<100 mm, 3.9 in), wild fish captured in recent years (1997-2012) may be due in part to a change in our trawl gear that was necessary to avoid abundant dreissenid mussels. Our new bottom trawls are not as efficient at capturing small benthic fishes.

The distribution of catches of wild fish suggests that lake trout are reproducing throughout New York waters of Lake Ontario (Figure 12). Catches from at least 18 cohorts of wild lake trout since 1994 and survival of those year classes to older ages meets the plan objective to demonstrate the feasibility of lake trout rehabilitation in Lake Ontario (Schneider et al. 1997). Although recent evidence of wild reproduction is encouraging, achieving the goal of a self-sustaining population requires improvement in production of wild lake trout.

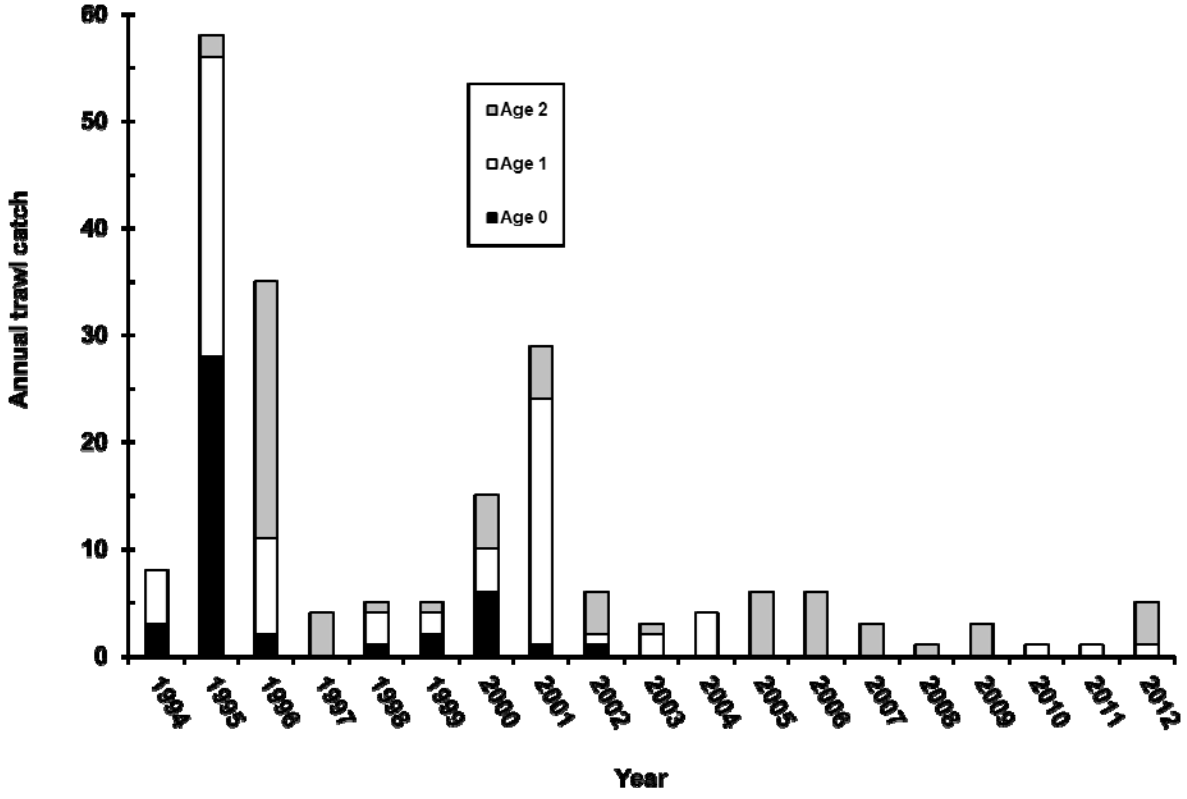

Figure 11. Numbers and ages of naturally produced (wild) lake trout captured with bottom trawls in Lake Ontario by NYSDEC and USGS, 1994-2012. During 1980-1993, only one naturally produced lake trout was captured with bottom trawls.

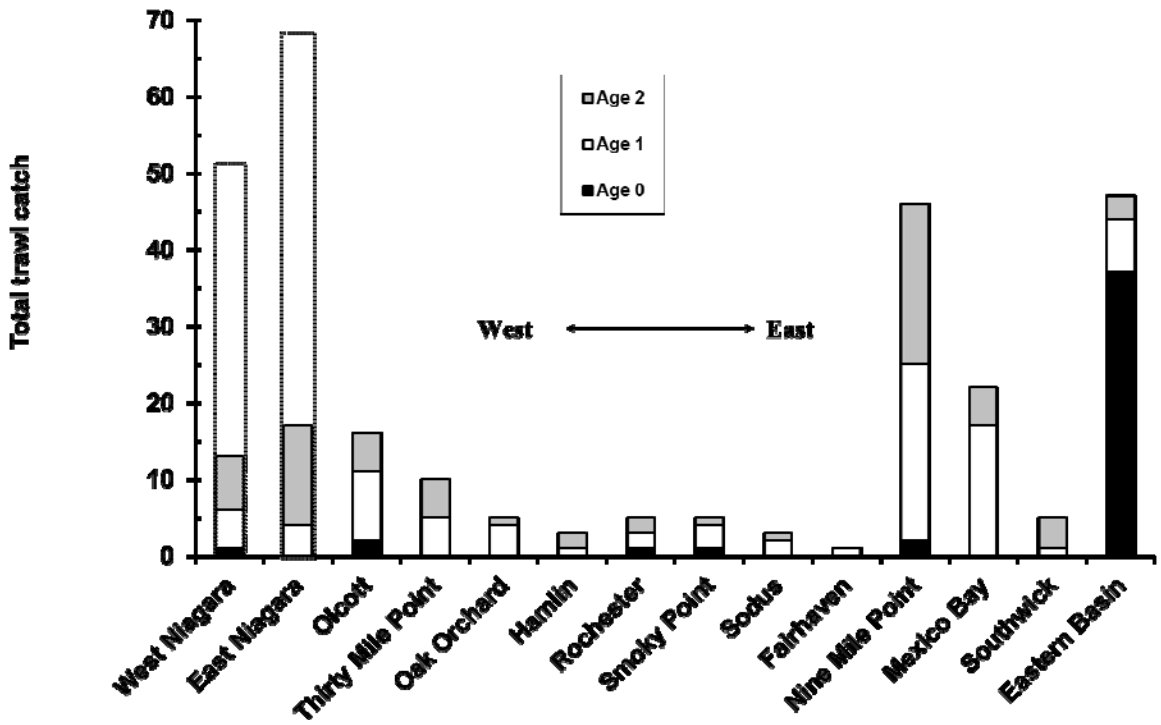

Figure 12. Numbers of wild lake trout (age 0 to 2) captured with bottom trawls at various locations in Lake Ontario by NYSDEC and USGS, 1994 – 2012. (Note: east and west Niagara are only sampled once per year whereas the other locations are usually sampled four times per year. Dashed lines show these catches adjusted for effort).

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Appendix 1.

Strain Descriptions

SEN - Lake trout descended from a native population that coexisted with sea lamprey in Seneca Lake, NY. A captive brood stock was maintained at the USFWS Alleghany National Fish Hatchery (ANFH) which reared lake trout for stocking in Lakes Erie and Ontario beginning with the 1978 year class. Through 1997, eggs were collected directly from fish in Seneca Lake and used to supplement SEN brood stocks at the USFWS Alleghany National Fish Hatchery (ANFH) and USFWS Sullivan Creek National Fish Hatchery (SCNFH). Beginning in 1998 SEN strain broodstocks at ANFH and SCNFH were supplemented using eggs collected from both Seneca and Cayuga Lakes. Since 2003 eggs were collected exclusively from Cayuga Lake.

LC - Lake trout descended from a feral population in Lake Champlain. The brood stock (Lake Champlain Domestic; LCD) is maintained at the State of Vermont's Salisbury Fish Hatchery and is supplemented with eggs collected from feral Lake Champlain fish. Eggs taken directly from feral Lake Champlain fish (Lake Champlain Wild; LCW) were also reared and stocked.

SUP - Captive lake trout brood stocks derived from "lean" Lake Superior lake trout. Brood stock for the Lake Ontario stockings of the Marquette strain (initially developed at the USFWS Marquette Hatchery; stocked until 2005) was maintained at the USFWS Alleghany National Fish Hatchery until 2005. The Superior – Marquette strain is no longer available for Lake Ontario stockings. Lake Ontario stockings of "lean" strains of Lake Superior lake trout resumed in 2007 with Traverse Island strain fish (STW; 2006-2008 year classes) and Apostle Island strain fish (SAW; 2008 year class). Traverse Island strain originated from a restored "lean" Lake Superior stock. The STW brood stock was phased out of production at USFWS Iron River National Fish Hatchery (IRNFH) and will no longer be available as a source of eggs for future Great Lakes stockings. The Apostle Island strain is similar to Traverse Island strain and was derived from a remnant "lean" Superior stock, restored through stocking efforts. The SAW brood stock is held at IRNFH.

SKW - Originated from a native, deep spawning "humper" morphotype of Lake Superior lake trout that are intermediate in fat content to lean and fat (siscowet) morphotypes. Captive brood stocks are held at the USFWS Sullivan Creek National Fish Hatchery and USFWS Iron River National Fish Hatchery.

CWL - Eggs collected from lake trout in Clearwater Lake, Manitoba, Canada and raised to fall fingerling and spring yearling stage at the USFWS Alleghany National Fish Hatchery in Warren, Pennsylvania (see Elrod et al. 1995).

JEN-LEW - Northern Lake Michigan origin stocked as fall fingerlings into Lewis Lake, Wyoming in 1890. Jenny Lake is connected to Lewis Lake. The 1984-1987 year classes were from brood stock at the Jackson (Wyoming) National Fish Hatchery and the 1991-1992 year classes were from broodstock at the Saratoga (Wyoming) National Fish Hatchery

ONT - Mixed strains stocked into and surviving to maturity in Lake Ontario. The 1983-1987 year classes were from eggs collected in the eastern basin of Lake Ontario. The 1988-1990 year classes were from broodstock developed from the 1983 egg collections from Lake Ontario. Portions of the 1991-1992 year classes were from ONT strain broodstock only and portions were developed from crosses of ONT strain broodstock females and SEN males (see Elrod et al. 1995).

Thousand Islands Warmwater Fish Stock Assessment

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Warmwater fish stock assessment on the St. Lawrence River began in 1977 as an outgrowth of environmental assessment projects related to proposed St. Lawrence Seaway navigation season extension. This program provides standardized indices of abundance for major gamefish and panfish stocks, information on year class strength, and age and growth relationships of these stocks. Information obtained is used to evaluate and, if necessary, modify existing fishing regulations. It also provides baseline information for evaluation of environmental disturbances.

Methods

Warmwater fish stock assessment in New York waters of the Thousand Islands is conducted from the upstream end of Grindstone Island (near Clayton, New York) downstream to the Morristown area (opposite Brockville, Ontario), a water surface area of approximately 43,000 acres (17,400 ha). The term warmwater fish stock assessment is applied to this project in keeping with NYS Bureau of Fisheries administrative structure, but many of the species of interest would normally be considered coolwater fishes (e.g. northern pike [*Esox lucius*], walleye [*Sander vitreum*] [Eaton et al. 1995]). Sampling was conducted during the period from the third week of July through the first week of August each year. Sampling effort consisted of 32 overnight gill net sets (16 sets prior to 1982) at standard sites. Multifilament nylon nets were used from 1977 through 2003; monofilament nets were used beginning in 2004. Based on 24 paired nets, catch rates of rock bass (*Ambloplites rupestris*) and yellow perch (*Perca flavescens*) in the two net types were significantly different ($\propto$ = .05). To correct monofilament catches to the multifilament standard, rock bass catches were multiplied by 1.7 and yellow perch catches by 0.74. Both types of net are 200 ft (61 m) long by 8 ft (2.4 m) deep and contain eight 25 ft (7.6) m panels. Stretch measure mesh sizes range from 1.5 in (38 mm) to 6 in (152 mm). Sampling was confined to the mid-depths of the river, from 10 to 60 ft (3 to 20 m). Nets were set on bottom, half in relatively shallow water, less than 30 ft (9 m) deep, and the other half at 33 to 60 ft (10 to 20 m).

All fish were identified, weighed and measured (total length). All game fish and sub-samples (Ketchen 1949) of panfish were examined for sex and maturity, and had scales (or cleithra for esocids) removed for age determination. Ages were determined from projections of scales or from direct examination of cleithra.

Results and Discussion

Environmental conditions

The mid-summer sampling period was chosen to minimize intra- and inter-annual variation in environmental conditions, chiefly water temperature. Surface water temperatures have varied from 64°F (18°C) during the 1982 sampling period to78°F (26°C) in 1979. Bottom temperatures are generally within 2°F (1°C) of surface temperatures. Surface temperature was relatively warm at 73-77°F (23-25°C) in 2012. Mean bottom temperature at 50 ft (15 m) was 74°F (23.5°C). Prior to colonization by dreissenid mussels, summer water transparency (Secchi depth) ranged down to about 10 ft (3 m , S. LaPan, pers. communication) and was not considered a significant influence on catchability. By 1995 it was apparent that significant increases in transparency had occurred, and transparency data are now collected during fish sampling. Secchi depths during the sampling period have ranged from 55 ft (16.8 m) in 1999 to 14.1 ft (4.3 m) in 1997. In 2012, mean Secchi depth was 30.5 ft (9.3 m) (Table 1).

Stock composition

A total of 37 species have been represented in Thousand Islands gill net sampling between 1977

and 2012 (Table 2). These nets were not designed to catch small-bodied species so that cyprinids, other than carp, are rarely captured. Annual catch (for 32 net sets) has historically ranged from 932 fish of 17 species in 2001 to 2,080 fish of 19 species in 1988. In 2012 the catch was very low at 847 individuals (adjusted to multifilament standard); diversity was high, with 19 species sampled (Table 2). Although they had been detected in predator stomachs for several years, round goby (*Neogobius melanostomus*) were captured in assessment nets for the first time in 2007. Gobies have been caught each year since. In most years, more than 90 percent of the catch consisted of six species: northern pike, brown bullhead (*Ameiurus nebulosus*), rock bass, pumpkinseed sunfish (*Lepomis gibbosus*), smallmouth bass *(Micropterus dolomieui*), and yellow perch (Table 3). In 2012, alewife (*Alosa pseudoharengus)* replaced pumpkinseed sunfish in the top 6 species (Figure 1). Pumpkinseed were at a very low abundance, while alewife (*Alosa pseudoharengus)* abundance, although declining from a recent peak, was relatively high.

Primary recreational fishery targets

Smallmouth Bass. Smallmouth bass are the most sought-after sport fish in the New York Thousand Islands fishery (McCullough 1987, Klindt 2011). Abundance of smallmouth bass was relatively high in the late 1970's, declined through 1982, then increased to its highest recorded level in 1988. After 1988 bass abundance generally declined and was low from 1996 through 2004 (Figure 2). The 2005 catch increased and has varied at relatively high levels since, and, in 2012 reached its highest level since 1988. The trend in smallmouth bass abundance is complicated by a disproportionate representation of younger fish since 2006. Abundance of age-5 and older fish, which have historically constituted the bulk of the catch, has generally declined in recent years (Figure 3). An expanding Double-crested cormorant (*Phalacrocorax auritus*) population was implicated in suppression of smallmouth bass recruitment in the nearby Eastern Basin of Lake Ontario (Lantry et al. 1999). Cormorants may also have affected Thousand Islands bass. Cormorant predation pressure has lessened since 2005 due to lower cormorant numbers and a cormorant diet shift to predominantly round goby at St. Lawrence River cormorant colonies (Johnson et al. 2008). Younger bass, ages 3-4 have generally been more abundant since 2006 relative to earlier years. This may indicate increased abundance of these fish, but likely reflects a change in catchability of young bass due to increased growth. Young fish were not particularly well represented in the 2012 sample, however, the overall catch rate was high due to the presence of an apparently very strong 2007 year class (Figure 4).

Smallmouth bass growth changed little between 1977 and 1998. Since then faster growth has produced an overall increasing trend in size of age-5 bass. Bass are now generally reaching legal size, 12" (305 mm), before age-5. In 2012 age-5 bass averaged a record 14.6 in (370 mm) (Figure 5). Smallmouth bass growth has also increased recently in Lake Ontario's Eastern Basin (Lantry 2010), in Lake St. Lawrence (Klindt 2010) and in Lake Erie (Einhouse et al. 2005). The most recent increase in growth is probably related to abundance of round goby as prey, although a density dependent effect may also be involved, particularly in Lake Ontario.

Northern Pike. Northern pike are an important part of the New York fishery (Klindt 2011) and are the most highly sought-after fish in the Province of Ontario Thousand Islands fishery (Bendig 1995). Their abundance peaked in 1981, generally declined through 1996 and varied without trend through 2001 (Figure 6). From 2001 through 2005 abundance generally declined and has varied without trend since. Evidence suggests that spawning habitat changes resulting from reduced water level fluctuation may be impairing recruitment (Farrell 2001, Farrell et al. 2006, Smith et al. 2007). Cormorant predation on young fish has also been implicated as a factor interfering with pike recruitment (Connerton 2003). Pike were less abundant, particularly at ages 3 and 4, in 2003 through 2009. A strong 2008 year class appeared to be present in the 2010 sample, however this year class has appeared to be of average strength (for recent years) since. Older fish have thus far shown little decline, suggesting that survival of recruited fish has improved relative to earlier years (Figure 7).

Northern pike growth varies over the data series with the highest mean total length of age-4 fish occurring prior to 1983 and the lowest in 1994 (Figure 8). Mean length increased through the late 1990s and mid 2000s. Total length of age-4 pike declined in

2007, but increased or remained steady through 2011. It did not, however, return to pre-1983 levels. In 2012 growth appeared to decline moderately (Figure 8).

Yellow Perch. Yellow perch abundance peaked in the late 1970's, then went into an irregular decline through 1992. The general decline through the early 1990's may have been connected with relatively high alewife populations at that time, which have been linked to high yellow perch larval mortality (Abraham 1994). From 1992 through 1999, yellow perch abundance tended to increase. After 1999, yellow perch catch generally declined, falling to its lowest recorded (adjusted) level in 2005. Catches increased dramatically in 2006 and remained moderately high in 2007 and 2008. Abundance declined in 2009 and remained low in 2010 and 2011, and fell to record-low levels in 2012 (Figure 9).

There have been several reasonably strong yellow perch year classes since 2000. A moderately strong 2007 year class appeared to be present in 2010 but was about average, for recent years, since then. The 2008 year class was unusually well represented in the 2011 sample and, given the generally low 2012 catch rate, reasonably well represented in 2012 (Figure 10).

Growth rate has generally increased since 1994 (Figure 11). Mean length at age-4 increased substantially in recent years, and was at or near 7.1 in (180 mm) in 2007-2009. Mean length at age-4 was unusually high in 2010 and reached a record 7.9 inches (210 mm) in 2011. Increased growth may be attributable to the availability of round goby as forage. There was a slight decline in 2012 to 7.5 inches (191 mm).

Walleye. Walleye were first captured in 1982 and were caught regularly in low numbers throughout the 1980s and 1990s (Figure 12). Abundance increased in the early 2000s and, while still relatively uncommon, Walleye were caught at substantially higher rates in the 2005 to 2011 period. Walleye catch was unusually low in 2012 (Figure 12).

<u>Other species of interest</u>

Sturgeon. Lake sturgeon (*Acipenser fulvescens*) is listed as a threatened species by New York State. Sturgeon generally survive gillnetting and all sturgeon captured during this project have been released alive. Most recently, one lake sturgeon was caught in 2009. Six of eight sturgeon caught in this project have been caught since 1999. During the 1990s sturgeon were stocked in St. Lawrence River tributaries (Grass River 1993, Oswegatchie River 1993-99); however, natural spawning has been observed in the upper St. Lawrence River (LaPan et al. 1997) and is thought to be the major source of recruitment to this population.

River Herrings. Alewives were frequently captured during the 1970s and 1980s. They were detected at very low levels from 1989 through 2006. The catch rate in 2009 was the highest yet recorded (Figure 13) but declined to a more moderate level in 2010 and 2011, and was closer to the background level in 2012. Alewives in the Thousand Islands are commonly regarded as strays from Lake Ontario. Gizzard Shad (*Dorosoma cepedianum)* were collected sporadically from 1978 through 1999.

Salmon, Trout and Smelt. Salmonids are not targeted in this assessment but have been collected incidentally. Coho salmon (*Oncorhyncus kisutch*), brown trout (*Salmo trutta*) and lake trout (*Salvelinus namaycush*) were captured occasionally in the 1980s and early 1990s. Rainbow smelt (*Osmerus mordax*) were captured in 1979. All of these species were considered strays from Lake Ontario.

Pikes. Like northern pike, muskellunge (*Esox masquinongy*) is an important sport fish in the St. Lawrence River. They are thought to occur at low density and historically approximately 50% of muskies tagged in the Thousand Islands migrated to eastern Lake Ontario in summer (LaPan et al. 1995). They have been caught in low numbers seven times since 1989. A possible chain pickerel was caught in 2010 and the presence of chain pickerel in the Thousand Islands has been confirmed by other investigators (J. Farrell, personal communication).

Carp and Minnows. Common carp (*Cyprinus carpio*) have been caught regularly since 1982. They are caught in low numbers, usually one to six individuals per year. Other minnows are usually not vulnerable to this sampling gear but a few, such as fallfish (*Semotilus corporalis*) or golden shiner

(*Notemigonus crysoleucas*), are caught occasionally. A single rudd (*Scardinius erythropthalmus*) was caught in 2000.

Suckers. White suckers (*Catostomus commersoni*) have been caught in substantial numbers (30-90 individuals) every year since 1977. White suckers have been in general decline since 1990 and are now found at about one third of their previous abundance (Figure 14). Silver (*Moxostoma anisurum*) and greater redhorse (*M. valenciennessi*) have been detected at low levels sporadically since they were first identified to the species level in 1987. A few shorthead redhorse (*M. macrolepidotum*) were caught in 1989, 1997 and 1998, and longnose suckers (*Catostomus catostomus*) in 1982 and 1984.

Catfishes. Brown bullhead have experienced several cycles of abundance since 1977 (Figure 15). They were abundant during the 1970s and 1980s, declined through the mid-1990s and increased again into the early 2000s. Brown bullhead are now in a period of low abundance. Channel catfish have been sampled regularly throughout the survey period. They have generally been present at about one fourth the abundance of brown bullhead, but this has changed with the decline in bullhead abundance in recent years (Figure 14). Channel catfish were most abundant during the 1980s and may be increasing in abundance again. For the first time, channel catfish were more abundant than brown bullhead in 2010 although this changed in 2011. Yellow bullhead (*Ameiurus natalis*) were caught for the second time in 2012. Stonecat (*Noturus flavus*) were caught twice during this project, most recently in 2000.

Sunfishes. Rock bass and pumpkinseed sunfish have typically been the most common sunfishes in Thousand Island gillnet sampling. Abundance of these species has tended to vary inversely ($r = -.40$, $P = 0.02$). From 1977 through 1999 abundance of rock bass and pumpkinseed varied at somewhat comparable levels (Figure 16). Since 2000, however, rock bass have generally increased while pumpkinseed have decreased in abundance. In 2011 rock bass were an order of magnitude more abundant than pumpkinseed.

Both bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) are captured regularly. Typically they are caught in low numbers (fewer than 10) although over 30 bluegills were caught in 1981, 1983 and 1992. Sixteen largemouth bass were caught in 1983. The sample nets are probably set too deep to sample these species effectively in most years. Black crappie (*Pomoxis nigromaculatus*) are sampled in very low numbers in about half the sample years.

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Table 1. Water temperature and secchi depth.

Sample Year	Water Temperature Range °C (°F)		Sample Year	Water Temperature Range °C (°F)	Secchi Depth m (ft)
1977	22-23 (72-73)		1995	22-24 (72-75)	10.7 (35)
1978	21-22 (70-72)		1996	21-21 (70-70)	8.8 (29)
1979	25-26 (77-79)		1997	20-22 (68-72)	4.3 (14)
1980	20-22 (68-72)		1998	22-24 (72-75)	8.0 (27)
1981	20-22 (68-72)		1999	23-24 (74-76)	16.8 (55)
1982	18-19 (64-66)		2000	21-22 (70-71)	13.4 (44)
1983	22-23 (72-73)		2001	20-24 (68-75)	6.2 (20)
1984	19-21 (66-70)		2002	21-23 (70-73)	7.3 (24)
1985	20-21 (68-70)		2003	21-24 (69-76)	6.5 (21)
1986	19-21 (66-70)		2004	21-22 (69-71)	8.1 (26.5)
1987	19-21 (66-70)		2005	22-24 (72-75)	11 (36)
1988	22-24 (72-75)		2006	22-24 (72-75)	8.8 (29)
1989	19-22 (66-72)		2007	21-22 (69-72)	7.8 (22.5)
1990	22-24 (72-75)		2008	20-24 (68-75)	10.4 (34)
1991	23-23 (73-73)		2009	21-23 (69-73)	9.5 (31)
1992	18-19 (64-66)		2010	23-25 (74-77)	6.0 (20)
1993	21-24 (70-75)		2011	23-24 (74-76)	8.8 (29)
1994	21-24 (70-75)		2012	23-25 (73-75)	9.3 (30.5)

Table 2. Total annual abundance index (catch/net-night), number of species sampled and number of individuals caught.

Year	Index*	Species**	Individuals	Year	Index*	Species**	Individuals
1977	44.3	13	709	1995	37.4	13	1,197
1978	59.7	16	955	1996	36.7	17	1,174
1979	57.7	12	923	1997	36.4	17	1,165
1980	47.5	13	760	1998	32.6	17	1,044
1981	38.1	14	610	1999	44.9	19	1,437
1982	41.5	17	1,328	2000	30.0	18	959
1983	39.0	16	1,249	2001	29.1	17	932
1984	39.7	18	1,271	2002	34.9	16	1,077
1985	40.4	17	1,292	2003	35.5	18	1,137
1986	50.7	12	1,622	2004	30.3a	15	970a
1987	51.9	17	1,661	2005	27.5a	16	880a
1988	65.0	19	2,080	2006	41.9a	15	1,352a
1989	45.3	19	1,450	2007	40.4a	18	1,293a
1990	49.2	19	1,574	2008	39.1a	14	1,196a
1991	41.5	18	1,328	2009	36.7a	16	1,160a
1992	31.7	19	1,014	2010	36.2a	18	1,158a
1993	38.6	15	1,235	2011	37.9a	16	1,214a
1994	35.1	16	1,123	2012	26.5a	19	847a

* 16 net-nights 1977-81, 32 net-nights thereafter. Change to monofilament nets in 2004.
**Prior to 1987 redhorse suckers were not identified to species.
a - adjusted to multifilament standard

Table 3. Abundance index (catch/net night) by species (* net type correction applied).

Species	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Lake Sturgeon	0	0	.06	.06	0	0	0	0	0	0	0	0	0	0
Bowfin	0	0	0	0	0	.06	0	0	.03	0	0	.03	0	.09
Alewife	1.5	1.1	2.3	2.6	5.0	0	2.0	1.5	1.0	6.5	2.2	1.5	.30	.28
Gizzard Shad	0	6	0	.06	0	0	0	0	0	0	0	0	0	0
Coho Salmon	0	0	0	0	0	0	0	.03	0	0	0	0	0	0
Brown Trout	0	0	0	0	0	.06	0	0	0	0	0	0	0	0
Lake Trout	0	0	0	0	0	0	0	0	0	0	0	0	.16	0
Rainbow Smelt	0	.18	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pike	3.20	2.30	2.50	4.10	7.30	4.90	4.50	3.90	4.80	3.70	3.63	4.03	5.31	4.38
Muskellunge	0	0	0	0	0	0	0	0	0	0	.03	0	.03	0
carp	0	0	0	0	0	.20	.10	.10	.03	0	.19	.09	.16	.31
Golden Shiner	0	0	0	0	0	0	0	0	0	0	0	.03	.03	0
Fallfish	0	0	0	0	.12	0	0	0	0	0	0	0	0	.03
Longnose Sucker	0	0	0	0	0	.39	0	.13	0	0	0	0	0	0
White Sucker	2.40	3.60	2.40	2.00	1.80	.80	1.40	1.30	2.10	1.70	1.81	2.50	3.03	3.06
Silver Redhorse	.10	.10	.20	0	.20	.10	.10	.10	.30	0	.16	1. 0	.09	.16
Shorthead Redhorse	*	*	*	*	*	*	*	*	*	*	0	.03	0	0
Greater Redhorse	*	*	*	*	*	*	*	*	*	*	0	0	0	0
Brown Bullhead	2.4	3	1.4	6.7	1.6	2.1	2.7	3.4	2.6	2.6	4.25	5.69	3	3.69
Yellow Bullhead	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Channel Catfish	.10	1.00	0	.20	0	.20	.40	.80	4.80	1.40	.41	1.31	.16	.97
Stonecat	0	0	0	0	0	0	0	.13	0	0	0	0	0	0
Burbot	0	0	0	0	0	0	.0 3	0	0	0	0	0	0	0
White Perch	.10	.80	.10	0	.10	.10	.10	0	.10	0	.03	.13	.16	.03
White Bass	0	0	0	0	0	0	0	0	.06	0	0	0	0	.09
Rock Bass	6.00	10.1	9.00	7.40	6.10	6.20	5.50	5.50	5.60	6.50	6.88	11.3	5.59	4.78
Pumpkinseed	6.30	5.20	8.30	4.50	11.5	9.30	12.3	7.80	5.70	6.40	10.3	10.2	9.66	11.8
Bluegill	.90	1.10	0	.60	2.80	.30	1+.30	.60	.60	.60	.59	.09	.59	.78
Smallmouth Bass	6.20	7.40	6.60	5.10	2.90	3.50	5.20	4.60	5.90	5.90	7.66	9.84	5.69	6.66
Largemouth Bass	0	.10	0	0	.10	0	.50	.10	0	.10	.28	.22	.09	.09
Black Crappie	.40	.20	.10	.10	.20	.10	0	0	.10	0	.13	.09	.06	.03
Yellow Perch	21.9	30.8	32.2	22.9	12.8	19.6	10.9	19.7	14.8	26.9	15.3	16.9	11.4	11.6
Walleye	0	0	0	0	0	.10	.10	.10	.10	.30	.03	.31	.09	.34
Freshwater Drum	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 3. Abundance index (catch/net night) by species (continued).

Species	91	92	93	94	95	96	97	98	99	00	01	02	03	04
Lake Sturgeon	0	0	0	0	0	0	0	0	.03	.03	.06	0	0	0
Longnose Gar	0	0	0	0	0	0	0	0	0	0	0	0	.03	0
Bowfin	.03	0	.03	.03	0	.03	0	.03	0	0	.03	0	0	0
Alewife	.91	.19	.07	.38	0	.63	.22	0	.09	.03	.18	.09	0	.03
Gizzard Shad	.06	.03	0	0	0	0	0	0	.03	0	0	0	0	0
Coho Salmon	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown Trout	0	.03	0	0	0	0	0	0	0	0	0	0	0	0
Lake Trout	0	.06	0	0	0	0	0	0	0	0	0	0	0	0
Rainbow Smelt	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern Pike	5. 28	3. 84	3. 87	3. 22	2. 90	2. 00	2. 53	2. 28	2. 50	2. 21	2.78	3.22	1.94	1.69
Muskellunge	0	0	0	0	.03	.03	.03	0	.03	0	0	0	.06	.03
Carp	0	.06	.20	.09	.06	.16	.06	.06	.03	.03	.03	.03	.06	.03
Rudd	0	0	0	0	0	0	0	0	0	.03	0	0	0	0
Golden Shiner	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fallfish	0	0	0	0	0	0	0	0	0	0	.03	0	0	0
Longnose Sucker	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White Sucker	1. 16	2. 06	1. 07	1. 28	1. 50	. 81	1. 30	1. 28	1.0	.97	1.34	1.13	1.41	1.03
Silver Redhorse	.09	.03	.03	0	.06	.13	0	.03	.03	.03	0	0	.06	0
Shorthead Redhorse	0	0	0	0	0	0	.06	.03	0	0	0	0	0	0
Greater Redhorse	.03	.03	0	.03	0	0	0	.03	0	.03	0	.06	0	0
Brown Bullhead	3.09	3.97	1.43	1.06	1.00	.44	.69	1.47	2.50	1.59	2.84	2.53	4.66	1.22
Yellow Bullhead	0	0	0	.03	0	0	0	0	0	0	0	0	0	0
Channel Catfish	.19	.13	.63	.22	.30	.13	.19	.31	.13	.06	.06	.03	.22	.22
Stonecat	0	0	0	0	0	0	0	0	0	.03	0	0	0	0
Burbot	0	0	0	0	0	0	0	0	0	0	0	0	0	0
White Perch	.09	.03	0	0	0	0	0	0	0	.03	0	.03	.03	0
White Bass	0	0	0	0	0	0	0	.03	.03	0	0	0	0	0
Rock Bass	5.06	3. 13	5. 17	7. 44	6. 40	9. 00	6. 31	5. 38	7. 80	8. 38	5.69	5.53	7.84	11.3*
Pumpkinseed	6. 94	6. 28	5. 43	5. 81	6. 20	4. 10	4. 65	4. 13	6. 80	2. 19	2.59	4.13	1.91	1.72
Bluegill	.72	1. 03	.20	.34	.50	.16	.06	.12	0.30	0	.06	.09	.03	0
Smallmouth Bass	6. 91	2. 47	5. 33	4. 53	5. 50	2. 94	2. 34	2. 91	3.30	1.84	3.06	2.16	2.78	3.13
Largemouth Bass	.16	.09	.10	.09	0	.03	.03	.06	.06	.03	.15	.06	.03	.06
Black Crappie	.09	0	0	0	0	.03	.03	0	.03	0	.06	0	.03	0
Yellow Perch	10.4	8. 16	14.8	10.4	12.8	15.7	17.2	14.4	20.7	12.2	9.81	14.4	14.0	10.6*
Walleye	.25	.09	.23	.13	.30	.25	.09	.06	.13	.19	.31	.5	.34	.28
Freshwater Drum	0	0	0	0	0	.03	0	0	0	0	0	0	.03	.06

Table 3. Abundance index (catch/net night) by species (continued).

Species	05	06	07	08	09	10	11	12	13	14	15	16	17	18
Lake Sturgeon	.03	0	0	0	.03	0	0	0						
Longnose Gar	0	0	0	0	0	0	0	0						
Bowfin	.03	0	0	0	0	.03	0	.03						
Alewife	.09	.03	2.25	.59	8.78	2.13	2.56	.50						
Gizzard Shad	0	0	0	0	0	0	0	0						
Coho Salmon	0	0	0	0	0	0	0	0						
Brown Trout	0	0	0	0	0	0	0	0						
Lake Trout	0	0	0	0	0	0	0	0						
Rainbow Smelt	0	0	.06	0	0	0	0	0						
Northern Pike	1.63	1.84	2.06	1.34	1.38	2.34	1.44	2.19						
Muskellunge	0	0	0	0	0	0	0	0						
carp	.12	.19	.16	.19	.09	.06	.16	.16						
Rudd	0	0	0	0	0	0	0	0						
Golden Shiner	0	0	.03	0	.03	.03	.03	0						
Fallfish	0	0	0	0	0	0	0	.03						
Longnose Sucker	0	0	0	0	0	0	0	0						
White Sucker	1.10	1.16	.88	.81	.63	.34	.69	.53						
Silver Redhorse	.03	.06	.03	.03	.03	.19	.03	.03						
Shorthead Redhorse	0	0	0	0	0	0	0	0						
Greater Redhorse	0	0	0	0	.16	0	0	0						
Brown Bullhead	1.53	2.47	1.22	.81	1.56	.72	.75	.97						
Yellow Bullhead	0	0	0	0	0	0	0	.03						
Channel Catfish	.38	.44	.25	.31	.84	1.06	0.03	.31						
Stonecat	0	0	0	0	0	0	0	0						
Burbot	0	0	0	0	0	0	0	0						
White Perch	0	.03	0	0	0	0	0	0						
White Bass	0	.03	0	0	0	0	0	0						
Rock Bass	8.23*[*]	11.3*	9.03*	8.87*	8.82*	10.46*	11.63*	5.47*						
Pumpkinseed	1.88	2.41	.97	.88	.81	.72	.69	.47						
Bluegill	.06	.03	.13	.06	0	.06	.09	.25						
Smallmouth Bass	4.75	7.84	5.13	6.69	4.19	7.5	5.0	8.91						
Largemouth Bass	0	0	.19	0	0	.03	0	.31						
Black Crappie	0	0	0	0	0	0	0	0						
Yellow Perch	6.82*[*]	12.95*	16.44*	15.4*	7.70*	9.48*	12.93*	5.7*						
Walleye	.75	.81	1.34	.84	1.03	.84	1.06	.47						
Freshwater Drum	.06	0	.13	0	0	0	.09	.06						
Round Goby	0	0	.09	.53	.19	.16	.75	.06						

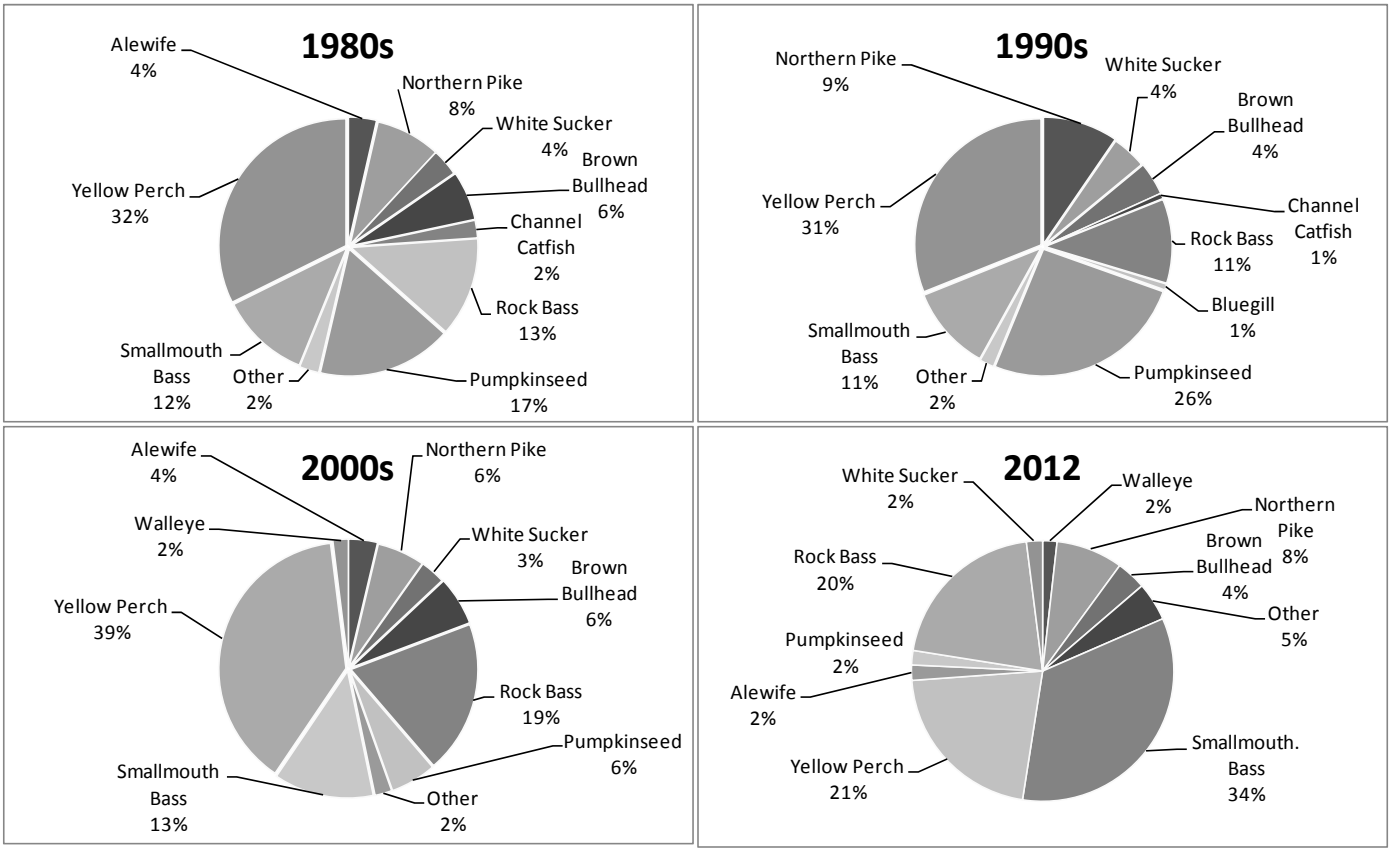

Figure 1. Composition of the warm/coolwater fish stock assessment sample from mid- depths of the St. Lawrence River Thousand Islands area.

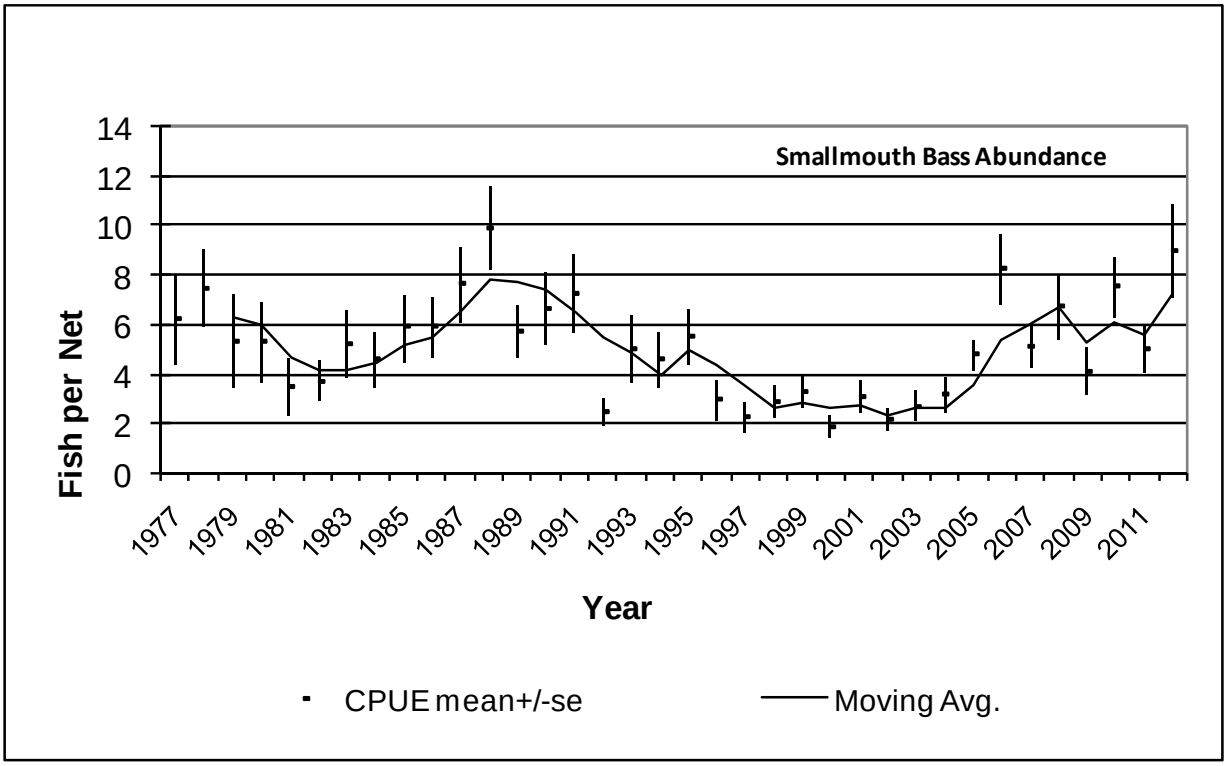

Figure 2. Smallmouth bass abundance index in the St. Lawrence River Thousand Islands area (Catch per Unit Effort +/- SE and 3-year moving average).

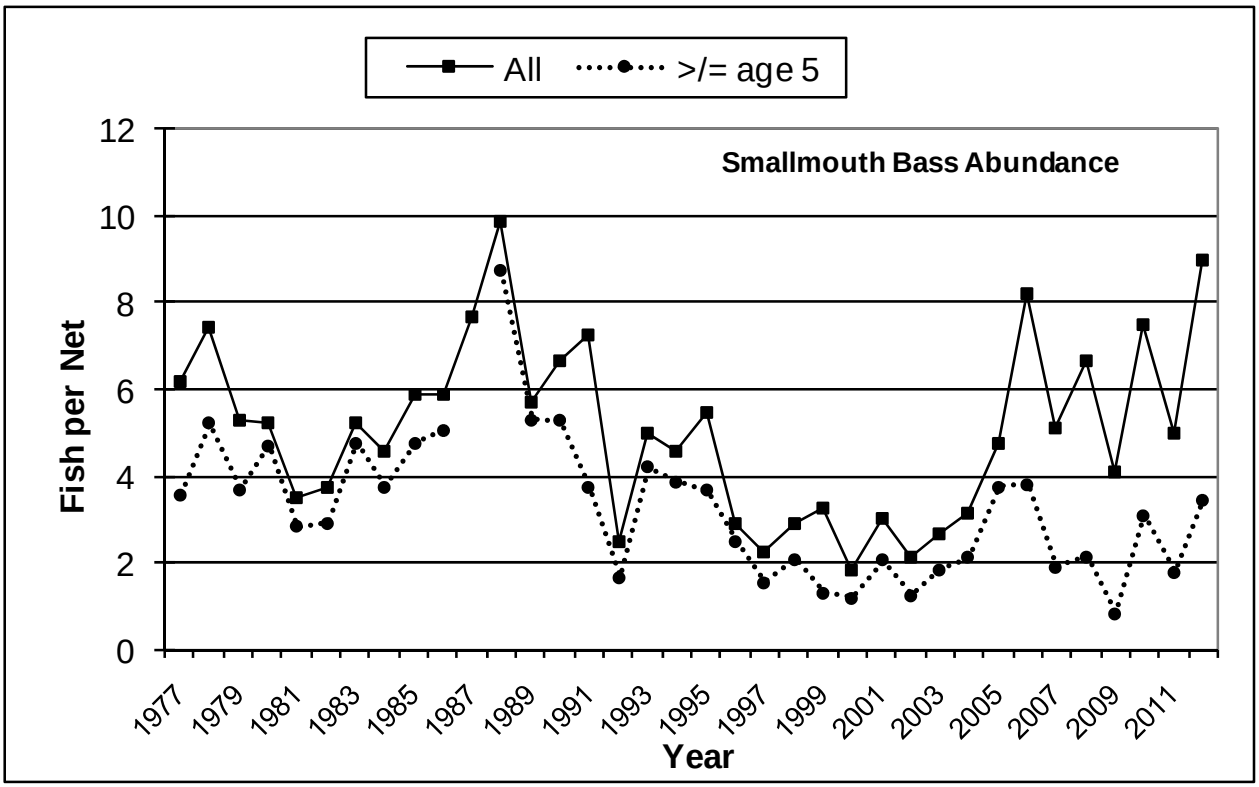

Figure 3. Smallmouth bass abundance index in the St. Lawrence River Thousand Islands area (all bass sampled and bass greater than or equal to age 5).

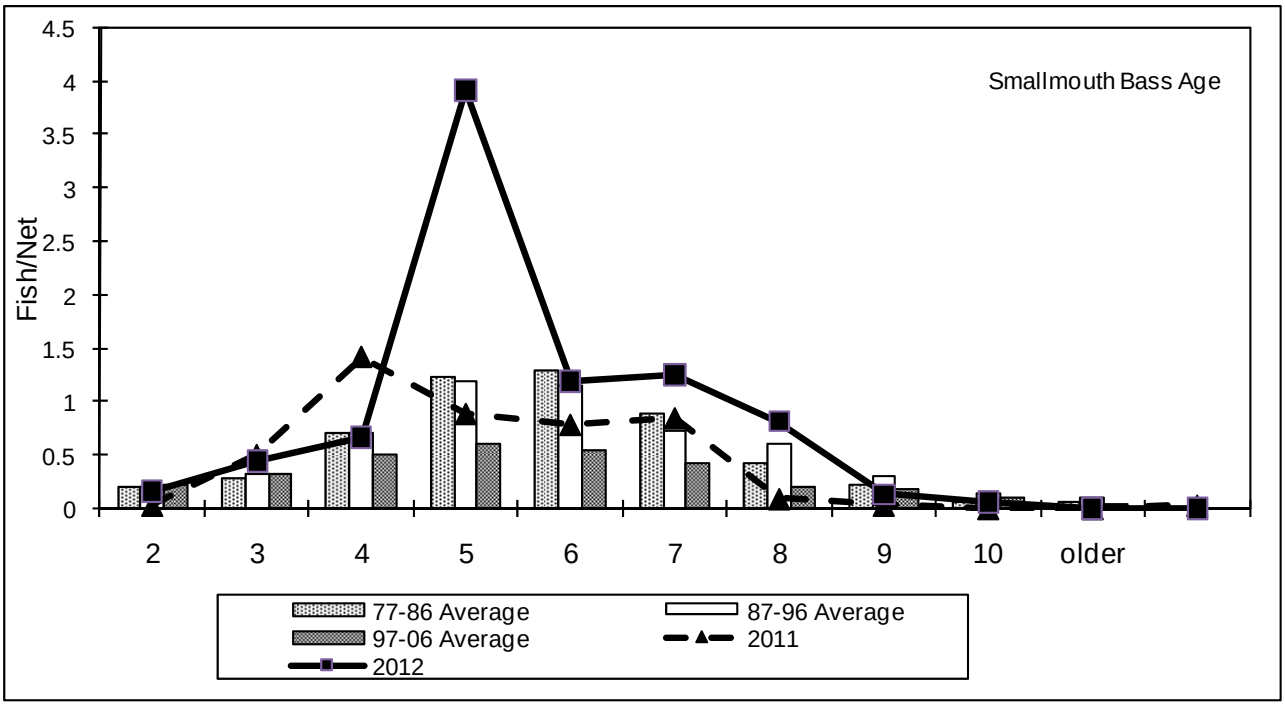

Figure 4. Smallmouth bass age distribution in the St. Lawrence River Thousand Islands area.

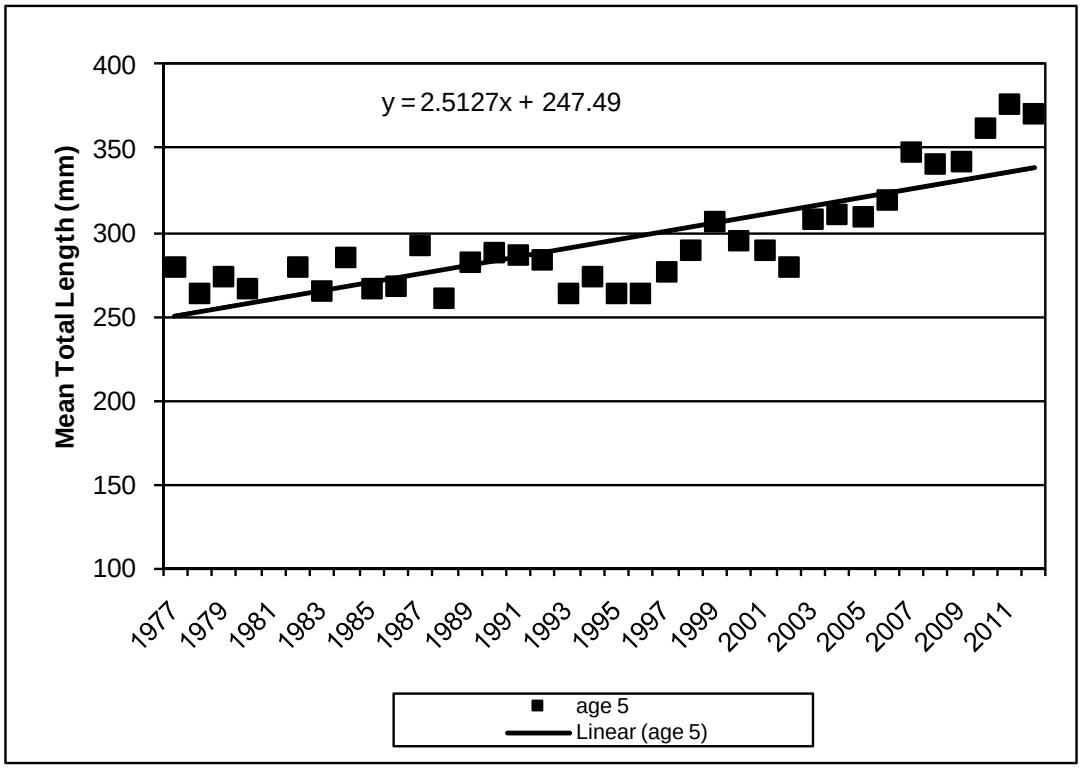

Figure 5. Mean total length of smallmouth bass at age 5 in the St. Lawrence River Thousand Islands area.

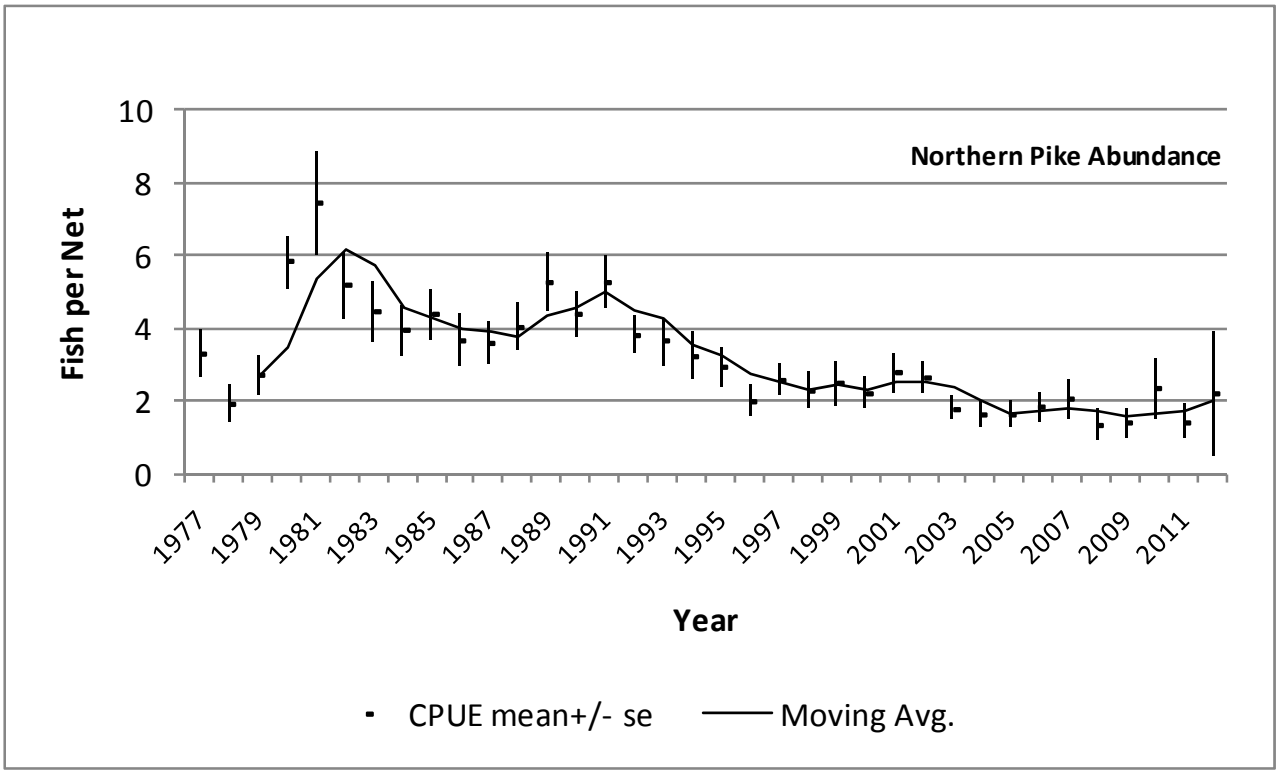

Figure 6. Northern pike abundance index in the St. Lawrence River Thousand Islands area.

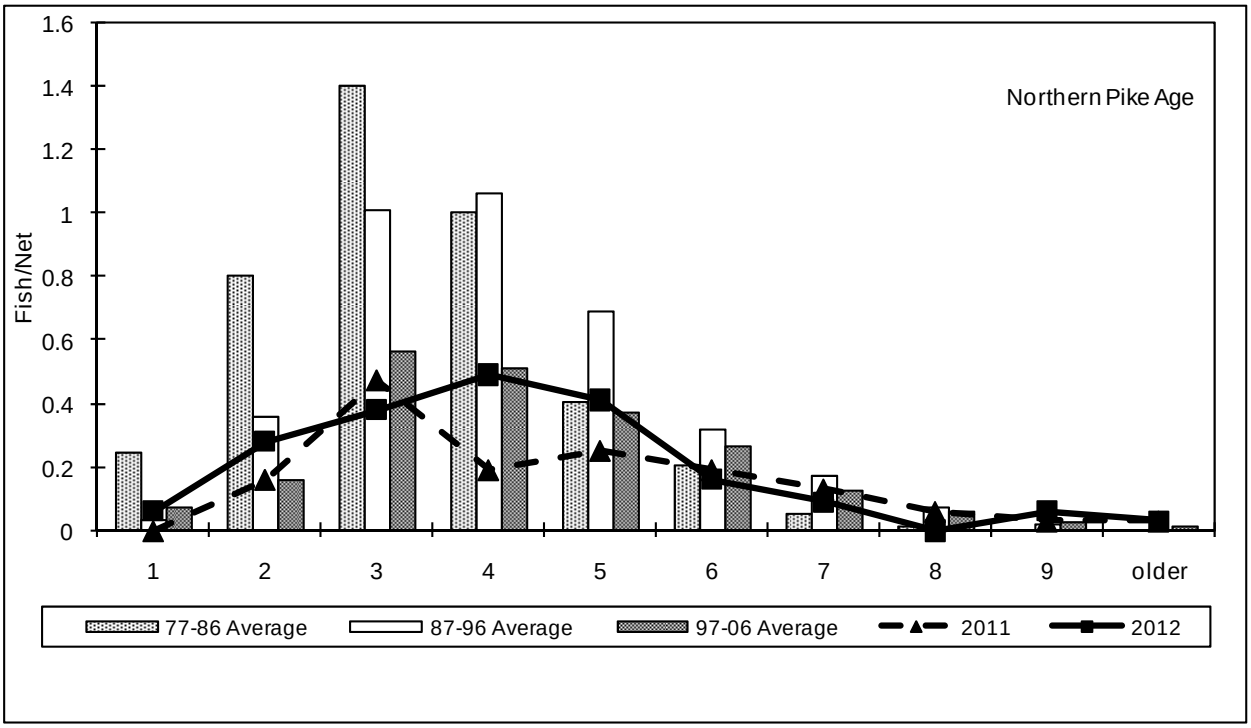

Figure 7. Northern pike age distribution in the St. Lawrence River Thousand Islands area.

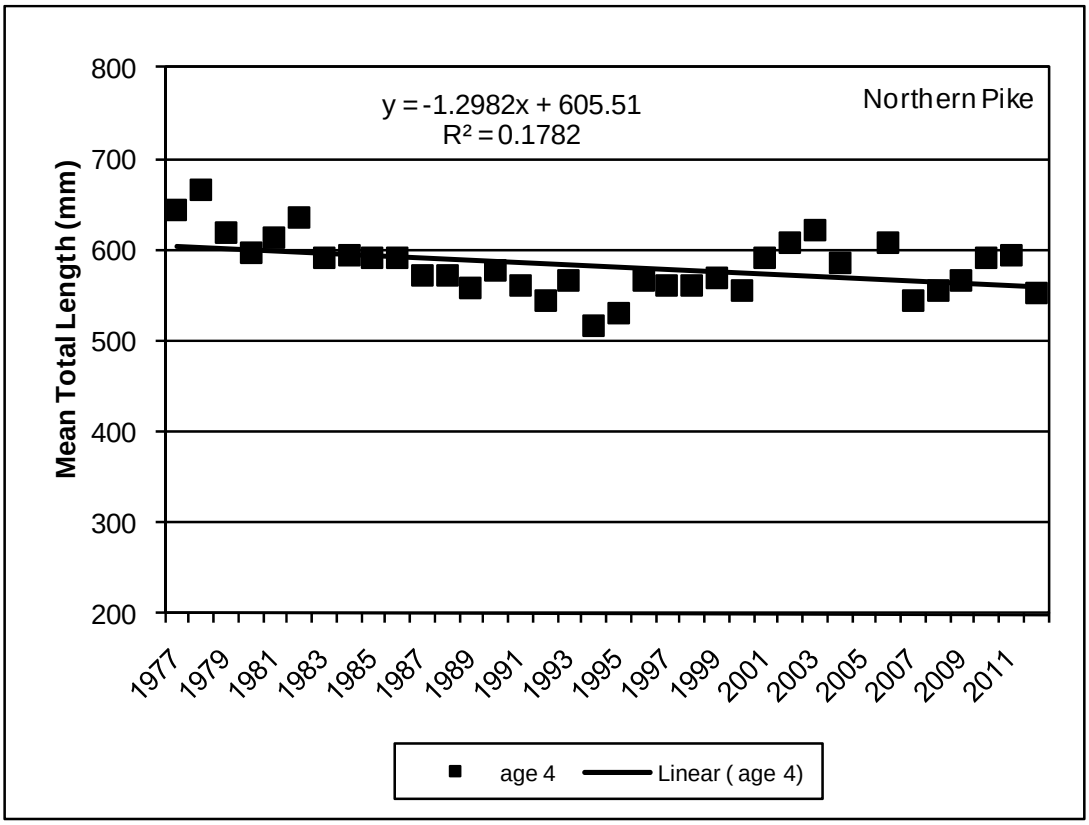

Figure 8. Mean total length of northern pike at age 4 in the St. Lawrence River Thousand Islands area.

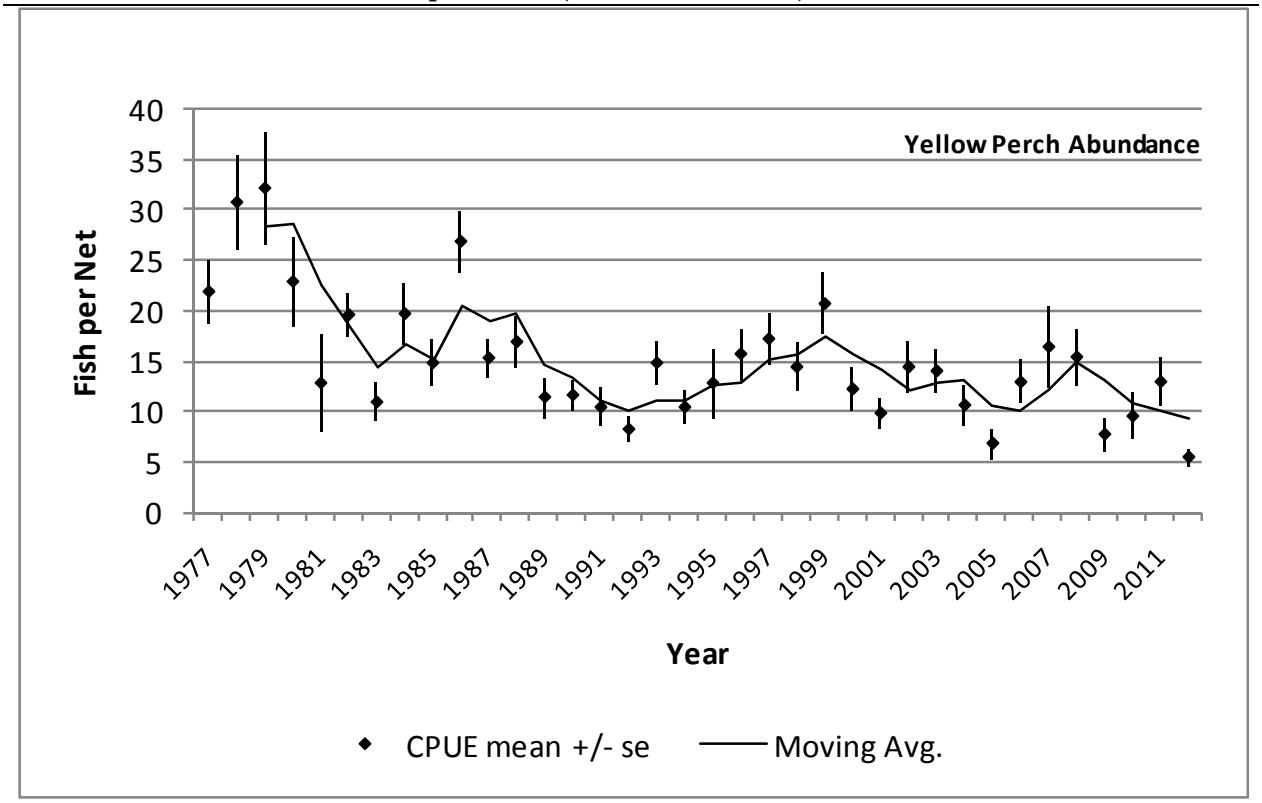

Figure 9. Yellow perch abundance index in the St. Lawrence River Thousand Islands area.

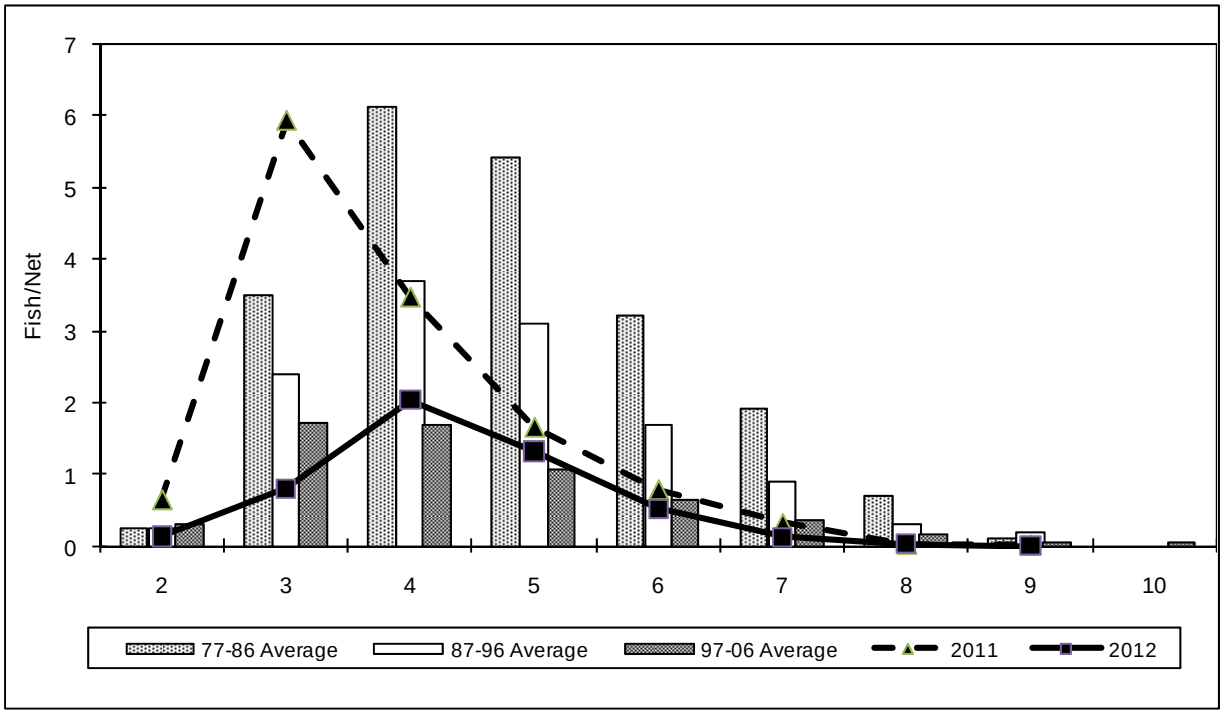

Figure 10. Yellow perch age distribution in the St. Lawrence River Thousand Islands area.

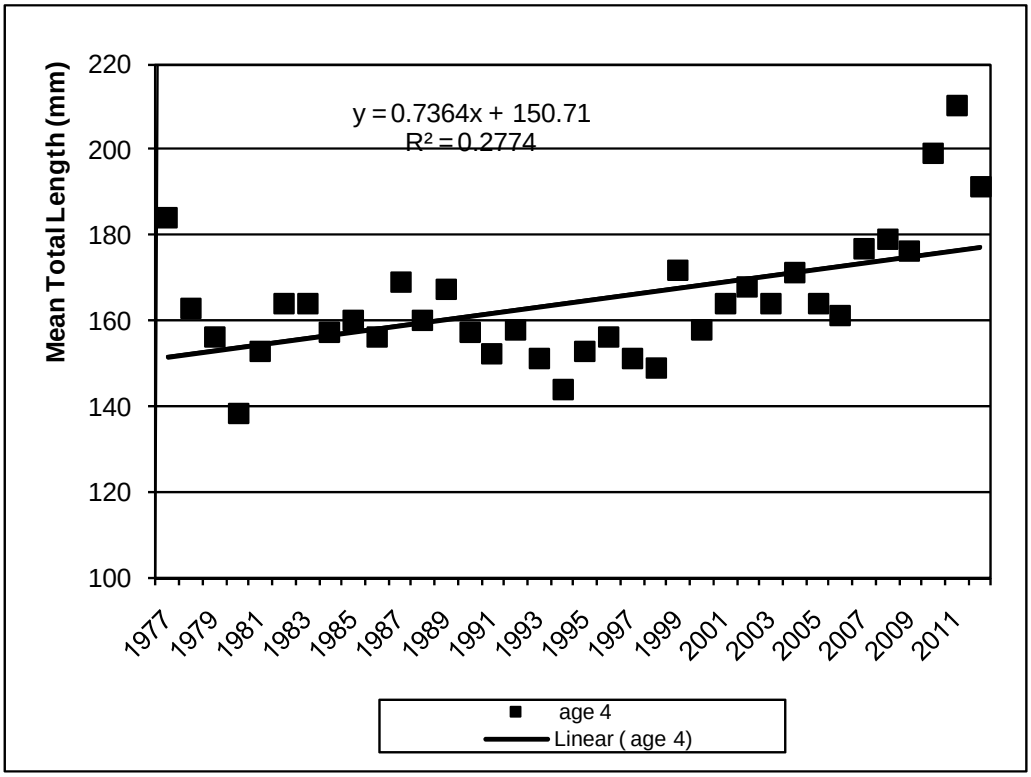

Figure 11. Mean total length at age 4 for yellow perch in the St. Lawrence River Thousand Islands area.

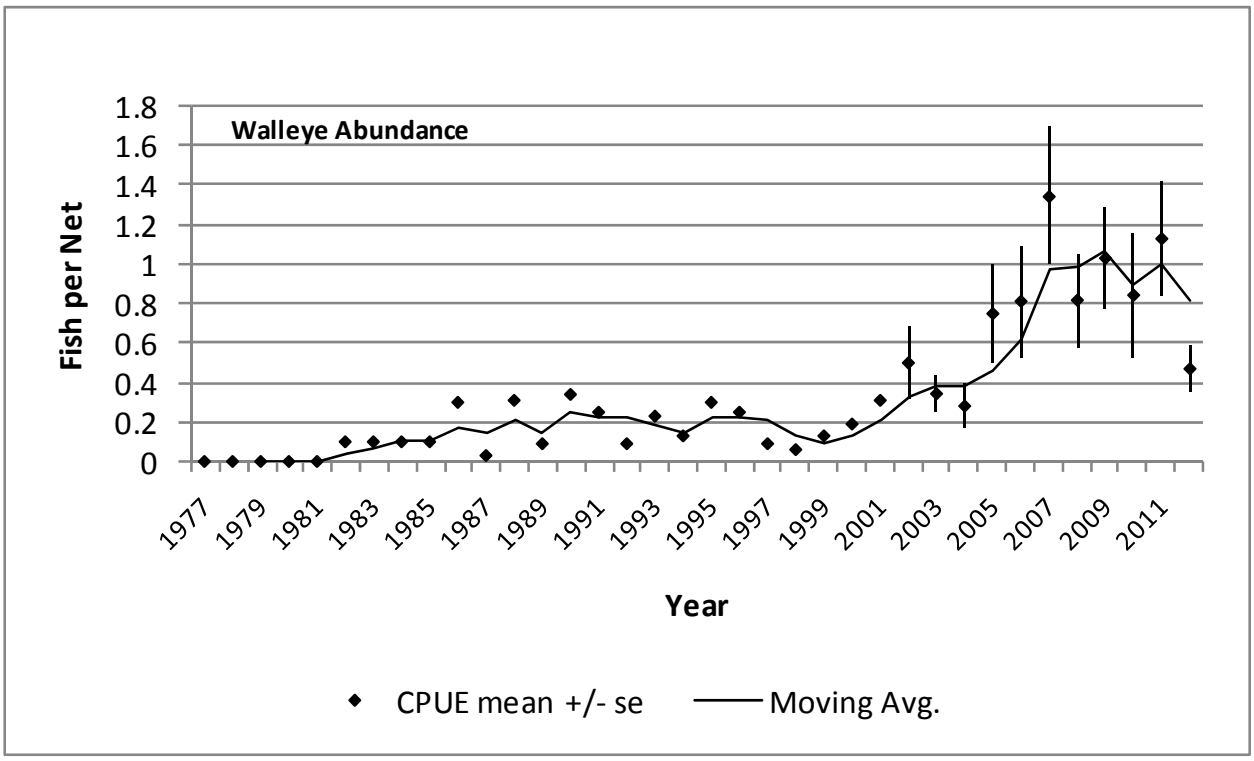

Figure 12 Walleye abundance index in the St. Lawrence River Thousand Islands area.

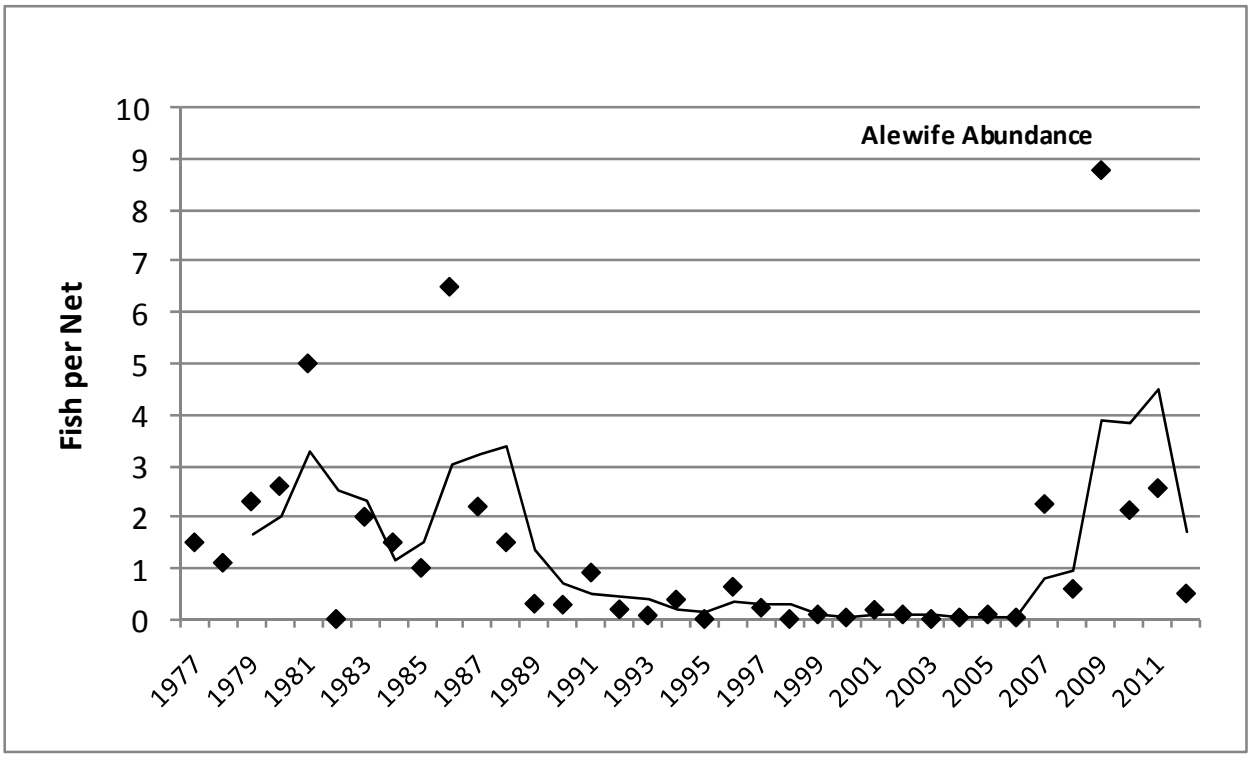

Figure 13. Abundance index for alewife in the St. Lawrence River Thousand Islands area (with 3-year moving average).

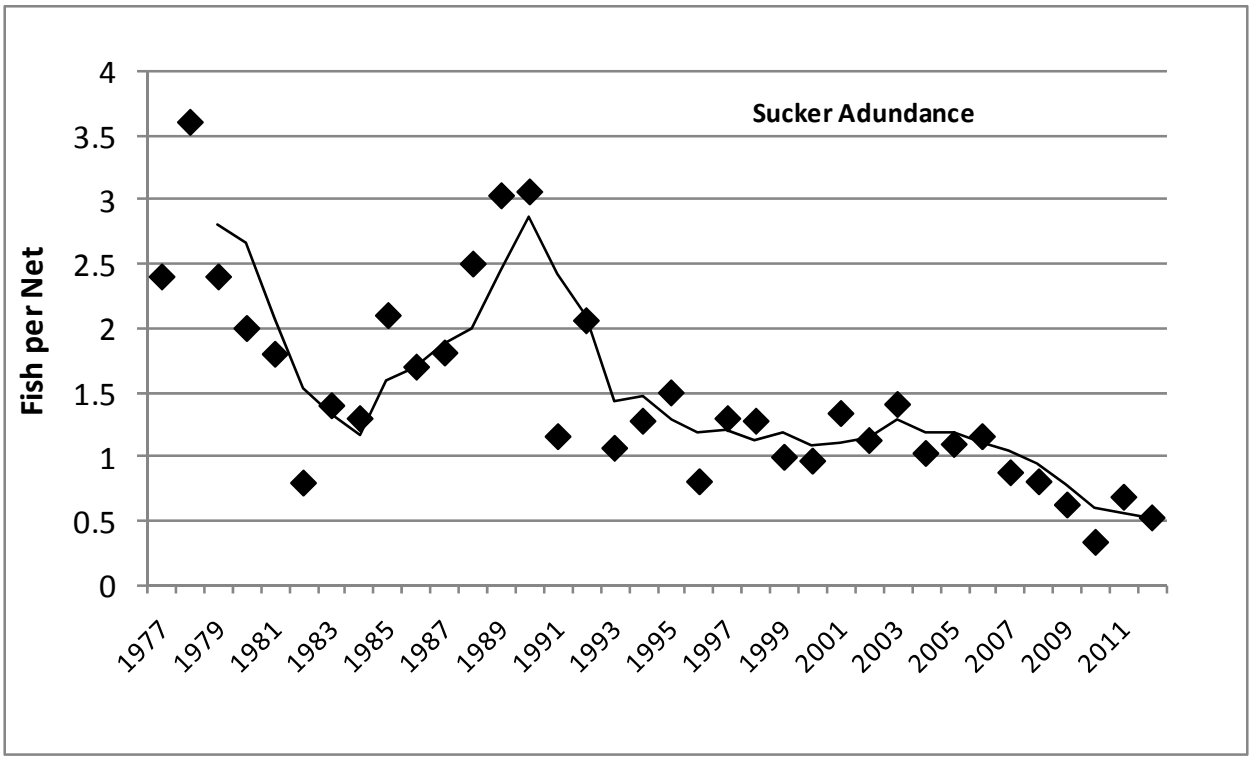

Figure 14. Abundance index for white sucker in the St. Lawrence River Thousand Islands area (with 3-yr moving average).

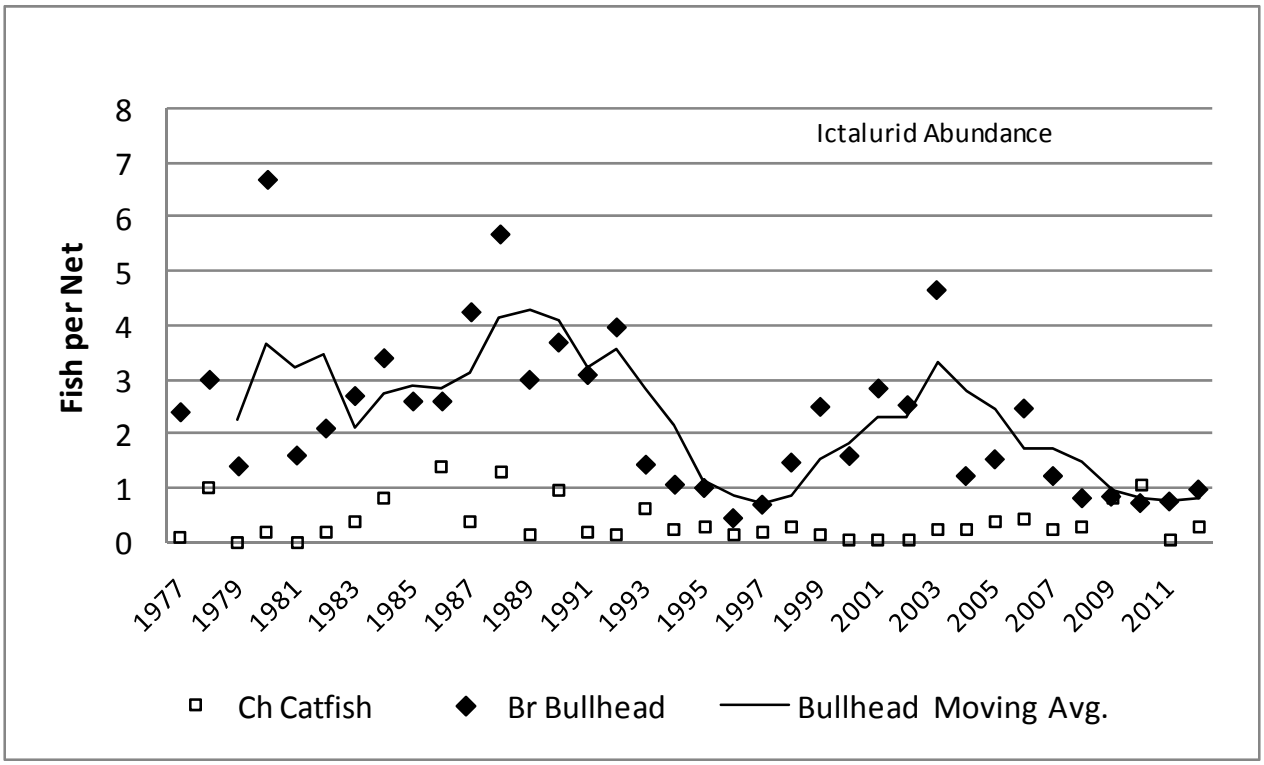

Figure 15. Abundance index for brown bullhead and channel catfish in the St. Lawrence River Thousand Islands area.

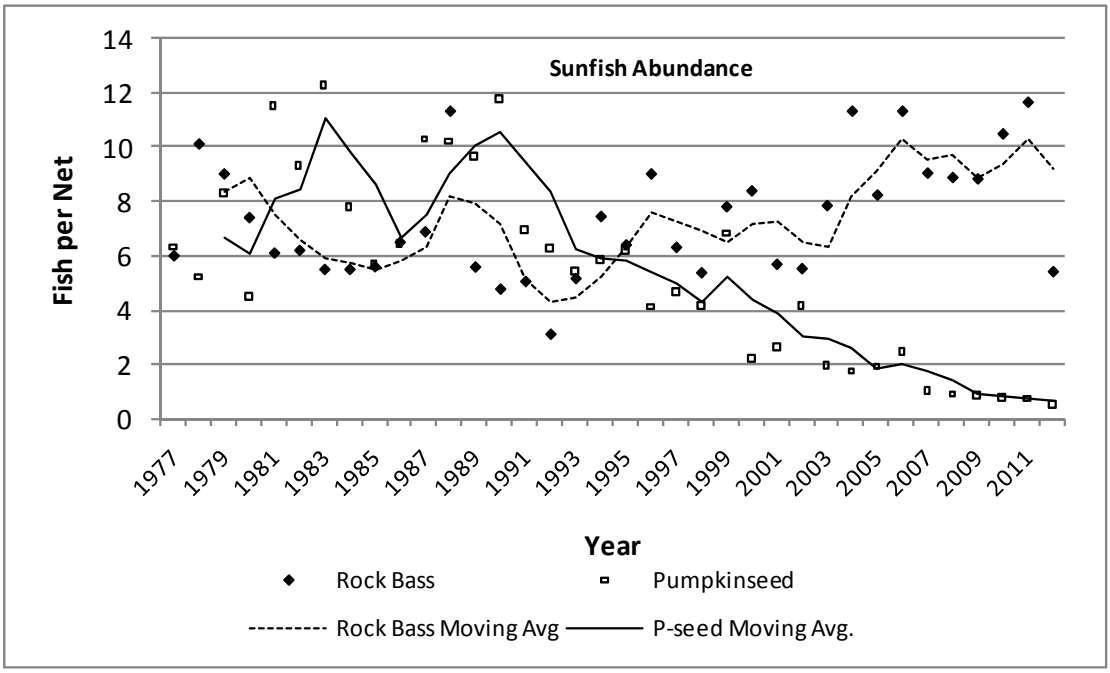

Figure 16. Abundance index for rock bass and pumpkinseed sunfish in the St. Lawrence River Thousand Islands area (with 3-year moving average).

2012 Lake St. Lawrence Warmwater Fisheries Assessment

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A cooperative fisheries assessment program for Lake St. Lawrence was initiated between the New York State Department of Environmental Conservation (NYSDEC) and the Ontario Ministry of Natural Resources (OMNR) in 1986. This program originated as an extension of the Thousand Islands and Middle Corridor assessment programs and is intended to measure long term trends in relative abundance, growth, age structure and condition of the fish community. Since 1996 the Lake St. Lawrence program has been maintained by NYSDEC.

Methods

In 2005 gill nets were converted from multifilament to monofilament utilizing the same mesh dimensions, hanging ratios, and panel height/length of the previous net. Monofilament gill nets measuring 200 ft (61 m) long by 8 ft (2.4 m) deep having eight panels measuring 25 ft (7.6 m), with mesh arranged in increasing size from 1.5-6 in (38-152 mm) stretch measure were used for this assessment.

Gill nets were set overnight and fished an average of 18.3 hours (SD=0.97) at standard New York (n=16) and Ontario (n=16) sites described by Klindt and Town (2002). Net sites were stratified in equal number by depth as shallow and deep (12-25 ft. and 30-50 ft., respectively).

Data collected from fish included total length (TL), weight, sex, and stage of maturity. Scale samples were taken from percids and centrarchids for age analysis. Cleithra were removed from northern pike for more reliable age determination. Data were entered into the NYSDEC Statewide Fisheries Database.

Total, and species specific, catch per unit effort (CUE; catch per gill net night) were calculated. Other metrics calculated include length-frequency and age-frequency. Yellow perch and smallmouth bass growth rates were plotted by year class using logarithmically transformed mean length at age.

Results and Discussion

The 2012 Lake St. Lawrence assessment was conducted from 17 to 19 September. Surface water temperatures ranged from 68-69°F (20.0-20.5^{o}C). A sample of 1,061 fish comprising 19 species was collected (Table 1). The catch was dominated by yellow perch (50.3%), rock bass (15.6%) and smallmouth bass (8.0%).

While overall diversity of the fish community in Lake St. Lawrence remains relatively stable, the contribution of individual species appears to have changed over time. Figure 1 shows species that comprised at least 3% of the total catch over three decades. Over time the yellow perch contribution has increased, while other common species such as rock bass, smallmouth bass and walleye have remained relatively stable. Species less often encountered, while still present, make up smaller proportions of the overall assemblage over time.

Total CUE increased by 72.6% from 19.3 in 2011 to 33.16 in 2012, which is the second highest catch on record (Figure 2). Total CUE is generally driven by fluctuations in the yellow perch population. A Chinook salmon (*Oncorhynchus tshawytscha*), of wild origin, was collected for the first time in the history of this survey in 2012.

Yellow perch CUE increased by 85% from 9.03 in 2011 to 16.7 in 2012 (Figure 3). This was the second highest yellow perch catch recorded. Few perch <6” were collected in this assessment, while a high proportion of fish >9” (29.7%) were present (Figure 4). From 2006 to present, perch >9” have comprised 19.8-33.9% of the catch. The age structure of perch shows that the majority of fish collected were ages 3-4 (Figure 5). The 2008 year class that was abundant in 2010 remains well represented as age-4 fish in 2012.

Localized impacts on yellow perch populations from predation by Double-crested cormorants (*Phalacrocorax auritus*) have been reported previously in Lake St. Lawrence (Klindt 2006, 2007, Klindt and Gordon 2008, 2009, 2010, 2011, 2012, Klindt and Town 2003, 2004, 2005). Regurgitated cormorant pellets were collected in 2012 from Bergin Island, located in the lowermost portion of the fisheries assessment area. Pellets had previously been collected from Strachan Island, approximately 2.2 miles to the east. A larger portion of the cormorant population now resides on the Bergin Island complex making collection of pellets at that location more efficient. Pellet analysis described by Johnson and Klindt (2013) indicated that diet was comprised predominantly of round goby (73.5%) and yellow perch (14.2%). Yellow perch had been the dominant forage until 2005 comprising from 50-60% of the diet (Johnson et al. 2005, 2006). Round goby have since become an important forage fish in the lower St. Lawrence River as demonstrated by cormorant consumption increase documented by Johnson et al. (2007, 2008, 2009, 2010, 2011, 2012, 2013).

The number of active nests at Strachan Island increased from 190 in 2011 to 230 in 2012 (I. Mazzocchi, NYSDEC, pers. communication). The Strachan-Bergin islands complex of nesting cormorants has been relatively stable at approximately 1,000 from 2009-2011 but dropped in 2012 to 885 total nests (Figure 6).

Gill net sites were stratified by distance from the nesting colony as described by Klindt and Lantry (2001). Yellow perch CUEs for "upriver" (>7.75 mi) and "colony" (within 7.75 mi) net strata were 7.5 and 10.7, respectively (Figure 6). The CUE differential between the upriver and colony strata for the last five years is similar to that expressed from 1986-1994, prior to the influence of cormorant predation. Pellet analysis has shown round goby consumption had risen sharply once they became well established in the area, with the highest percent composition recorded (75.4%) in 2009. (Johnson et al. 2010). With round goby dominating cormorant diets, it is likely that cormorant predation pressure on yellow perch is lower than previously observed, in spite of an increase in total active cormorant nests on Lake St. Lawrence (Figure 6).

Growth rates of yellow perch were determined by year class for fish ages 2-7 years. The slope of the regression line of log transformed mean length at age for each year class is illustrated in Figure 7. A minimum of four data points is needed to plot an individual year class to decrease variability. Although variability remains high within the series (r^2=0.38), an increasing growth rate trend remains apparent overall. Round goby have become a forage source for most piscivorous species in the river, and it is probable that increased growth rates seen since the expansion of gobies (circa 2000) are a result of perch exploiting gobies as a primary forage species.

Smallmouth bass CUE had been relatively stable from 1998-2004, but has gone through a period of substantial fluctuations from 2005 to the present. Smallmouth bass CUE rose above the long term average of 2.24 in 2012 (Figure 8). The majority of the 2012 catch were bass >16" in length (Figure 9). An uncharacteristically high number of age-3 fish (2009 year class) were collected. The 2005 year class, previously noted as being strong in 2008, continues to be well represented as age-7 fish in the 17-20 inch range (Figure 10). Predicting year class strength of smallmouth bass has been difficult within this program as small fish are seldom or sporadically encountered.

Growth rates of smallmouth bass were determined by year class for fish ages 3-7 years. The slope of the regression line of log transformed mean length at age for each year class is presented in Figure 11. The relationship has weakened considerably (r^2=0.14), however it continues to show an overall increase in growth rate. Data points for the1998, 1999 and 2001-2004 year classes demonstrate a marked increase in growth rate, likely due to foraging on round goby. Mean length at age-6 is also illustrated in Figure 11 to demonstrate a similar trend of increasing growth. When considering only year classes 2000-2006, it appears that growth rate may be stabilizing.

Walleye CUE (2.09) increased by 15.4% from 2011 and represents a high catch for this

assessment (Figure 12). The length-frequency distribution of the walleye catch (Figure 13) was dominated by 12-15 inch fish. Catch was dominated by age 1&2 year fish, typical for this survey. The strong 2007 year class, reported as an anomaly in 2009, continues to be detectable as age 5 fish (Figure 14). All walleye to date have been aged using scales which may have led to some inconsistencies in reporting year class strength. Future surveys will incorporate otoliths as aging structures since many researchers report improved accuracy (Beamish and McFarlaine 1987).

Northern pike CUE (0.19) in 2012 decreased to its lowest level since 1987 (Figure 15). Total length of northern pike ranged from 23.3-34.0 inches (Figure 16). Fish ages 2-8 were represented in the catch (Figure 17).Northern pike CUE has been in a general state of decline since 2002.Netting strata were not designed to take advantage of limited littoral zone habitat in Lake St. Lawrence, therefore northern pike are poorly represented in this assessment.

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Table 1. Relative abundance (number of fish per net night) and long term average (LT Avg.) of primary species collected in the assessment of Lake St. Lawrence, 1983-2012.

	Year	1983	1985	1986	1987	1988	1989	1990	1991	1992
SPECIES	**# Nets**	48	47	32	47	32	46	32	47	32
Lake Sturgeon		0.02	0.02	x	x	x	x	x	x	x
Bowfin		x	x	x	x	0.03	x	x	x	x
Alewife		0.73	1.15	1.50	0.11	0.06	0.06	0.34	0.04	0.66
Gizzard Shad		x	x	x	0.26	0.09	0.33	0.13	0.21	x
Rainbow Trout		x	x	0.03	x	x	x	x	x	x
Brown Trout		x	x	0.09	0.02	x	x	x	x	x
Lake Trout		x	x	x	x	x	0.06	x	0.02	x
Rainbow Smelt		x	x	x	x	x	x	x	x	0.02
Northern Pike		0.23	0.62	0.94	0.04	0.63	0.85	0.69	0.66	0.53
Muskellunge		x	x	x	0.02	x	0.02	x	x	0.03
Lake Chub		x	x	x	0.02	x	x	x	x	x
Carp		1.46	0.23	1.94	1.06	0.66	0.72	1.06	0.87	1.13
Golden Shiner		x	x	x	x	x	x	x	0.02	x
Fallfish		0.17	0.21	0.25	0.32	0.19	0.15	0.19	0.09	0.09
White Sucker		1.54	1.45	0.91	1.04	1.41	1.43	1.47	0.89	1.06
Silver Redhorse		0.58	0.21	0.06	0.23	0.44	0.15	0.31	0.15	0.50
Shorthead Redhorse		x	x	x	x	x	x	x	x	x
Greater Redhorse		x	x	0.03	x	x	x	x	x	x
Yellow Bullhead		x	x	x	x	x	x	x	x	x
Brown Bullhead		1.25	2.15	0.63	0.79	0.97	1.61	2.06	2.55	2.28
Channel Catfish		0.04	0.09	x	x	0.09	0.02	0.03	x	0.03
White Perch		1.23	1.06	0.38	0.96	3.00	0.87	1.50	1.09	0.91
White Bass		0.06	0.13	x	0.02	x	0.04	0.03	0.11	x
Rock Bass		2.19	1.23	2.41	1.36	1.84	1.02	2.03	1.17	2.00
Pumpkinseed		0.33	0.21	0.13	0.26	0.28	0.74	0.19	0.21	0.34
Bluegill		x	x	x	x	x	x	x	x	x
Smallmouth Bass		3.77	2.15	2.03	2.36	2.28	2.65	1.97	1.68	2.94
Largemouth Bass		x	x	x	x	x	0.02	0.03	0.04	x
Black Crappie		0.08	0.09	x	0.02	0.16	0.13	0.09	0.04	0.22
Yellow Perch		7.60	11.3	9.63	8.61	6.94	4.41	4.34	5.83	4.72
Walleye		0.42	1.38	0.53	1.04	1.38	0.83	1.34	1.21	0.94
Freshwater Drum		0.02	0.02	x	x	x	0.06	x	x	0.03
TOTAL CATCH		21.7	25.9	21.5	18.9	20.4	16.2	17.8	16.9	18.5

Table 1. Relative abundance (number of fish per net night) and long term average (LT Avg.) of primary species collected in the assessment of Lake St. Lawrence, 1983-2012 (continued).

	Year	1993	1994	1995	1996	1997	1998	1999	2000	2001
SPECIES	**# Nets**	47	32	47	32	32	32	32	32	32
Lake Sturgeon		x	0.03	x	x	0.09	x	x	x	x
Bowfin		x	x	x	x	x	x	x	0.03	0.03
Alewife		0.02	0.28	0.43	x	x	x	x	0.03	x
Gizzard Shad		0.32	x	x	0.09	x	x	0.13	0.03	x
Rainbow Trout		x	x	x	x	x	x	x	x	x
Brown Trout		0.02	x	0.21	x	x	x	x	x	x
Lake Trout		0.02	x	x	x	x	x	x	x	x
Rainbow Smelt		x	x	x	x	x	x	x	x	x
Northern Pike		0.32	0.31	0.36	0.22	0.41	0.50	0.91	0.44	0.59
Muskellunge		x	x	x	x	x	x	x	x	x
Lake Chub		x	x	x	x	x	x	x	x	x
Carp		0.64	0.75	0.43	0.56	0.41	1.16	0.78	0.38	0.47
Golden Shiner		x	x	x	x	x	x	x	x	x
Fallfish		0.06	0.63	0.13	0.09	0.06	x	0.03	0.09	0.06
White Sucker		0.87	0.94	0.55	1.28	0.47	0.53	1.16	0.69	0.66
Silver Redhorse		0.17	0.28	0.13	0.53	0.53	0.94	1.19	1.06	0.94
Shorthead Redhorse		x	x	x	x	x	x	0.28	0.03	0.13
Greater Redhorse		x	0.03	x	x	x	x	x	0.03	x
Yellow Bullhead		x	x	x	x	x	x	0.03	x	x
Brown Bullhead		0.21	0.31	0.36	0.63	0.81	1.34	2.69	0.56	2.94
Channel Catfish		x	0.16	0.02	0.06	0.03	0.09	0.03	0.06	0.41
White Perch		0.70	1.19	0.06	0.69	0.31	0.50	0.44	0.28	0.03
White Bass		x	x	x	0.06	x	x	x	0.13	x
Rock Bass		1.34	1.69	1.21	2.75	2.40	3.44	3.09	3.38	2.72
Pumpkinseed		0.02	0.31	0.36	0.28	0.63	1.16	0.78	0.56	0.75
Bluegill		x	x	x	x	x	x	0.03	x	0.03
Smallmouth Bass		1.51	2.41	1.47	1.22	1.09	2.78	3.28	2.56	2.31
Largemouth Bass		0.02	x	x	x	x	x	x	0.03	x
Black Crappie		0.11	0.03	0.04	x	x	0.06	x	0.03	x
Yellow Perch		4.62	4.56	4.57	4.19	4.59	6.97	3.66	2.59	2.44
Walleye		1.64	0.75	0.94	1.72	1.38	1.34	2.09	1.69	1.06
Freshwater Drum		0.06	x	0.21	x	x	x	0.03	x	x
TOTAL CATCH		12.7	14.1	11.7	14.4	13.2	20.9	20.6	14.7	15.6

Table 1. Relative abundance (number of fish per net night) and long term average (LT Avg.) of primary species collected in the assessment of Lake St. Lawrence, 1983-2012 (continued).

	Year	2002	2003	2004	2005	2006	2007	2008	2009
SPECIES	**# Nets**	32	32	32	32	32	32	32	32
Lake Sturgeon		x	0.06	0.03	x	x	0.06	x	x
Bowfin		0.06	x	0.03	x	x	x	0.06	x
Alewife		0.06	x	x	x	x	x	x	x
Gizzard Shad		0.03	x	0.06	0.06	0.06	x	0.53	0.06
Rainbow Trout		x	x	x	x	x	x	x	x
Brown Trout		x	x	x	x	0.03	x	x	x
Lake Trout		x	x	x	x	x	x	x	x
Rainbow Smelt		x	x	x	x	x	x	x	x
Northern Pike		0.63	0.56	0.47	0.44	0.59	0.41	0.28	0.31
Muskellunge		x	x	x	x	x	x	x	x
Lake Chub		x	x	x	x	x	x	x	x
Carp		0.91	0.41	0.19	0.50	0.25	0.31	0.41	0.06
Golden Shiner		x	x	x	x	x	x	x	x
Fallfish		0.03	x	x	x	0.06	0.16	x	0.25
White Sucker		0.66	0.25	0.16	0.25	0.31	0.44	0.81	0.59
Silver Redhorse		0.88	0.28	0.53	0.53	0.25	0.25	0.28	0.31
Shorthead Redhorse		0.06	0.03	0.03	0.06	x	0.09	x	x
Greater Redhorse		x	x	x	x	x	x	0.03	0.03
Yellow Bullhead		x	x	x	x	x	x	x	x
Brown Bullhead		2.47	0.56	0.44	0.22	0.22	0.19	0.06	0.09
Channel Catfish		0.06	0.09	0.16	0.03	0.03	0.09	0.09	0.09
White Perch		0.09	x	0.19	x	1.75	x	0.25	1.22
White Bass		x	x	x	0.06	x	0.06	x	0.09
Rock Bass		2.59	2.63	2.5	3.38	2.50	4.03	6.38	4.19
Pumpkinseed		0.56	1.41	0.09	0.03	0.16	0.16	0.16	0.13
Bluegill		x	0.03	x	x	x	x	x	x
Smallmouth Bass		2.53	2.06	2.22	4.28	1.63	1.44	3.03	1.00
Largemouth Bass		0.06	x	0.03	0.28	0.13	x	0.13	0.03
Black Crappie		0.03	x	x	x	x	x	0.06	0.03
Yellow Perch		4.53	4.34	1.78	4.44	3.78	7.13	11.22	8.16
Walleye		1.75	1.28	0.72	1.44	1.91	1.09	1.94	3.03
Freshwater Drum		x	x	x	0.13	0.06	0.06	x	0.03
TOTAL CATCH		17.9	14.0	9.69	16.19	13.78	15.96	25.75	19.67

Table 1. Relative abundance (number of fish per net night) and long term average (LT Avg.) of primary species collected in the assessment of Lake St. Lawrence, 1983-2012 (continued).

	Year	2010	2011	2012	LT Avg.
SPECIES	**# Nets**	32	32	32	
Lake Sturgeon		0.06	0.03	x	0.01
Bowfin		0.03	x	x	0.01
Alewife		x	0.03	0.09	0.19
Gizzard Shad		0.06	0.03	0.63	0.11
Rainbow Trout		x	x	x	0.00
Brown Trout		x	x	x	0.01
Lake Trout		x	x	x	0.00
Rainbow Smelt		x	x	x	0.00
Northern Pike		0.28	0.31	0.19	0.47
Muskellunge		x	0.03	x	0.00
Lake Chub		x	x	x	0.00
Carp		0.19	0.16	0.41	0.64
Golden Shiner		x	x	0.03	0.00
Fallfish		0.19	0.19	0.16	0.13
White Sucker		0.44	0.53	1.22	0.83
Silver Redhorse		0.19	0.63	0.44	0.45
Shorthead Redhorse		x	x	x	0.02
Greater Redhorse		0.06	0.03	x	0.01
Yellow Bullhead		x	x	x	0.00
Brown Bullhead		0.16	0.22	0.66	1.01
Channel Catfish		0.03	0.09	0.09	0.07
White Perch		0.41	1.03	1.75	0.75
White Bass		x	x	x	0.03
Rock Bass		8.03	3.41	5.16	2.83
Pumpkinseed		0.19	0.09	0.16	0.37
Bluegill		x	x	x	0.00
Smallmouth Bass		2.22	1.34	2.66	2.24
Largemouth Bass		0.22	0.22	0.69	0.07
Black Crappie		x	x	x	0.04
Yellow Perch		18.78	9.03	16.69	6.60
Walleye		2.75	1.81	2.09	1.43
Freshwater Drum		0.03	x	0.03	0.03
TOTAL CATCH		34.25	19.34	33.16	18.37

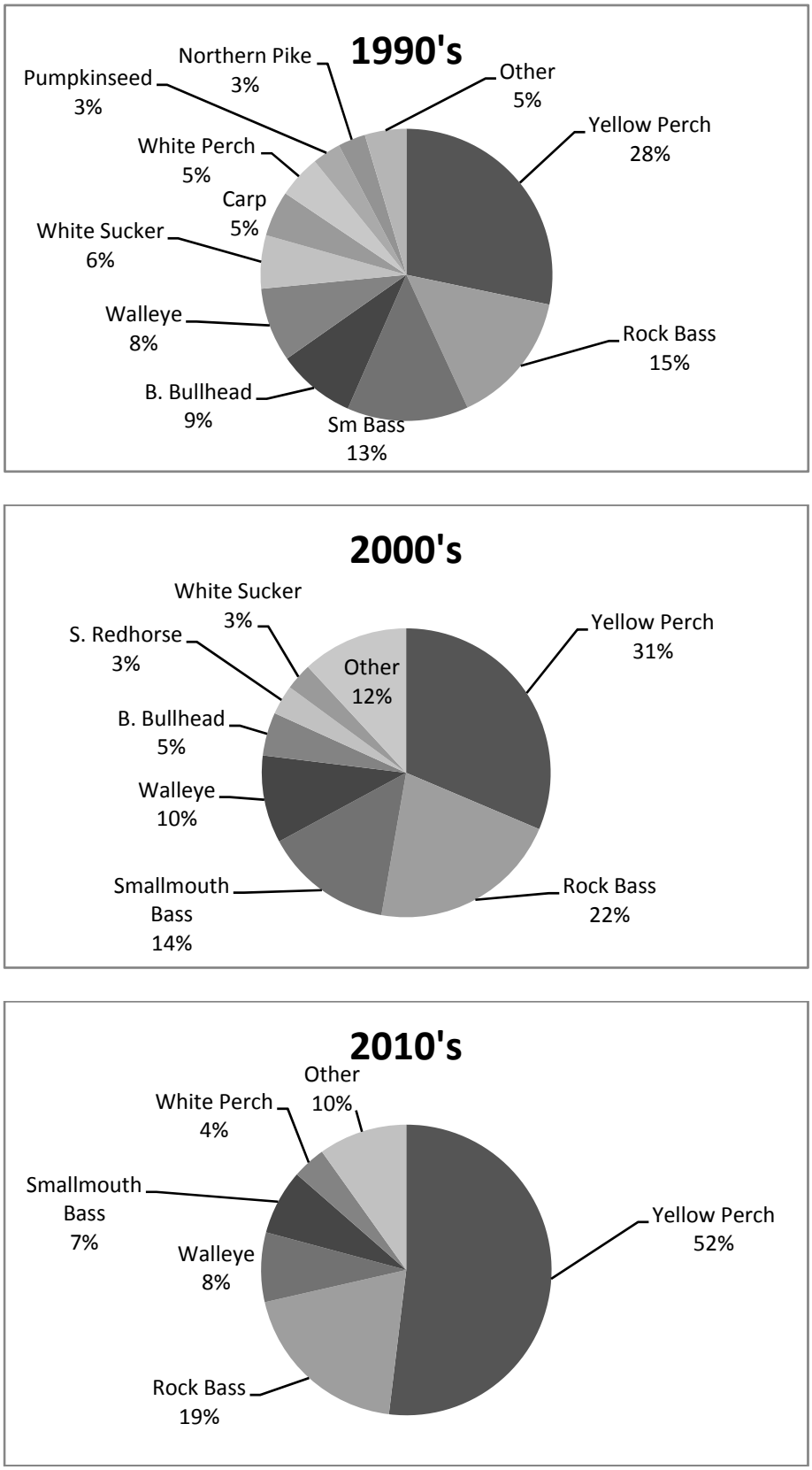

Figure 1. Composition of the Lake St. Lawrence fish community sampled by gill nets and presented by decade.

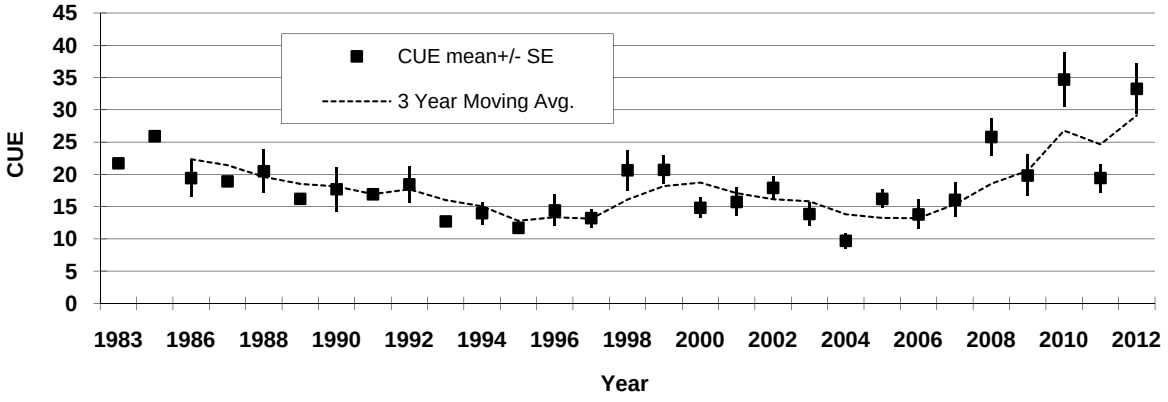

Figure 2. Total catch per gill net night (CUE) for Lake St. Lawrence, 1983-2012.

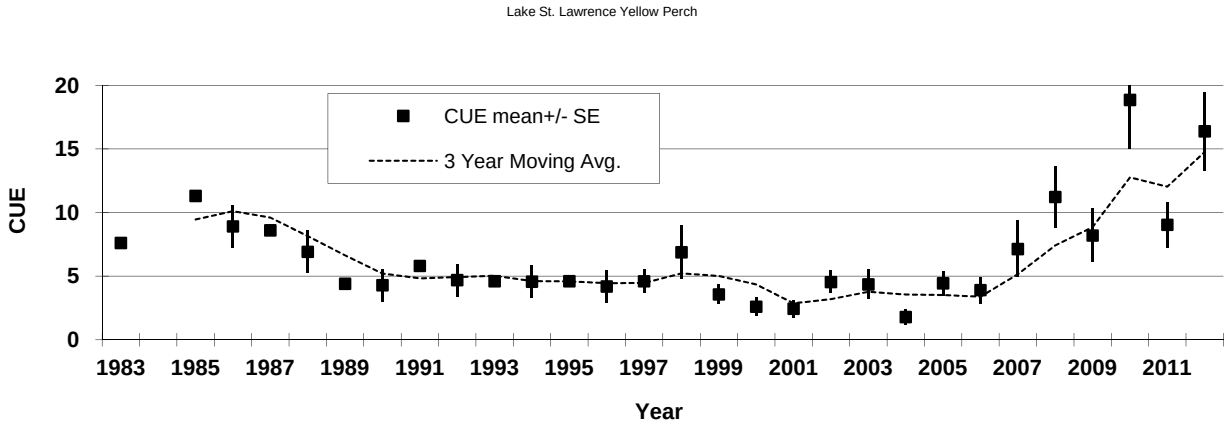

Figure 3. Yellow perch total catch per gill net night (CUE) for Lake St. Lawrence, 1983-2012.

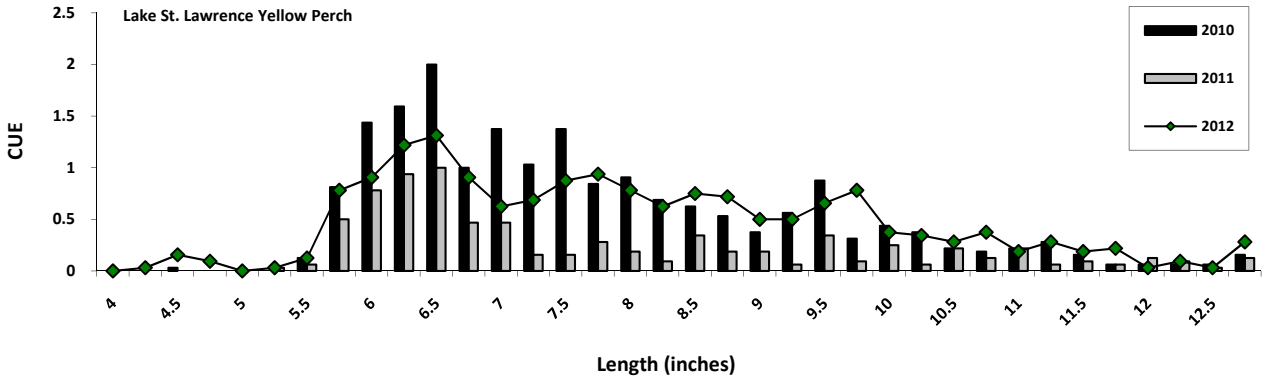

Figure 4. Yellow perch length-frequency distribution for Lake St. Lawrence.

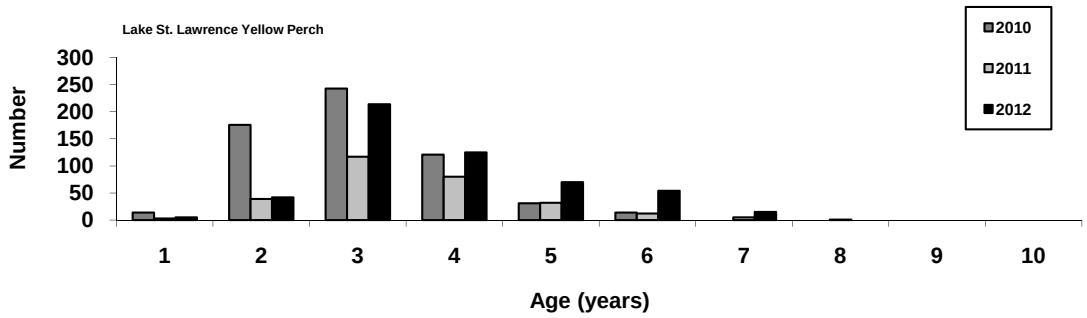

Figure 5. Yellow perch age-frequency distribution for Lake St. Lawrence.

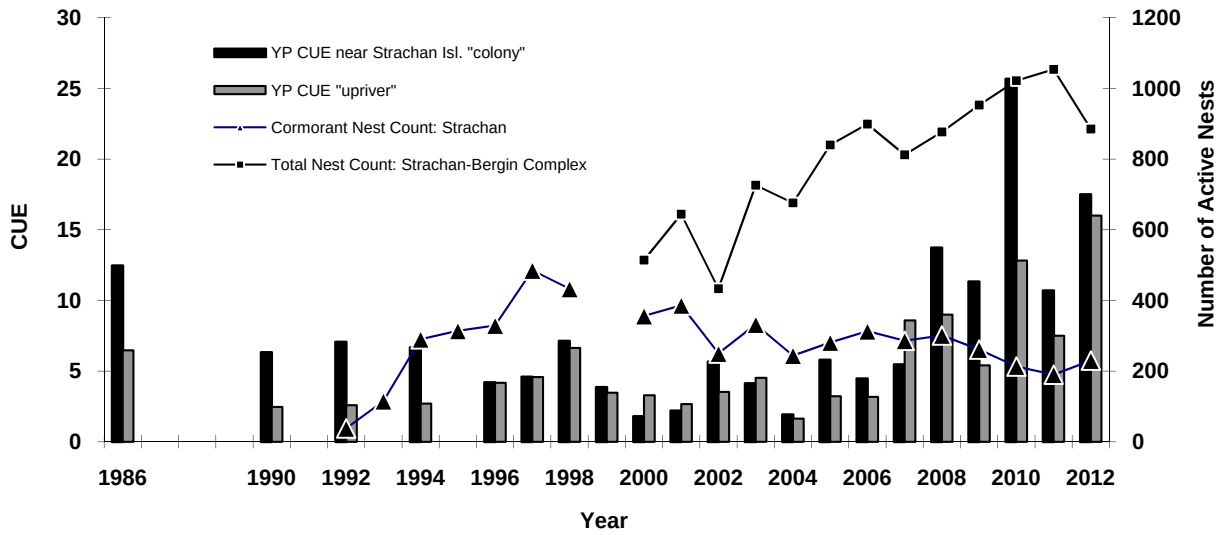

Figure 6. Yellow perch catch per gill net night (CUE) separated by distance from the Strachan Island cormorant colony. The "colony" designation incorporates net sites within 7.75 mi. of Strachan Island, "upriver" incorporates net sites greater than 7.75 mi. from the colony in a given year. A total of all nest counts in lower Lake St. Lawrence is illustrated by "Strachan – Bergin Complex".

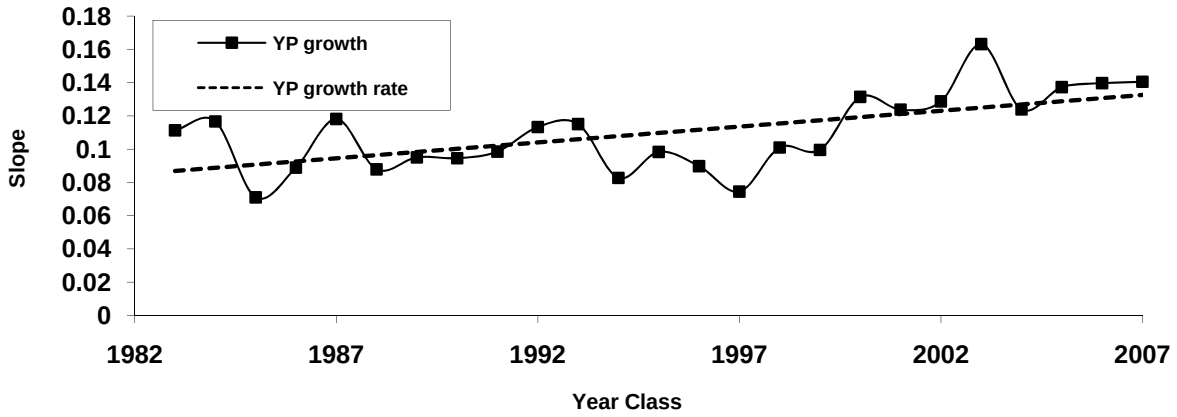

Figure 7. Yellow perch growth rates by year class using fish ages 2-7.

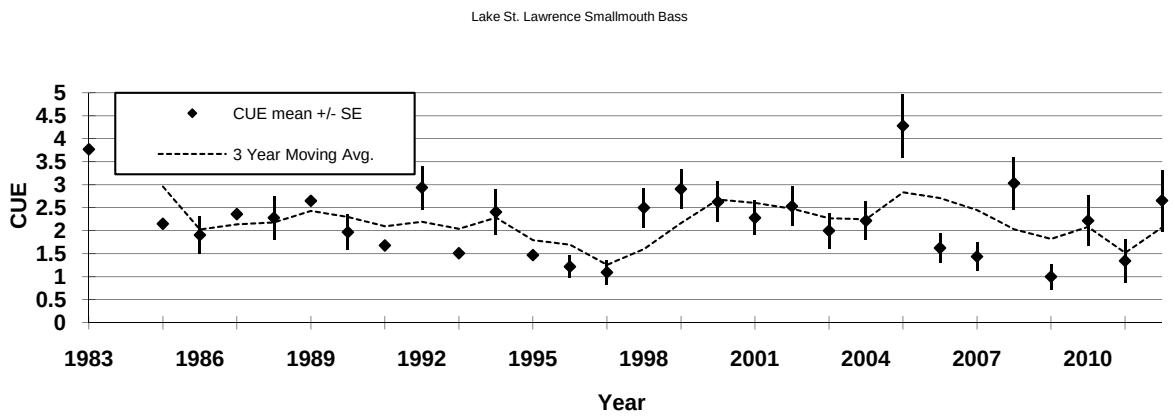

Figure 8. Total catch per gill net night (CUE) for smallmouth bass in Lake St. Lawrence, 1983-2012.

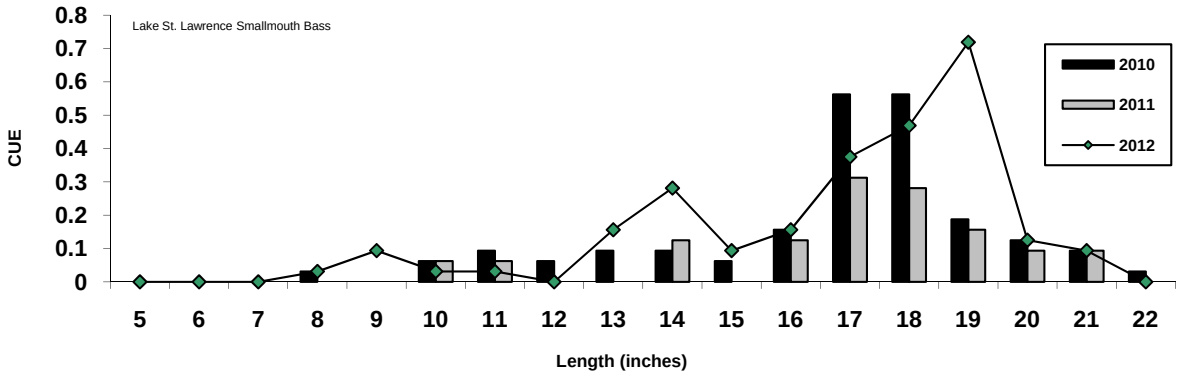

Figure 9. Smallmouth bass length-frequency distribution for Lake St. Lawrence.

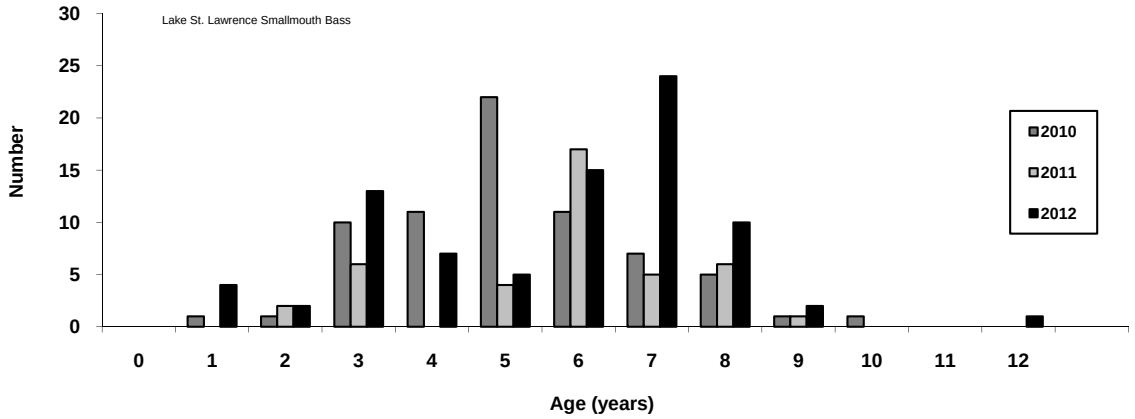

Figure 10. Smallmouth bass age-frequency distribution for Lake St. Lawrence.

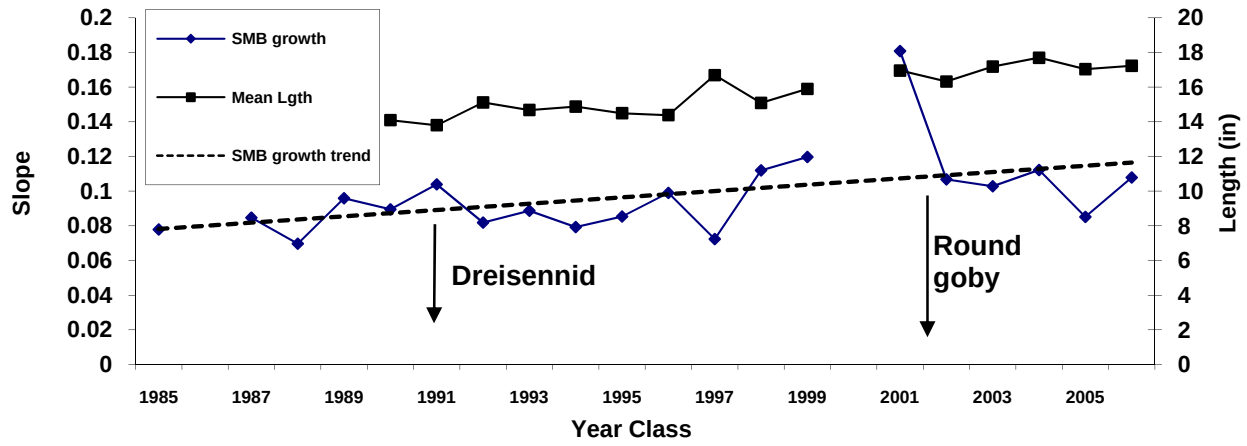

Figure 11. Smallmouth bass growth by year class described using two methods: growth rate (slope) using fish ages 3-7 and mean length (in) at age-6.

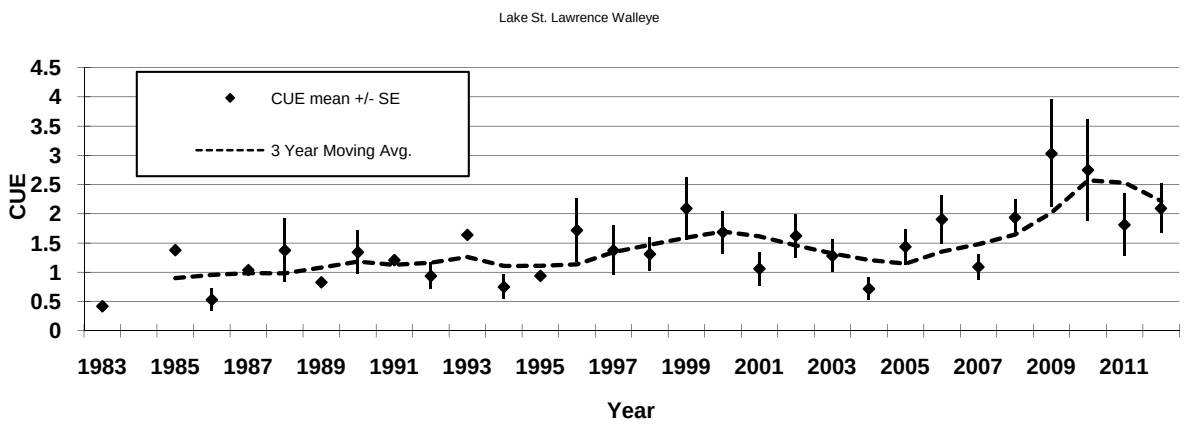

Figure 12. Total catch per gill net night (CUE) for walleye in Lake St. Lawrence, 1983-2012.

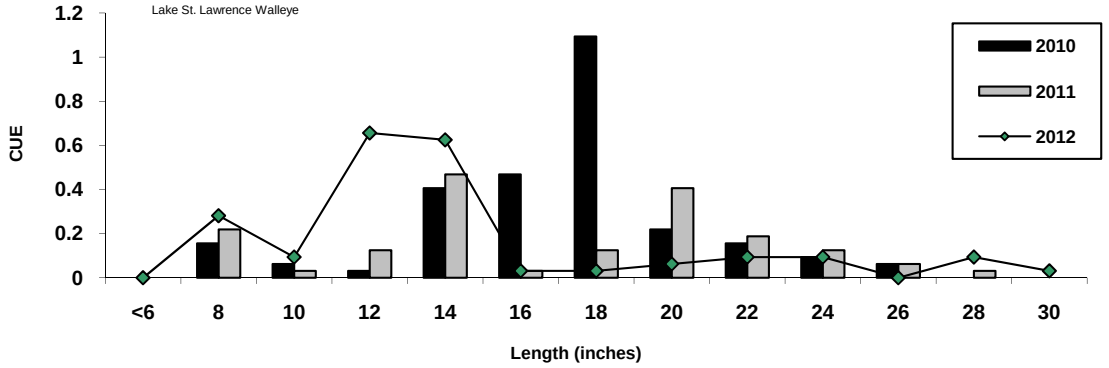

Figure 13. Walleye length-frequency distribution for Lake St. Lawrence.

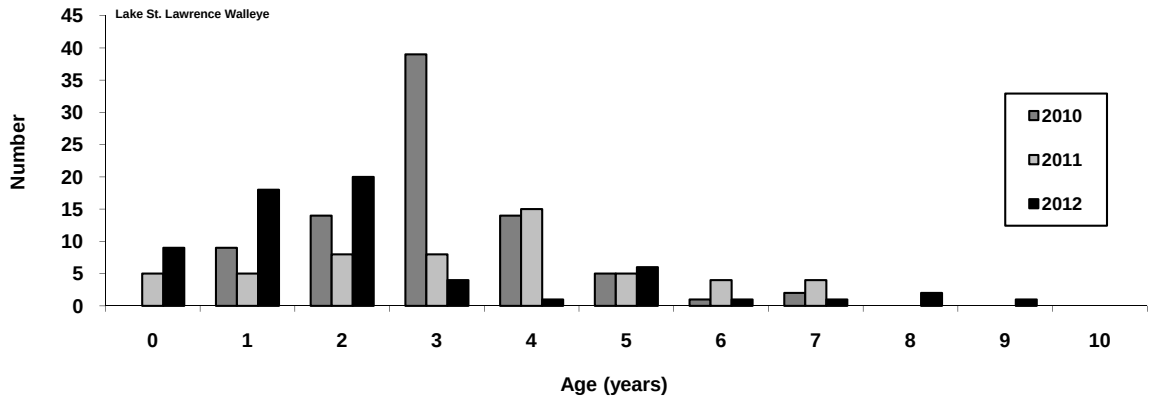

Figure 14. Walleye age-frequency distribution for Lake St. Lawrence.

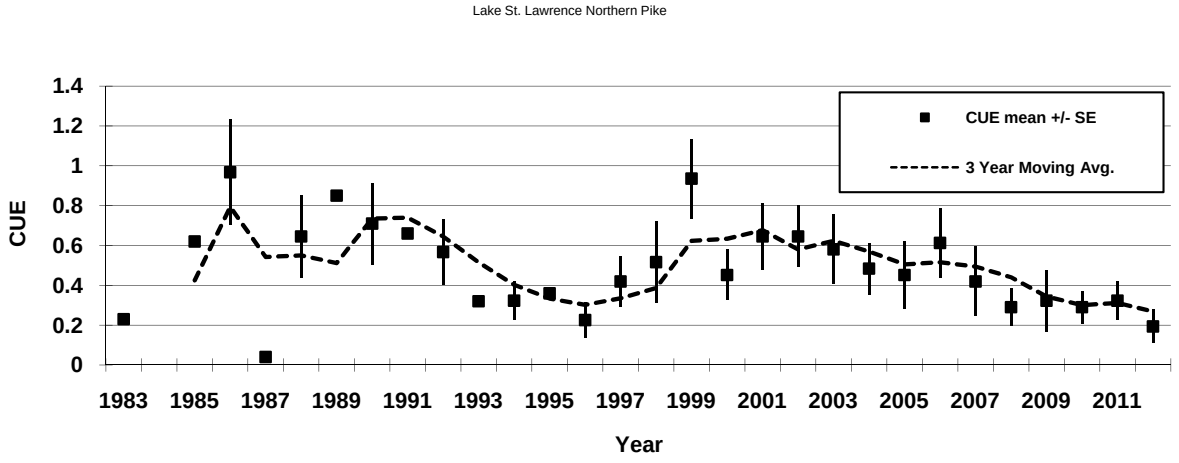

Figure 15. Total catch per gill net night (CUE) for northern pike in Lake St. Lawrence, 1983-2012.

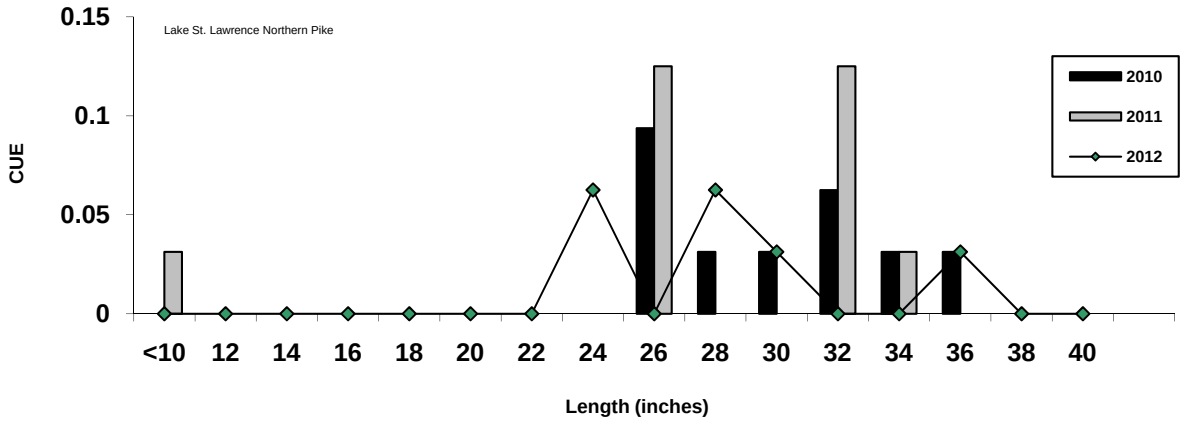

Figure 16. Northern pike length-frequency distribution for Lake St. Lawrence.

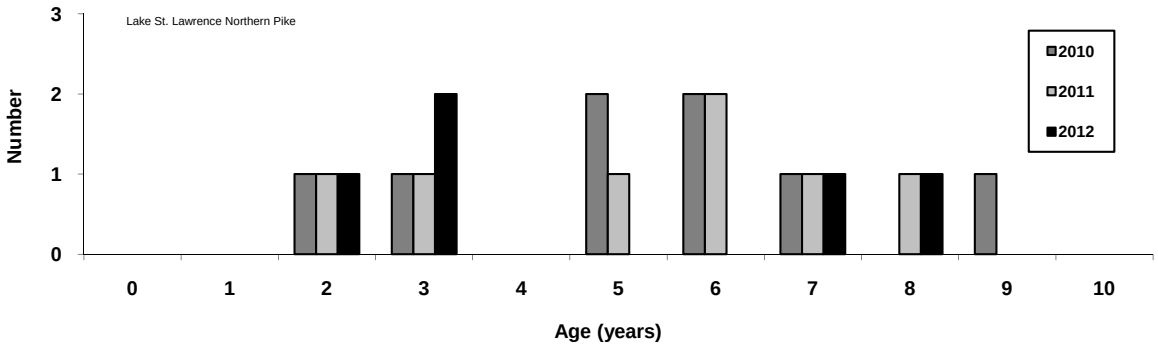

Figure 17. Northern pike age-frequency distribution for Lake St. Lawrence.

2012 Salmon River Wild Young-of-Year Chinook Salmon Seining Program

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A cooperative index seining program was initiated in the spring of 1999 by the U.S. Geological Survey (USGS) and the New York State Department of Environmental Conservation (NYSDEC) to assess spatial and temporal aspects of relative abundance, size structure, and distribution of wild young-of-year (YOY) Chinook salmon in the Salmon River, NY. The initial work in 1999 served as a pilot study to establish sampling techniques and sites. The 2000 and 2011 surveys were hampered by high flows that prevented sampling during peak Chinook salmon YOY emergence. The surveys conducted from 2001 through 2010 and 2012 were relatively seamless and provide consistent data for useful comparisons.

Methods

Weekly seine hauls were conducted at four sites (Altmar, Pineville, CO. RT. 2A, and Douglaston, Figure 1) from 3 May through 21 June. The bag seine was 20 feet wide by 6 feet deep with 1/8 inch bar mesh. Hauls were made by stretching the seine perpendicular to the current and sweeping toward one bank to a suitable landing area. A sample consisted of one seine haul per site. Obstacles on the river bottom and differences in the lengths of the hauls prevented the use of catches per unit of effort as precise density estimates but the range of numbers captured between sites and dates do provide a relative estimate of abundance. All species captured were counted and sub-samples of up to 30 Chinook salmon were measured (total length) for each haul.

We calculated “mean peak catches” for each year to provide an index of relative abundance, using the average number of YOY Chinook caught per haul for the three consecutive weeks with the highest catches in each year. High flows prevented sampling the third week of May in 2011, which was likely the peak period of abundance, so we used the average cathes of the second and fourth weeks in May to speculate that production was relatively high in 2011. Historical mean peak catches are presented in Figure 2.

Results and Discussion

Previous surveys indicated that high YOY Chinook production occurred in years following relatively high flows during the spawning period which is the previous October. In addition, fish appeared to leave the system more rapidly when flows were high in May resulting in lower catches. The prescribed baseflows for October and May are 335 cubic feet/second (cfs) and 185 cfs, respectively (FERC 1996).

Prior surveys suggested that high flows in October generally resulted in relatively high numbers of fish reaching the upper river to spawn increasing the numbers of YOY caught the following spring. High flows in May tended to increase YOY outmigration or decreased their vulnerability to our sampling gear resulting in lower catches. In 2012 we anticipated moderate catches based upon relatively low flow conditions in the fall of 2011 (mean = 324 cfs) and near average flows in May (614 cfs). What we observed, however, was a record high mean peak catch of 872 fish per haul during the last three weeks of May (Figures 2 - 4).

The 2012 results suggest that there are variables other than October and May flows influencing survey catches. The mild winter of 2011-12, with little snow and the lack of a single high flow event

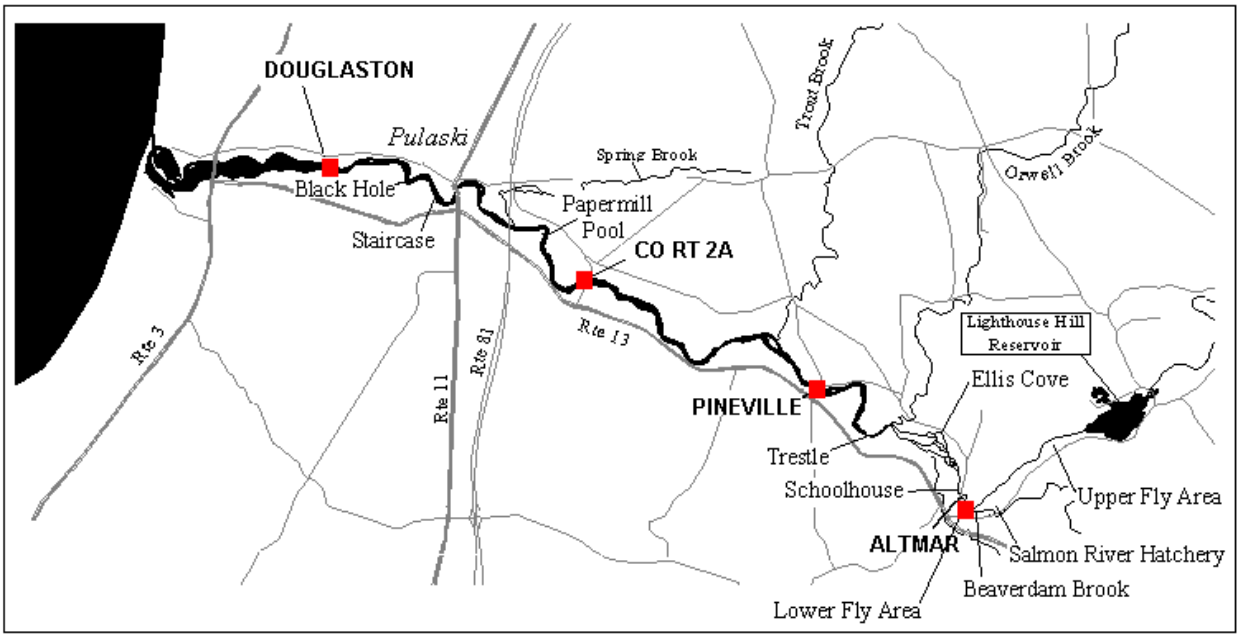

Figure 1. Sampling sites for the USGS/DEC Salmon River seining program.

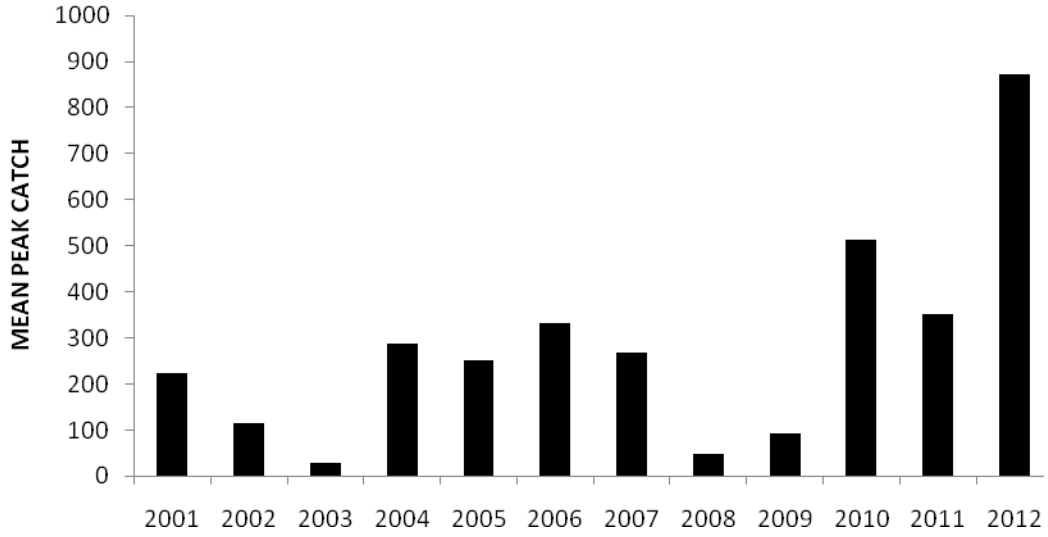

Figure 2. Mean peak catches of YOY Chinook salmon (mean number per seine haul) captured in the three consecutive weeks with the highest catches from the USGS/DEC Salmon River seining program 2001-2012.

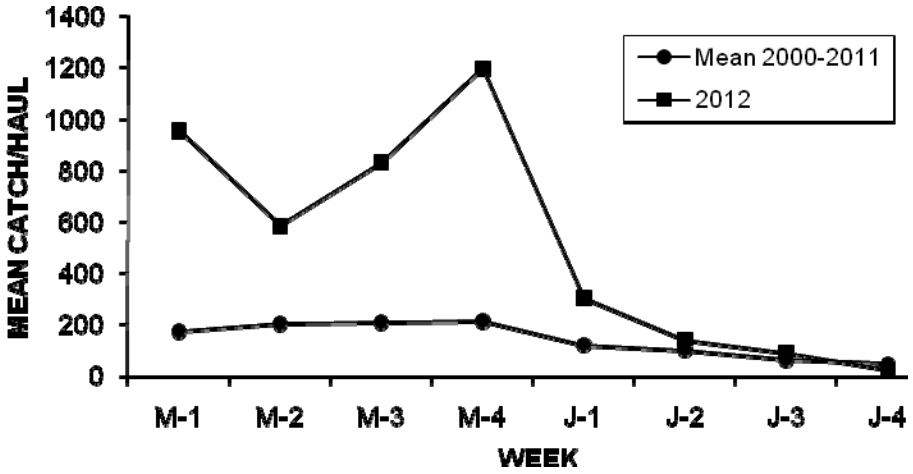

Figure 3. Mean numbers of YOY Chinook salmon captured per seine haul by week in the USGS/DEC Salmon River seining program for 2000-2011 and 2012 (M=May, J=June).

during the entire spawning and incubation period (October through May maximum of 1,764 cfs), provided conditions conducive to high redd survival and a prolonged hatch, resulting in high numbers of recently hatched fish in Altmar over a longer than normal time period (Figures 3 - 4).

We then examined maximum flow events from October to May as a predictor for our catches. The flow events, as measured by mean daily discharge at the Lighthouse Hill Reservoir (http://www.h2oline.com/365123.asp) were negatively correlated with mean peak catches and explained about two thirds of the variability in our catches ($r^2 = 0.66$, $p = 0.01$, Figure 5).

The mild winter may also have reduced the amount of anchor ice (another factor potentially limiting egg survival) in the Salmon River. However, in most winters anchor ice is seldom abundant above County Route 2A, which is the area of peak salmon spawning and fry production.

We are rapidly gaining an understanding of the role of naturally reproduced fish in the Lake Ontario and Salmon River systems. All of the Chinook stocked in the system from both New York and Ontario were marked with an adipose fin clip from 2008-2011. The marking study (See Connerton et al. 2013, section 3 of this report) provides a variety of information including the relative contribution of wild Chinook to the Lake Ontario and Salmon River systems. Returns to date have shown that wild fish comprise a substantial portion of the lake population and of the adult returns to the Salmon River. For example in 2012, 60% of age-2 and 50% of age-3 Chinook salmon in the Lake Ontario harvest were wild. In the Salmon River, 75% of age-2 and 60% of age-3 Chinook salmon harvested by anglers were wild. The proportions of wild age 2-3 Chinook salmon in other New York tributaries was low (4%-24%) suggesting that the Salmon River is the largest single source of wild Chinook production in New York. More research is needed to understand the cumulative contribution of all tributaries including the Province of Ontario where little information exists; however, mass marking results thus far

demonstrate that wild fish are an important component of the Lake Ontario sportfishery.

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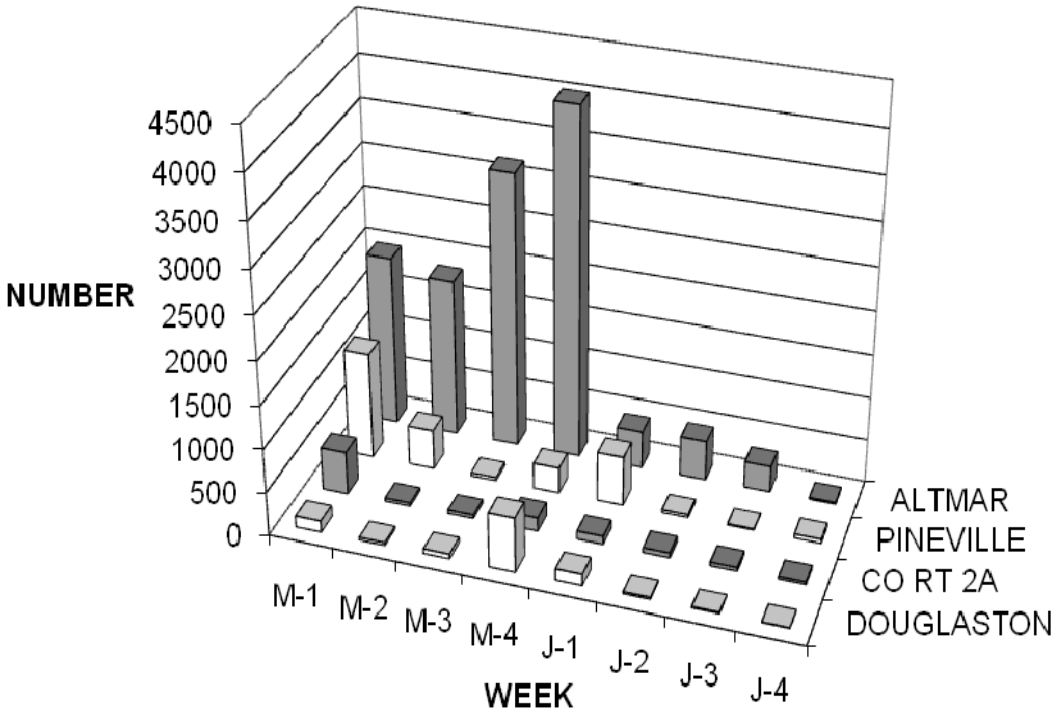

Figure 4. Numbers of YOY Chinook caught by week and site from the USGS/NYSCEC seining program 2012.

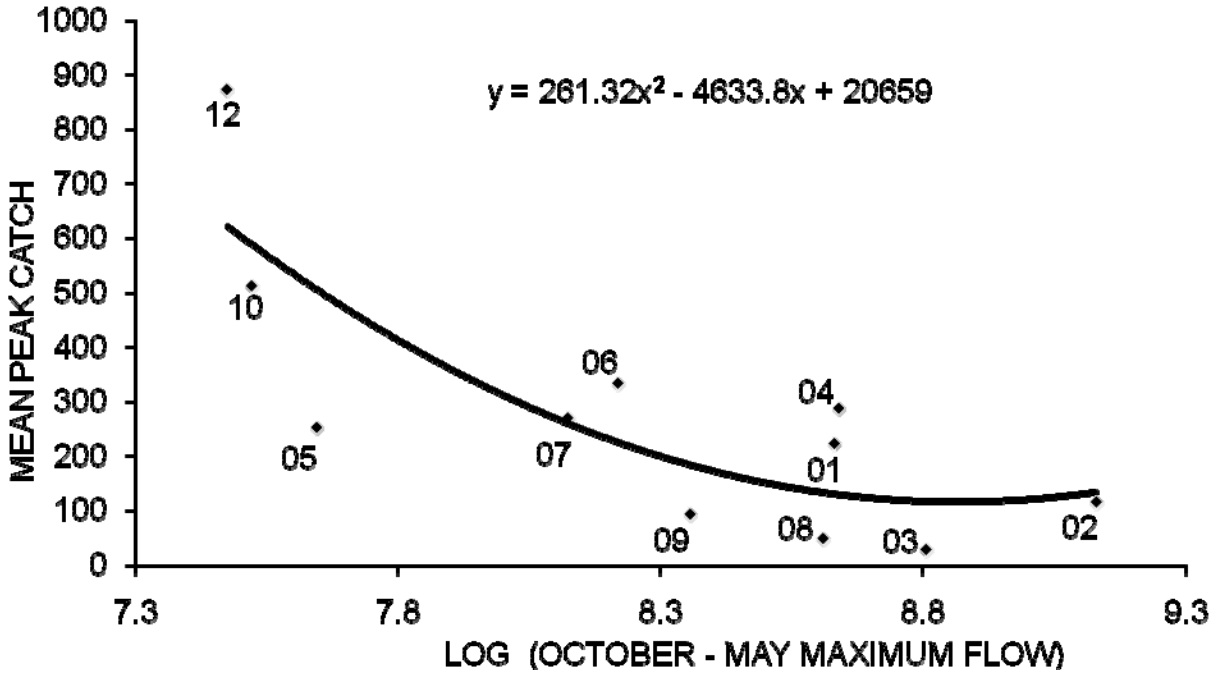

Figure 5. Maximum flow events, October through May, predicting mean peak catches of YOY Chinook salmon from the USGS/NYSCEC seining program 2001-2010 and 2012 (r^2 = 0.66, p = 0.01).

Population Characteristics of Pacific Salmonines Collected at the Salmon River Hatchery 2012

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Spawning populations of Lake Ontario Chinook and coho salmon (fall) and steelhead rainbow trout (spring) have been monitored annually since the mid-1980s at the NYS Department of Environmental Conservation's Salmon River Hatchery in Altmar, NY. This report documents the biological characteristics of these populations.

Methods

Hatchery Sampling

Staff at the Salmon River Hatchery processed 1,527 steelhead during the spring 2012 spawning operations (Nelson 2012a). Washington strain (Chamber's Creek) winter run fish comprised 96% (1,459) of the returns. Marked Skamania strain summer run fish (left pelvic) accounted for the remaining 4% (68).

A total of 2.3 million Washington strain steelhead eggs were taken from 662 females. The Skamania egg total was 102,100 from 26 females. Biological data were collected from 231 Washington strain steelhead.

Returns of Pacific salmon in the fall included 3,178 Chinook salmon (629 females) and 4,100 coho salmon. Biological data were collected at the hatchery from 574 Chinook salmon and 231 coho salmon. The egg totals were 2.75 million Chinook salmon from 597 females and 1.7 million coho salmon from 668 females (Nelson 2011b). An additional 579,000 Chinook salmon eggs were collected from the Black River.

All statistical analyses were done with PC-SAS rel. 8.0 (SAS Institute 1999). ANOVAs of all weight at age comparisons over a series of years were done with the SAS PROC GLM-Tukey's Studentized Range test multiple comparison procedure with the type I experiment-wise error rate set at $\alpha = 0.05$.

Results and Discussion

Chinook Salmon

Growth

The mean weight of age-1 Chinook males (jacks) sampled in 2012 was very near the long term average (Figure 1). Age 2 males were 0.4 pounds above average (13.9 lbs) with only three years being significantly heavier (1996, 1999, and 2000). Females were less than 0.1 pound below average (14.8 lbs), with only the 1995 fish being significantly heavier (17.3 lbs) (Figure 2). Age 3 males were 3.9 lbs below average (19.2 lbs) and 5.5 pounds less than 2011, yielding the second lowest value in the time series. Females were almost two pounds below average (19.3 lbs) and significantly lighter than fifteen other years in the time series. Mean lengths and weights at age for all species sampled in 2012 are provided in Table 1. A likely explanation for the smaller fish in 2012 is the low water levels experienced during the salmon run. The river was maintained at the summer base flow of 185 cubic feet per second (cfs) through the first half of October due to drought conditions. The prescribed base flow for this time period is 335 cfs. The water level was sufficient to draw fish into the river, but also allowed for effective sight fishing, likely resulting in selective harvest of larger fish. Disproportionate harvest of larger individuals may have biased and age/size distribution of fish reaching the hatchery.

Wet weight condition of large Chinook was measured by predicting the weight of a 36 inch fish from linear regressions on natural log transformed lengths and weights. The predicted weight was 16.7 pounds in 2012, which is also the historical average. This is the fifth consecutive year of at or above average condition, following seven consecutive years of below average condition (Figure 3).

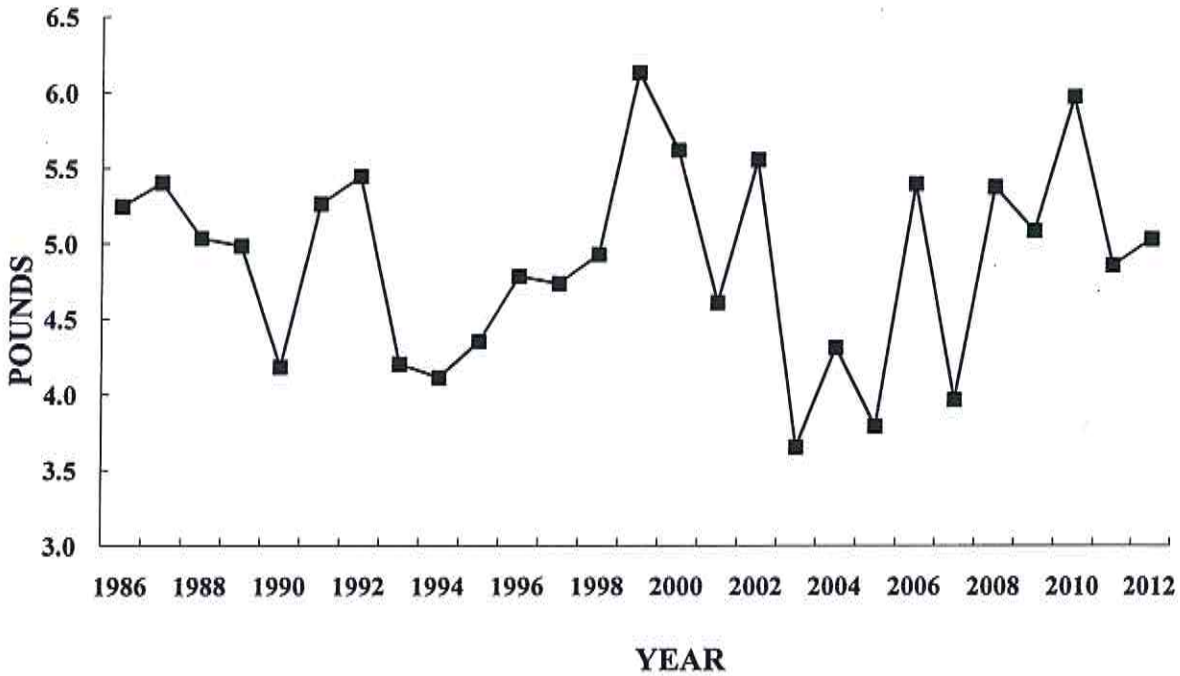

Figure 1. Mean weights of Chinook jacks at Salmon River Hatchery, 1986-2012.

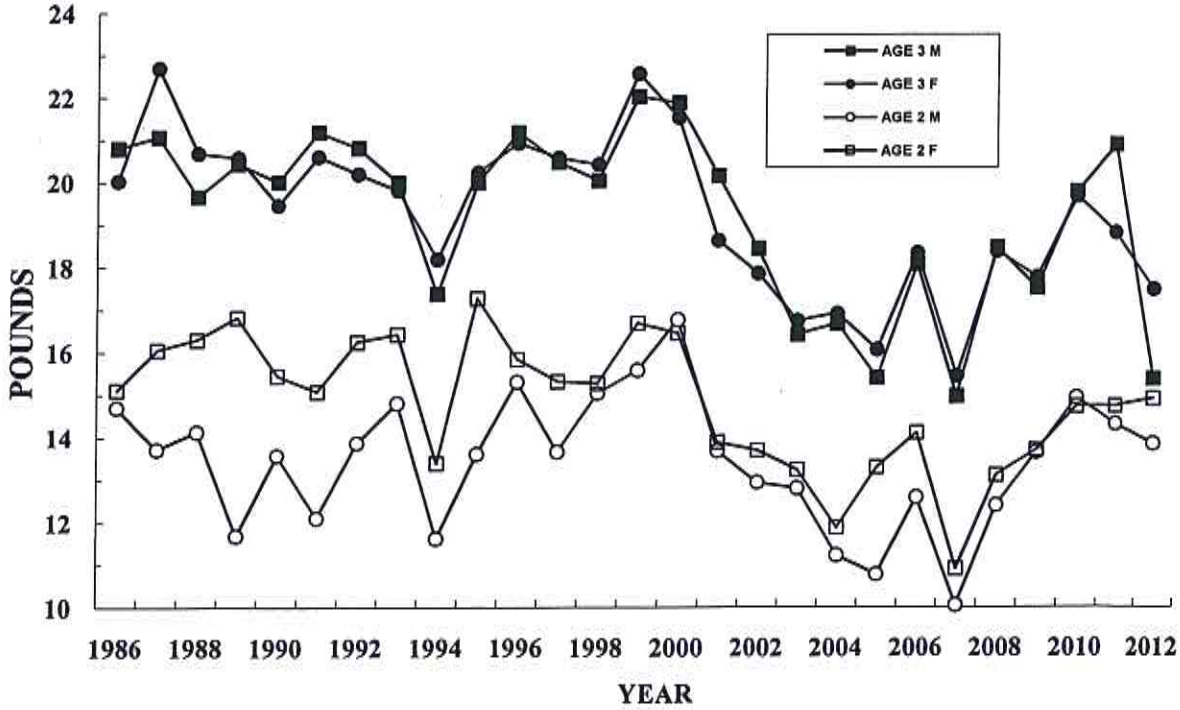

Figure 2. Mean weights of Chinook salmon ages 2-3 at Salmon River Hatchery, 1986-2012.

Table 1. Mean lengths and weights of Chinook salmon, coho salmon and Washington steelhead sampled at Salmon River Hatchery 2012 (STD= standard deviation).

AGE	SEX	N	MEAN LENGTH (in)	STD	MEAN WEIGHT (lbs)	STD
			CHINOOK SALMON			
1	M	129	23.8	1.5	5.0	1.0
2	M	231	33.9	2.3	13.9	2.8
2	F	104	33.8	1.5	14.9	2.1
3	M	43	35.5	3.3	15.4	3.9
3	F	61	36.0	2.3	17.5	3.2
			COHO SALMON			
1	M	21	14.0	2.0	1.0	0.5
2	M	98	28.3	2.2	7.7	1.9
2	F	112	28.1	1.7	8.4	1.6
			WASHINGTON STEELHEAD			
3	M	55	24.4	1.7	4.7	1.3
3	F	120	25.8	2.3	6.2	1.9
4	M	6	28.7	3.2	7.9	2.9
4	F	37	28.5	1.3	8.2	1.5
5	M	1	29.3	0.0	8.0	0.0
5	F	5	30.6	1.1	10.2	1.3

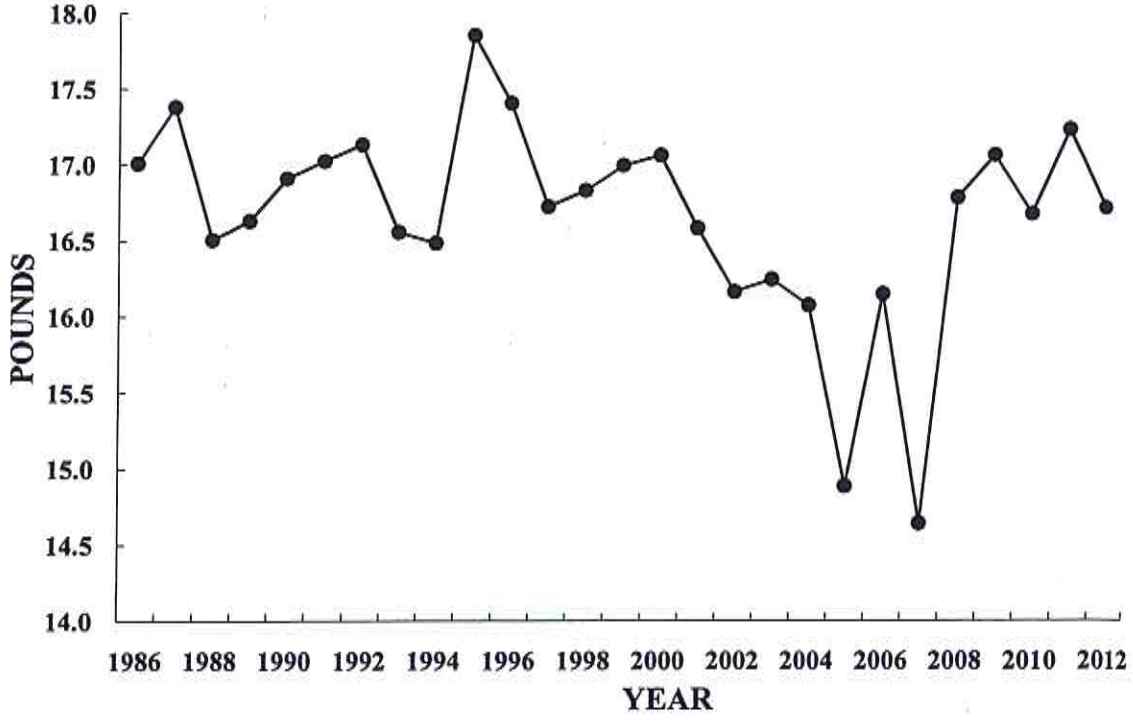

Figure 3. Estimated weights of a 36-inch Chinook salmon from the Salmon River Hatchery fall (October) collections 1986-2012.

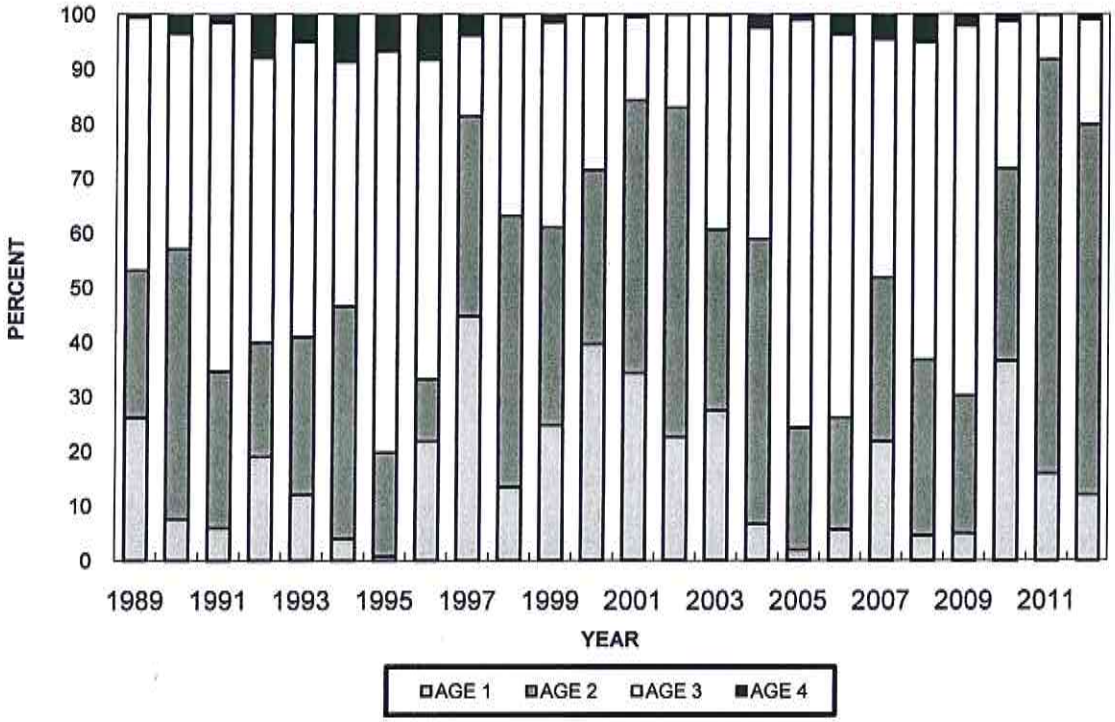

Figure 4. Estimated age structures of Chinook salmon runs at Salmon River Hatchery 1989-2012.

Age Structure

The estimated age structure of the 2012 Chinook salmon run to the Salmon River Hatchery was 12% age-1 males, 68% age-2, 19% age-3, and <1% age-4 (Figure 4). As in 2011, the age-3 fish, which are typically the highest percentage of the hatchery run, were overshadowed by the age-2 fish. This may have been due to a relatively small number of age-3 fish in the run or an atypically high number of age-2s. The low water levels in fall 2012 may have allowed and encouraged a higher level of "sight fishing". The selective removal of larger fish may have altered the age and size structure of the salmon that did make it to the hatchery.

Coho Salmon

Growth

The average weight of age-2 female coho salmon in 2012 (8.4 pounds) was approximately 0.1 pound less than 2011, but very near the long term average (8.6 lbs, Figure 5). Age-2 males (7.7 pounds) weighed 0.6 pounds less than those sampled in 2011 and 0.7 pounds less than the long term average (Figure 5). Males were not significantly heavier than those sampled in 17 of the 25 years in the time series, including 2011. Females were not significantly heavier than fish sampled in 14 of 25 years, including 2011.

Washington Steelhead

Growth

Steelhead are sampled in the spring and, unlike Chinook and coho salmon, do not reflect growth during the 2012 growing season. Weights reported here reflect conditions prior to and including 2011. The mean weights of age-3 males and females were 4.7 and 6.2 lbs, respectively; 1.0 and 0.5 lbs lighter than 2011 (approximately 1.0 and <0.1 pound less than their respective long-term averages). The mean weights of age-4 males and females were 7.9 lbs and 8.2 lbs, respectively, with males 0.9 lbs lighter than their long-term average, and females at the long-term average. Only age-3 females in 2001 were significantly heavier than those in 2012(8.7 lbs.). Age 3 males were not significantly heavier than any year in the time Series, and weighed significantly less than 17 of the 25 years. Age 4 fish of both sexes were in the lightest Tukey grouping in the multiple range test (Figure 6).

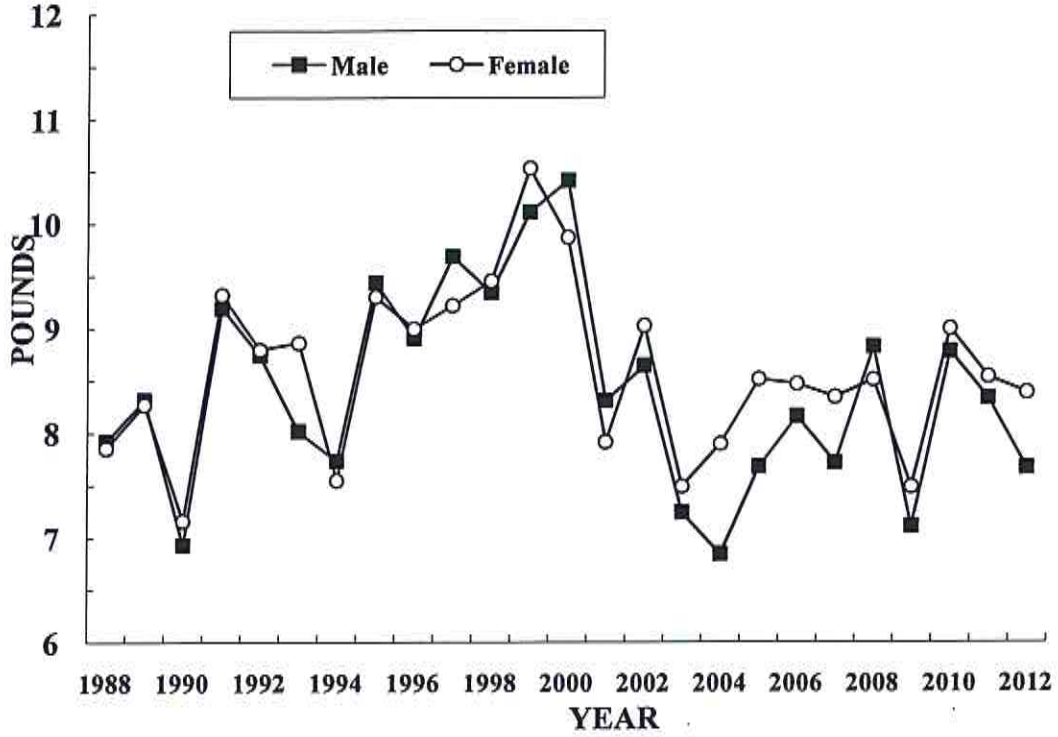

Figure 5. Mean weights of age-2 coho salmon at Salmon River Hatchery, 1988-2012.

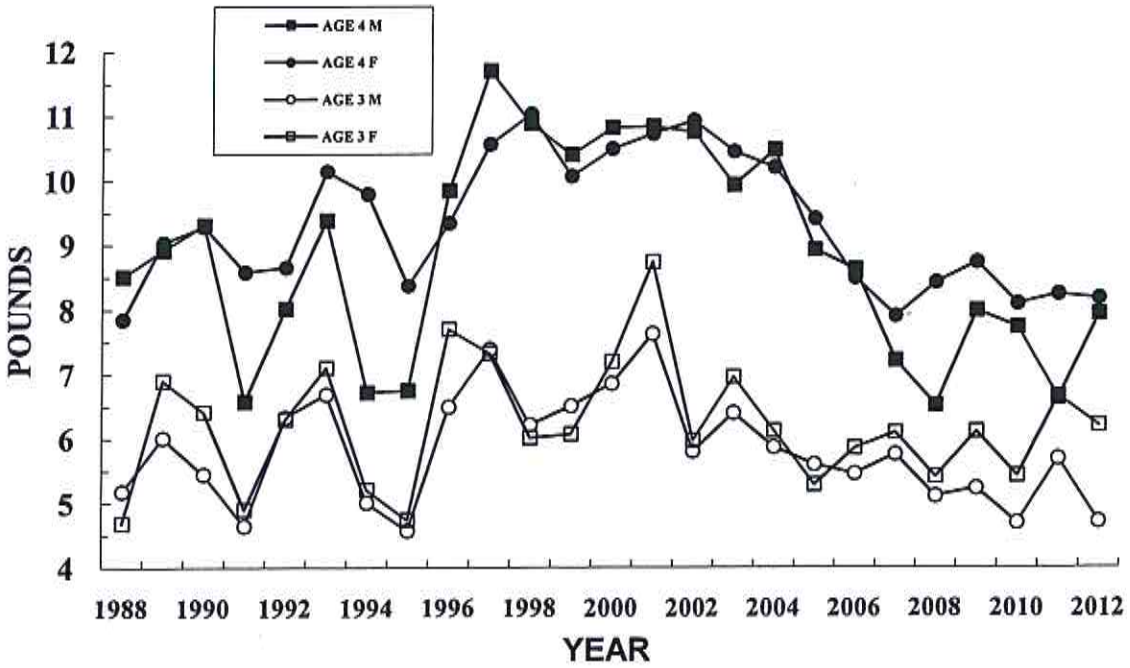

Figure 6. Mean weights of Washington steelhead ages 3-4 at Salmon River Hatchery, 1988-2012.

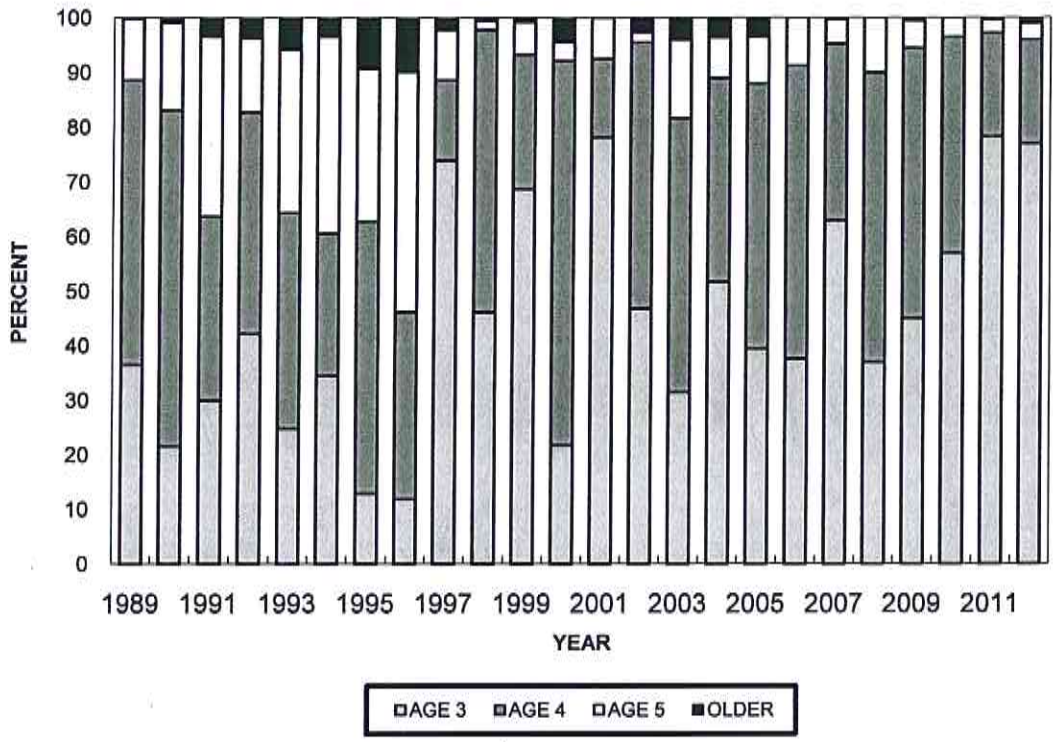

Figure 7. Age structures of Washington steelhead samples at Salmon River Hatchery, 1989-2012.

Age Structure

Similar to age structures observed in recent years, age-3 and age-4 steelhead dominated the run again in 2012 (Figure 7). As in 2011, the 2012 age-3 fish comprised a noticeably higher proportion of the run compared to the previous 10 years. The age structure of the fish sampled was 77% age-3, 19% age-4, 3% age-5, and 0.9% age-6.

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2012 New York Cooperative Trout and Salmon Pen-Rearing Projects

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In 1998, concerns over post-stocking survival and imprinting of steelhead (*Onchorynchus mykiss*) and Chinook salmon (*O. tshawytscha*) to stocking sites led to the formation of several cooperative sportsmen's groups interested in pen rearing (Bishop and Pearsall 1999). Concerns from the eastern basin of Lake Ontario centered on predation of stocked steelhead trout by cormorants. Western basin concerns included the apparent lack of imprinting and subsequent impaired homing of Chinook salmon and steelhead to the stocking streams.

After the successful completion of pen-rearing projects at Oswego Harbor and Oak Orchard Creek in 1998, a number of other sportsmen's groups expressed interest in pen-rearing. New sites were added in 1999 including the Lower Niagara River, Sandy Creek, Genesee River and Sodus Bay. No additional sites were added until 2003, when a new pen project for Skamania steelhead was initiated at the Little Salmon River. In 2005, a Chinook salmon pen-rearing project was initiated at Olcott Harbor on Eighteenmile Creek, and steelhead were added there in 2006. Also in 2006, a steelhead -rearing project was initiated at Wilson Harbor on East Branch Twelvemile Creek. In 2009, a new pen site was added at Anchor Resort and Marina on Little Sodus Bay where both steelhead and Chinook salmon were reared. In 2010, Chinook salmon were raised at the Sandy Creek pen project site for the first time since 2002. Steelhead pen-rearing at Little Salmon River resumed in 2011 after a one-year hiatus; however, Washington strain steelhead were reared instead of Skamania strain. Additionally, Washington strain steelhead were reared at Little Salmon River pen site in 2012. This report summarizes pen-rearing activities and results for 2012, the fifteenth year of pen projects along the New York shoreline of Lake Ontario.

Methods

Pen rearing was conducted at ten different sites along New York's coastline of Lake Ontario in 2012. The project sites, along with a description of site locations and project sponsors, are listed from east to west in Table 1.

All sites used similar pen materials, design and netting as described for the 1998 Oak Orchard Creek Project in Bishop and Pearsall (1999). Standard operating procedures for stocking, maintaining, feeding, and releasing penned salmon and trout were developed and refined by NYSDEC (Wilkinson 1999, Sanderson 2006). Rearing methods have remained very similar at most sites from year to year, with the exception of the lower Niagara River where in 2004 conventional floating pens were switched to two larger fixed pens located within a bulkheaded boat slip (Wilkinson et al. 2005). Additional information about methods used at pen sites in 2012 is provided in Table 2.

Water temperature monitoring was done mostly using hand-held and digital thermometers, with manual recording of observations. Frequency of temperature measurements is provided in Table 2. Dissolved oxygen was measured at the Lower Niagara River site using a YSI 55 Dissolved

Oxygen Meter. Water temperature and dissolved oxygen measurements are provided in Table 3.

During 2010 and 2011, all eight Chinook salmon rearing sites were part of a planned three-year marking study to assess the performance of pen-reared and direct-stocked salmon in the open lake and tributaries. The third and final year of marking for this project was scheduled for 2012; however, salmon-rearing procedures at the hatchery in 2012 were not consistent with the previous two years. Therefore, to avoid compromising the experiment, the tagging study was postponed for a year allowing the 2013 pen-reared fish to be reared in a manner similar to that in 2010 and 2011.

Observed mortalities for all projects were based on the number of dead fish collected from the pens during captivity and from the bottom of the pens after release. Both sources of mortality were noted by cooperators, except where listed otherwise. Mortality does not include fish lost to cannibalism or from predators that may have gained access to pens.

Results and Discussion

A total of 83,300 Washington strain steelhead were raised at nine pen sites, comprising 15% of NYSDEC's Lake Ontario steelhead stocking allotment in 2012. Observed mortalities at the steelhead rearing sites ranged from 0 to 0.46%. One location did not report steelhead mortalities. Results for all steelhead pen projects are summarized in Table 4.

Eight pen-rearing sites raised a total of 497,970 Chinook salmon fingerlings, representing 33% of NYSDEC's 2012 Chinook salmon stocking allotment. At sites where salmon were penned, observed mortalities ranged from 0 to 0.15%. One pen location did not report Chinook salmon mortalities. Results for all Chinook salmon pen projects are provided in Table 4.

At two Chinook salmon pen locations, Olcott Harbor and Sandy Creek, there were reported exceedances of the water temperature thresholds (65°F) established for pen projects, (Table 3). Chinook salmon were stocked into pens approximately two weeks later than steelhead; April 18-27 for salmon and April 5-12 for steelhead, thus salmon were more likely to be subjected to warming waters than were steelhead

Summary results for individual projects are presented below, arranged by site location from east to west.

Little Salmon River

Washington strain steelhead for the Little Salmon River project were placed in a pen on 5April at 26 fish per lb. The steelhead were released 22 days later at a weight of 14 fish per lb, and only three mortalities were observed.

Oswego Harbor

Steelhead were delivered to three pens in Oswego Harbor on 6 April. The steelhead initially weighed 26 fish per lb, and when released on 5 May, weighed 16 fish per lb. Only three steelhead mortalities were reported.

Chinook salmon were delivered to the pen site weighing 129 fish per lb on 26 April. Salmon were released on 9 May and weighed 106 fish per lb. During the project, netting on one Chinook pen was compromised resulting in salmon escapement prior to sampling for weight.

Little Sodus Bay

At Little Sodus Bay**,** steelhead weighing 26 fish per lb were delivered to pens on 5 April. Steelhead were released on 26 April weighing 14 fish per lb. Pens were towed to the bay outlet for fish release.

Chinook salmon were delivered to the pen site on 18 April. Salmon weighed 120 fish per lb when delivered and weighed 84 fish per lb when released on 9 May. Salmon pens were towed to the bay outlet for fish release.

Sodus Bay

Chinook salmon grew from 130 fish per lb to 64 fish per lb with an average total length of 3.7 in after 22 days.

Genesee River

Steelhead were held for 22 days and released on 1 May weighing 19 fish per lb, compared to a delivery weight of 26 fish per lb. Steelhead had an average length of 5.6 in at release.

Chinook salmon were delivered to Shumway

Marina at a weight of 130 fish per lb on 20 April. They were held in pens for 27 days and released on 17 May weighing 72 fish per lb. Average total length of salmon was 3.5 in.

Sandy Creek

Steelhead were delivered at a weight of 26 fish per lb on 9 April. They were held in the pens for 22 days and released on 1 May weighing 14 fish per lb. Steelhead had an average total length of 5.3 in.

Chinook salmon were delivered at a weight of 130 fish per lb on 20 April. They were held in pens for 14 days and released on 4 May weighing 113 fish per lb, with an average total length of 3.1 in.

Oak Orchard Creek

Steelhead were held in pens from 10 to 24 April. Steelhead final weight and length were not measured. The pens were towed to the lake for fish release

Chinook salmon were delivered at a weight of 129 fish per lb on 25 April. They were held for 22 days and released on 17 May weighing 74 fish per lb with an average total length of 3.5 in. Salmon pens were towed to the lake to release fish.

Olcott Harbor

Steelhead were released on 3 May after 22 days in the pen. Initial weight of steelhead was 25 fish per lb, and final weight was 17 fish per lb. Fish were released at the pen site.

Chinook salmon were delivered at a weight of 129 fish per lb on 26 April. When the fish were released on 15 May, after 19 days in the pens, final weight was 65 fish per lb. Water temperatures ranged from 46 to 66°F during the project. The 66°F water temperature on 15 May caused the Chinook salmon to be released several days earlier than normal due to exceeding temperature guidelines.

Wilson Harbor

Steelhead were delivered to the Wilson Boatyard Marina on 11 April and were released on 2 May after 21 days in the pens. Steelhead weighed 12 fish per lb when released at the pen site. Water temperature data were monitored every 2-3 days for the project.

Lower Niagara River

The lower Niagara River pen site is typically last to receive its fish due to slowly warming river water temperatures. In 2012, steelhead were delivered into a single large pen on 12 April and weighed about 22 fish per lb initially. Steelhead were released 27 days later on 9 May at the pen site. Weight of released steelhead was not measured. Water temperature was approximately 51°F at time of release.

Chinook salmon were loaded into a single large pen on 27 April weighing 129 fish per lb. Salmon were released 27 days later on 24 May weighing 55 fish per lb.

Conclusions

Of the nine locations where steelhead were penned, target weights (12-15 fish per lb) were reached at four sites in 2012. Final steelhead weights were not available for two of the nine sites, however it is believed that steelhead likely achieved target weight at these two sites.

Chinook target weights (90 fish per lb) were exceeded at six of eight sites. At the six successful sites, it is likely that a large percentage of the penned salmon imprinted to water at their respective pen sites, increasing the likelihood that salmon will return as spawning adults to their respective pen site tributaries.

The fifteenth year of pen-rearing steelhead and Chinook salmon along the New York shoreline of Lake Ontario was successful due to low fish mortality, substantial percentages of steelhead and Chinook salmon reaching target weights, and the goodwill generated through partnerships in the projects.

Acknowledgments

We wish to express our very sincere appreciation to the many individuals, businesses, municipalities and organizations that made these pen projects possible. Their dedicated efforts demonstrate a deep commitment to the Lake Ontario sportfishery and provide a management technique that would not be available without their valuable help.

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Table 1. Description of 2012 Lake Ontario pen project locations and sponsors.

Pen Site	Location	Project Sponsors
Little Salmon River	Salmon Country Marina	Salmon Country Marina
Oswego Harbor	Oswego Marina	Oswego Harbor Charter Captains Oswego Marina
Little Sodus Bay	Anchor Resort and Marina	Anchor Resort and Marina Jim Jared
Sodus Bay	Sodus Bay near First Creek	Arney's Marina Ethan Irwin Lake Ontario Charter Boat Association Prime Time Storage Wayne County Tourism Wayne County Pro-Am
Genesee River	Shumway Marina	Genesee Charter Association Greater Rochester Sportfishing Association Irondequoit Bay Fish and Game Club Shumway Marina
Sandy Creek	Sandy Creek Marina	Boy Scouts Genesee Charter Association Sandy Creek Marina Sandy Creek Shoot - Out Fishing Tournament S.U.N.Y. at Brockport
Oak Orchard Creek	Lake Breeze Marina	Lake Breeze Marina Oak Orchard Pen-Rearing Association Orleans County Department of Tourism
Olcott Harbor	Town of Newfane Marina and adjacent private docks	Lake Ontario Trout and Salmon Association Slippery Sinker Bait and Tackle Town of Newfane (including Town Marina)
Wilson Harbor	Wilson Boatyard Marina	Central Niagara County Rotary Niagara Cerebral Palsy Association Sevenson Environmental Town of Wilson Wilson Boat House Restaurant Wilson Boatyard Marina
Lower Niagara River	Constitution Park, Youngstown	Fox Fence Company Niagara River Anglers Association Village of Youngstown

Table 2. Methods used at 2012 Lake Ontario pen project sites.

Pen Site	Pen Stocking Method	Feeding Frequency (times per day)	Manual Water Temperature Measurement (times per day)	Pen Cleaning Frequency	Fish Release Method
Little Salmon River	Hydraulic transfer	5	1	4 times	Pen towed to river mouth for fish release
Oswego Harbor	Hydraulic transfer	4-5	0-4	2 times	Fish released at pen site
Little Sodus Bay	Hydraulic transfer	5	0-4	0 times	Pens towed to bay outlet for fish release
Sodus Bay	Hydraulic transfer	5	5	as needed	Pens towed to lake for fish release, pens inverted
Genesee River	Hydraulic transfer	5	daily	weekly	Fish released at pen site.
Sandy Creek	Hydraulic transfer	6	6	as needed	Pens towed to mouth of creek Cable ties cut to release fish.
Oak Orchard Creek	Hydraulic transfer	5	1	every three days	Pens towed to lake. Cable ties cut to release fish
Olcott Harbor	Hydraulic transfer	5	5	every three days	Fish released at pen site
Wilson Harbor	Hydraulic transfer	5	every 2-3 days	eight times	Fish released at pen site
Lower Niagara River	Hydraulic transfer	5	5	not available	Fish released at pen site

Table 3. Water temperature and dissolved oxygen measurements at 2012 Lake Ontario pen project sites.

Pen Site	Minimum Water Temperature (^{o}F)	Maximum Water Temperature (^{o}F)	Inside Pen Dissolved Oxygen (ppm)
Chinook salmon pen sites			
Genesee River	na	na	---
Little Sodus Bay	48[A]	57[A]	---
Lower Niagara River	na	na	9.02 to 10.66[B]
Oak Orchard Creek	48	63	---
Olcott Harbor	46	66	---
Oswego Harbor	49[A]	59[A]	---
Sandy Creek	45[A]	68[A]	---
Sodus Bay	42[A]	59[A]	---
Steelhead pen sites			
Genesee River	na	na	---
Little Salmon River	39[A]	53[A]	---
Little Sodus Bay	48[A]	55[A]	---
Lower Niagara River	42.0	49.3	9.08 to 9.59[B]
Oak Orchard Creek	48	56	---
Olcott Harbor	44	59	10.74, 11.68[C]
Oswego Harbor	49[A]	57[A]	---
Sandy Creek	45[A]	64[A]	--
Wilson Harbor	45	57	9.25, 8.49[D]

[A] – Measured with hand-held thermometer
[B] – Measured on 18 May 2012
[C] – Measured on 24 and 25 April, respectively
[D] – Measured on 24 and 28 April, respectively

Table 4. Results of 2012 Lake Ontario trout and salmon pen-rearing projects.

Pen Site	Species	Number Stocked	Number of pens	Date Stocked	Size at Stocking (#/ Lb)	Date Released (Days Held)	Size at Release (#/ Lb)	Mortality (# Fish)	Mortality (%)
Genesee	Chinook	85,250	4	20-Apr	130	17 May (27)	72	72	0.084
Little Sodus	Chinook	25,000	1	18-Apr	120	9 May (21)	84	A	A
Lower Niagara	Chinook	75,000	1	27-Apr	129	24 May (27)	55	na	na
Oak Orchard	Chinook	106,560	5	25-Apr	129	17 May (22)	74	109	0.10
Olcott	Chinook	67,100	3	26-Apr	129	15 May (19)	65	36	0.054
Oswego	Chinook	34,060	2	26-Apr	129	9 May (13)	106	50	0.15
Sandy Creek	Chinook	55,000	2	20-Apr	130	4 May (14)	113	69	0.13
Sodus	Chinook	50,000	2	23-Apr	130	15 May (22)	64	15	0.030
Genesee	steelhead	10,000	2	9-Apr	26	1 May (22)	19	35	0.35
Little Salmon	steelhead	5,000	1	5-Apr	26	27 April (22)	14	3	0.06
Little Sodus	steelhead	6,000	1	5-Apr	26	26 April (21)	14	A	A
Lower Niagara	steelhead	10,000	1	12-Apr	22	9 May (27)	na	na	na
Oak Orchard	steelhead	14,000	3	10-Apr	25	24 April (14)	na	39	0.28
Olcott	steelhead	3,500	1	11-Apr	25	3 May (22)	17	16	0.46
Oswego	steelhead	20,000	3	6-Apr	26	5 May (29)	16	3	0.2
Sandy Creek	steelhead	7,300	1	9-Apr	26	1 May (22)	14	2	0.03
Wilson	steelhead	7,500	2	11-Apr	25	2 May (21)	12	6	0.08

na – not available
[A] – no mortalities observed

Lake Ontario Tributary Creel Survey
Fall 2011 – Spring 2012

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Introduction

Angler surveys of all the major Lake Ontario tributaries in New York were conducted in 2005-2006 and 2006-2007 (Prindle and Bishop 2007). The purpose of these surveys was to provide baseline information for a longer-term data set consisting of periodic surveys to monitor trends in the Lake Ontario tributary fishery. The most recent survey was conducted in 2011-2012. Prior to the 2005 study, the last comprehensive tributary survey was the 1984 New York State Great Lakes Angler Survey (NYSDEC 1984). Creel surveys of varying duration and purpose were also conducted on the Salmon River in 1989 (Connelly et al. 1989), 1992 (Bishop 1993), and 1997 through 2004 (Bishop 1998-2004, Bishop and Penney-Sabia 2005). The 1989 survey covered the fall fishery, through the salmon and early steelhead runs. The 1992 survey captured the salmon run, but ended on November 1st, missing most of the fall steelhead fishery. The 1997-2003 surveys were conducted from mid-October through the last weekend in November to examine the fall steelhead angling seasons. The 2004 survey ran from the day after Labor Day through the last weekend in November, to cover the fall salmon and steelhead fisheries. Several creel surveys have also been conducted on other eastern Lake Ontario tributaries since 1982 (McCullough 2003).

On the Salmon River, this study ran from 1 September 2011 through 16 May 2012, while the previous survey periods were 5 September 2005 through 15 May 2006, and 9 September 2006 through 16 May 2007. Surveys on the remaining tributaries covered 15 September 2011 through 29 April 2012, 19 September 2005 through 25 April 2006, and 15 September 2006 through 25 April 2007. We plan to repeat this survey every third year hereafter.

Methods

Data Collection

Four agents surveyed 21 Lake Ontario tributaries (Figure 1) in 2011-2012. This is a reduction from the five agents and 29 streams surveyed in the baseline studies. We made these changes to eliminate 9 low use tributaries surveyed during the initial surveys, add the lower Niagara River and reduce the number of agents required to carry out the surveys.

We used an instantaneous access site survey design on the Salmon River that duplicated the surveys conducted in 2004 and 2005-07. We used an instantaneous roving design on the other tributaries. Counts (numbers of anglers, vehicles and/or boats) and interviews were conducted for each tributary.

We estimated effort (numbers of angler hours and angler trips), catch and harvest (total numbers), and catch and harvest rates (fish per angler hour) for each species in each tributary. For interviews, we recorded site, date, interview time, residency, angler party size, start time, time taken for breaks, trip status (complete versus incomplete), species targeted, fish kept and released, weather effects, and any relevant comments made by the angler or survey agent. The proportion of non-NYS resident anglers was calculated individually for "high use" tributaries and collectively for groups of tributaries assigned to "medium use" and "low use" categories based on levels of estimated effort.

A detailed description of the statistical analyses used in this report is provided in Appendix 1. All statistical analyses were conducted with SAS release 8.0 (SAS Institute 1999).

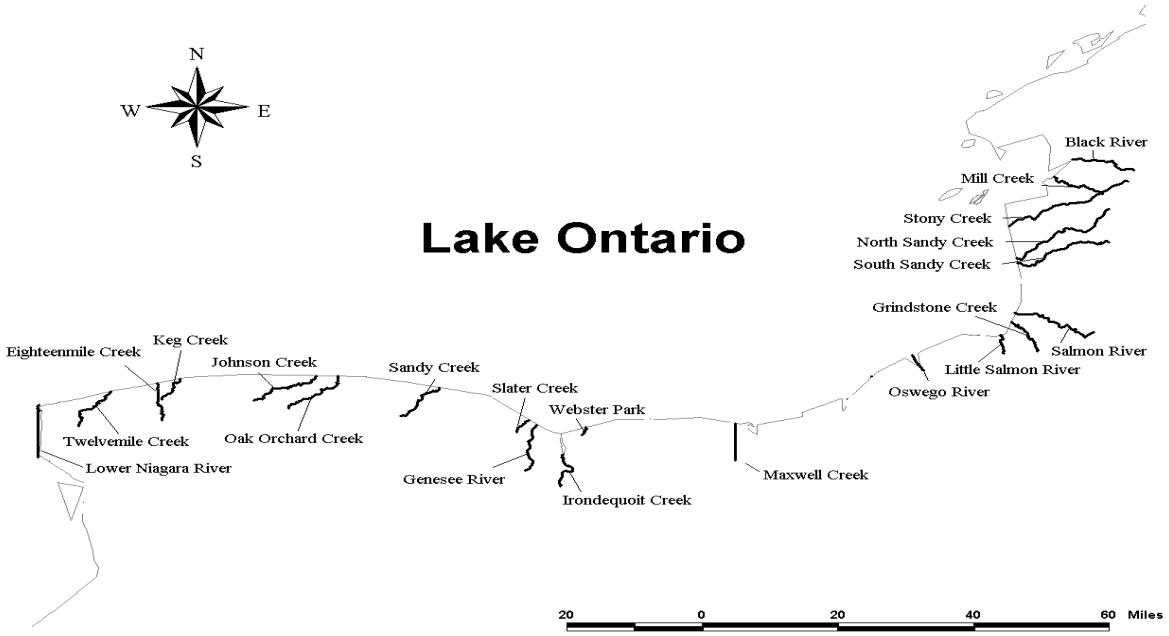

Figure 1. Lake Ontario tributary creel survey streams for 2011-2012.

Salmon River

On the Salmon River, the agent sampled three randomly selected weekdays and one weekend day each week. A staggered shift was used to cover the morning counts and interviews, the afternoon shift continued until ½ hour after sunset. Twenty-five sites were sampled for vehicle, angler, boat (or boat trailer) counts, and angler interviews.

Counts were done twice each day during the early part of the survey when days were longer and once daily as day length shortened. Angler counts were necessary in the Village of Pulaski and in the estuary because angler's vehicles were not confined to designated parking areas. Angler counts were also done in the lower fly-fishing area in Altmar because anglers used various parking lots for both conventional shore fishing and the special regulations catch and release fly-fishing area. Boat counts were done in the estuary.

On the Salmon River, interviews were obtained at angler access parking areas. Angler interviews were done later in the day to question anglers that had fished for several hours. Consequently, there were a high proportion of completed trip interviews. Interviews consisted of a series of questions posed to angler parties (a party is all of the anglers associated with a vehicle, boat, or drift boat) returning to access sites after fishing. Time spent interviewing anglers at individual sites was at the discretion of the agents and was roughly proportional to activity at the sites.

Effort and interview data were stratified by week and the interview data were also stratified by fishing type (conventional regulations shore access, drift boat, special regulations catch and release fly fishing, tributary, and estuary boat) to estimate

angler effort, catch, and harvest of trout and salmon. We used the ratio of means catch/harvest estimator on all Salmon River interviews because of the high proportion of complete trips and incomplete trips where anglers had fished for several hours (Lockwood 1999).

Non-Salmon River Tributaries

The non-Salmon River tributaries were sampled on three randomly selected weekdays each week, including all holidays, and each weekend day. Each agent was responsible for two routes that consisted of sites on three or more adjacent tributaries. Each route was surveyed every other sampling day. The sampling day was defined from ½ hour after sunrise to ½ hour after sunset and was divided into eight hour AM or PM shifts. One shift was randomly selected for each sampling day.

Instantaneous counts of anglers and/or vehicles were done at a randomly selected time within a shift for that route. Vehicle counts were used for sites where anglers were not readily visible. To estimate the number of anglers, vehicle counts were multiplied by the mean angler party size obtained from the interview data for that tributary. Boats were counted on the Black, Niagara, and Oswego rivers. Boat counts were multiplied by the mean boat party size specific to that river to estimate the number of boat anglers. Estimates of boat anglers were added to estimates (or actual counts) of shore anglers to estimate the total number of anglers present on that day.

Time not spent conducting the instantaneous count during a shift was used to interview anglers. Interviews from anglers who had been fishing for at least ½ hour were used in the analyses. Interviews were obtained from both parking areas and streamside, resulting in a mixture of completed and incomplete trip interviews. Effort data were stratified by month (with October split into two strata) and day-type (weekend or weekday). Interview data used in calculating catch and harvest rates were stratified by month. We used the ratio of means estimator for complete trip interviews and a mean of ratios estimator on incomplete trip interviews to estimate catch and harvest rates. These values were then combined to obtain a single weighted estimate (Appendix 1).

Results and Discussion

Angler Effort

Total estimated effort for all tributaries in 2011-2012 was 1,582,428 angler hours, which was an increase from 999,182 and 910,413 angler hours the 2005-06 and 2006-07 surveys, respectively (Table 1). The Salmon River accounted for 68% of the total with 1,077,316 angler hours, compared to 59% and 64% of the effort in 2005-06 and 2006-07, respectively.

Note that estimates for angler trips presented in Table 1 are not proportional to the estimates of angler hours. This is because angler trips were estimated by dividing the estimates of angler hours by the mean lengths of completed trips for each tributary (from the interview data), and trips on the Salmon River were much longer on average. Total estimated angler trips for all 21 tributaries in 2011-12 was 409,211, which was up from 216,811 and 244,836 in 2005-06 and 2006-07, respectively (Table 1). This compares to 276,000 trips reported in 1984 (NYSDEC 1984).

The Salmon River accounted for 39% of the total trips, similar to the 44% and 34% in reported in 05-06 and 06-07, respectively. Eighteenmile Creek in Niagara County also accounted for a large share of the effort (14%; 58,271 trips) in 2011-2012 (Table 1).

Table 1. Total estimated number of angler hours, angler trips, and mean trip length on Lake Ontario tributaries by year.

	2005-06			2006-07			2011-12		
Tributary	Hours	Trip Length	Trips	Hours	Trip Length	Trips	Hours	Trip Length	Trips
Salmon River	**605,772**	**6.1**	**98,959**	**595,267**	**6.8**	**87,539**	**1,077,316**	**6.8**	**158,214**
18 Mile Creek	87,471	4.0	21,743	72,000	2.0	35,477	119,222	2.0	58,271
Oswego River	70,078	4.2	16,834	48,789	2.5	19,707	59,091	1.9	30,993
South Sandy Creek	26,944	3.9	6,880	22,961	1.8	12,940	56,150	1.8	31,185
Oak Orchard Creek	69,941	3.6	19,581	49,029	2.0	24,278	55,738	2.1	26,149
Maxwell Creek	17,685	3.6	4,925	24,331	1.9	13,075	44,032	1.7	25,452
Niagara River	***	***	***	***	***	***	41,567	5.1	8,096
Black River	21,136	3.1	6,723	13,985	2.6	5,294	32,047	2.4	13,477
Sandy Creek	15,818	3.9	4,105	16,454	2.0	8,295	21,878	1.6	14,051
Irondequoit Creek	14,227	2.4	6,018	13,587	1.5	9,308	17,912	1.6	11,263
North Sandy Creek	18,744	2.6	7,126	7,515	1.6	4,734	14,216	1.5	9,589
Genesee River	21,596	4.3	5,040	14,815	2.4	6,065	11,677	1.9	6,121
Johnson Creek	5,553	4.1	1,347	9,413	1.9	4,954	7,620	1.8	4,202
Mill Creek	3,783	2.9	1,309	1,061	4.0	266	6,467	NA	NA
12 Mile Creek	7,386	0.7	10,387	3,949	3.4	1,159	5,692	2.7	2,137
Little Salmon River	4,930	3.5	1,410	4,799	1.0	4,598	5,129	1.8	2,901
Stony Creek	1,959	4.2	463	1,568	0.9	1,659	2,875	0.6	4,792
Webster Park	2,852	1.5	1,963	4,752	1.4	3,369	2,137	1.2	1,714
Grindstone Creek	2,070	1.4	1,455	1,759	1.7	1,046	1,379	2.3	604
Keg Creek	1,238	2.3	544	4,381	4.1	1,074	283	NA	NA
Slater Creek	13,569	2.7	5,016	7,228	1.7	4,260	86	NA	NA
Catfish Creek	3,886	3.3	1,181	1,942	0.9	2,164	***	***	***
Little Sandy Creek	2,808	1.9	1,504	3,232	1.9	1,696	***	***	***
Sterling Creek	2,223	4.1	540	1,866	4.5	414	***	***	***
Bear Creek	1,631	1.7	964	1,875	0.8	2,430	***	***	***
Ninemile Creek	1,127	3.4	327	3,785	1.7	2,239	***	***	***
Skinner Creek	923	2.5	375	1,075	4.0	267	***	***	***
Marsh Creek	604	3.0	201	1,238	2.2	563	***	***	***
Lindsey Creek	41	3.0	14	334	2.2	152	***	***	***
Fourmile Creek	***	***	***	171	2.2	78	***	***	***
Totals	**999,182**		**216,811**	**910,413**		**244,836**	**1,582,428**		**409,211**

NA = Insufficient interview data on trip lengths, *** = Stream not surveyed

October accounted for the highest monthly effort for all the non-Salmon River tributaries in 2011-2012, with an estimated 203,735 angler hours, followed by November (110,913) and September (45,619) (Table 2). This translated to 40% of the total effort occurring in October compared to 46 % in 2005-2006, 39% in 2006-2007, and 33% in 1984 (NYSDEC 1984). Peak effort on the Salmon River occurred in September and October. A more detailed seasonal breakdown of angler effort on the Salmon River is provided in Table 3.

The estimated number of angler trips on the Salmon River during the fall season (Sept. to Nov.) was 112,109, compared to 75,985 and 83,409 in 2005-2006 and 2006-2007, respectively (Table 4). Flow levels (Figure 2) were markedly higher for much of the 2005 and 2006 fall salmon seasons (Sept. through Nov.). This may have negatively affected the number of angler trips in those years due to more difficult fishing conditions. Additionally, rapidly rising gasoline prices during the fall of 2005 and 2006 likely contributed to lower effort in those years.

The proportion of Salmon River trips that occurred during the fall season in 2011-2012 was 71% (112,109), consistent with the 1984 (76%, 107,306 trips), and 2005-2006 (77%, 75,985 trips) surveys (Table 4). In 2006-2007, however, 95% (83,409 trips) of the trips occurred in the fall season.

The majority of trips on the Salmon River (129,351 trips – 82%) in 2011-2012 engaged in shore access fishing in the conventional regulations portion of the river, compared to 76 and 74% in the previous studies, respectively (Table 5). The special regulations fly-fishing areas accounted for about 10% of the overall effort in all three of the recent studies (Table 5).

The trend in Salmon River fishing effort over time appears similar to that observed in the open lake boat fishery (Eckert 2006), with a peak in the late 1980s and early 1990s (Table 4). Observed declines from peak effort were of similar magnitude (approximately 50%) for both the tributary and open lake fisheries. Salmon River angler effort, however, returned to an historic, high level in 2011-2012. Estimates for the tributary fishery (September through April/mid-May) were 1,582,428 angler hours in 2011-2012 compared to 999,182 and 910,413 in 2005-2006 and 2006-2007 surveys, respectively (Table 1). Tributary angling effort greatly exceeded open Lake Ontario boat angling effort in 2011 (898,339 angler hours; Lantry and Eckert 2012). Salmon River angling effort alone exceeded the boat fishery by nearly 179,000 angler hours.

The estimate of 409,211 tributary angler trips in 2011-2012 (Table 1) was more than twice the estimated open lake boat trips in 2011 (171,519) (Lantry and Eckert 2012). In 2005-2006 the number of tributary angling trips was very similar to the number of 2005 open lake angler trips. In 2006-2007, the tributary estimate was 244,836 angler trips, approximately 72,000 more angler trips than the 2006 boat fishery.

Interviews

A total of 8,953 interviews were obtained during 2011-2012, up from 6,225 and 6,516 in 2005-2006 and 2006-2007, respectively (Table 6). On the Salmon River, angler parties associated with a specific vehicle or boat were interviewed, and accounted for 49% of all interviews. Interviews from the other tributaries were obtained from individual anglers. Eight tributaries had over 200 interviews completed (Table 6). Slater Creek was the only tributary that did not produce a single interview in 2011-2012, likely due to cessation of power generation at the site, which had produced a warmwater discharge that had attracted large numbers of fish and anglers.

Table 2. Estimated number of angler hours, angler trips on Lake Ontario tributaries by month and year.

	September						October					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
Tributary	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips
12 Mile Creek	548	201	742	575	1,245	----	1,178	326	965	561	407	----
18 Mile Creek	1,416	756	11,820	5,766	5,104	3,980	29,000	7,274	29,140	13,186	59,740	27,419
4 Mile Creek	***	***	40	----	***	***	****	****	131	----	***	***
Bear Creek	351	280	32	----	***	***	213	59	490	300	***	***
Black River	2,491	911	3,637	1,749	2,135	----	12,875	1,756	7,209	2,704	19,494	6,601
Catfish Creek	0	0	151	76	***	***	2,896	824	965	425	***	***
Genesee River	1,840	466	3,632	3,632	4,309	2,086	8,831	1,866	6,093	3,605	4,764	2,208
Grindstone Creek	40	15	153	76	79	----	1,305	921	696	407	579	----
Irondequoit Creek	434	185	677	594	426	----	1,054	591	907	682	2,669	1,795
Johnson Creek	350	90	1,291	676	242	----	2,901	613	3,403	1,526	4,901	3,128
Keg Creek	0	0	63	----	0	0	0	0	1,087	544	0	0
Lindsey Creek	0	0	0	0	***	***	41	11	0	0	***	***
Little Salmon River	0	0	628	251	148	69	4,251	1,027	2,526	856	3,737	2,074
Little Sandy Creek	278	149	378	275	***	***	1,472	1,282	1,438	848	***	***
Marsh Creek	0	0	0	0	***	***	73	20	1,162	----	***	***
Maxwell Creek	78	52	836	444	38	----	3,587	2,609	5,126	2,465	8,151	2,946
Mill Creek	127	46	0	0	0	0	2,645	710	378	----	3,968	----
Niagara River	***	***	***	***	3,717	713	***	***	***	***	9,558	1,625
Ninemile Creek	0	0	0	0	***	***	112	31	1,924	789	***	***
North Sandy Creek	501	177	520	533	290	----	13,750	5,063	3,484	1,350	5,568	8,017
Oak Orchard Creek	1,866	537	9,625	4,695	1,787	1,521	38,450	9,041	24,452	10,361	20,737	6,936
Oswego River	10,778	2,355	21,186	8,180	19,640	14,771	40,170	9,092	19,798	7,279	18,799	9,124
Salmon River	**183,019**	**30,503**	**171,265**	**25,186**	**261,838**	**38,453**	**212,213**	**35,369**	**251,031**	**36,916**	**339,017**	**49,790**
Sandy Creek	83	30	531	531	0	0	5,520	1,216	1,042	489	6,172	4,708
Skinner Creek	0	0	78	----	***	***	375	104	155	----	***	***
Slater Creek	80	160	389	389	0	0	2,548	1,019	2,590	1,850	86	----
South Sandy Creek	2,380	499	3,254	2065	6,158	----	16,992	5,061	14,551	7,960	33,917	18,558
Sterling Creek	0	0	0	0	***	***	1,251	198	1,073	436	***	***
Stony Creek	94	34	623	----	301	----	516	106	200	----	67	----
Webster Park	77	28	163	123	0	0	453	349	919	585	423	----
Totals	**206,830**	**37,476**	**231,713**	**53,220**	**307,457**	**61,594**	**404,674**	**86,537**	**382,937**	**96,125**	**542,752**	**144,928**

---- = Insufficient interview data on trip lengths, ***= Creek not sampled

Table 2 cont. Estimated number of angler hours, angler trips on Lake Ontario tributaries by month and year.

	November						December					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
Tributary	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips
12 Mile Creek	497	150	493	288	677	----	63	21	247	----	199	89
18 Mile Creek	37,689	6,989	23,453	10,424	32,668	14,647	4,549	899	4,219	2,402	8,192	9,071
4 Mile Creek	***	***	0	0	***	***	****	****	0	0	***	***
Bear Creek	468	216	190	87	***	***	0	0	20	----	***	***
Black River	2,082	628	1,326	255	3,132	1,833	145	50	320	124	161	42
Catfish Creek	798	319	503	151	***	***	0	0	124	----	***	***
Genesee River	3,333	814	482	482	880	860	643	124	1,059	460	93	----
Grindstone Creek	341	103	572	260	158	47	0	0	46	----	0	0
Irondequoit Creek	731	418	1,214	971	1,483	872	225	225	591	586	1,288	1,041
Johnson Creek	927	415	2,448	1,149	1,094	----	121	----	690	----	471	----
Keg Creek	346	104	762	318	0	0	32	25	489	----	0	0
Lindsey Creek	0	0	0	0	***	***	0	0	0	0	***	***
Little Salmon River	83	25	209	----	90	----	0	0	171	114	35	----
Little Sandy Creek	36	12	152	----	***	***	56	23	72	289	***	***
Marsh Creek	0	0	76	----	***	***	0	0	0	0	***	***
Maxwell Creek	5,469	1,054	7,221	3,099	11,761	10,629	1,165	373	2,935	1,640	5,377	2,671
Mill Creek	656	605	258	265	184	----	0	0	0	0	25	----
Niagara River	***	***	***	***	11,781	2,879	***	***	***	***	3,447	843
Ninemile Creek	870	176	646	394	***	***	0	0	179	105	***	***
North Sandy Creek	2,539	826	1,682	1,150	2,631	1,710	270	64	939	845	2,578	1,726
Oak Orchard Creek	21,538	6,522	10,241	5,020	18,278	----	993	415	2,130	1,653	5,366	3,211
Oswego River	9,449	2,988	3,327	1,592	11,042	3,116	1,452	422	1,648	881	2,502	1,022
Salmon River	**61,418**	**10,236**	**44,752**	**6,581**	**145,522**	**21,372**	**23,220**	**3,870**	**36,783**	**5,409**	**59,603**	**8,754**
Sandy Creek	6,409	1,568	2,569	1,359	9,737	6,141	342	105	617	258	2,143	765
Skinner Creek	45	13	0	0	***	***	0	0	147	----	***	***
Slater Creek	2,656	892	1,440	935	0	0	999	277	369	243	0	0
South Sandy Creek	2,137	529	2,944	1,472	4,312	2,754	294	196	1,001	----	2,719	1,887
Sterling Creek	678	130	336	117	***	***	0	0	0	0	***	***
Stony Creek	165	50	96	165	180	----	0	0	150	295	173	----
Webster Park	921	625	1,642	821	825	686	129	83	380	200	437	582
Totals	**162,283**	**36,408**	**109,035**	**37,355**	**256,435**	**67,547**	**34,700**	**7,172**	**55,327**	**15,505**	**94,808**	**31,704**

---- = Insufficient interview data on trip lengths, *** = Creek not sampled

Table 2 cont. Estimated number of angler hours, angler trips on Lake Ontario tributaries by month and year.

	January						February					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
Tributary	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips
12 Mile Creek	225	82	144	----	189	50	0	0	0	0	213	----
18 Mile Creek	3,254	1,308	164	----	3250	1,662	3,255	974	95	----	3,104	2,641
4 Mile Creek	***	***	0	0	***	***	***	***	0	0	***	***
Bear Creek	125	45	0	0	***	***	55	37	0	0	***	***
Black River	203	160	225	2	860	----	108	53	80	----	393	----
Catfish Creek	103	38	0	0	***	***	0	0	0	0	***	***
Genesee River	50	66	48	24	87	44	452	108	1,748	692	73	43
Grindstone Creek	50	18	23	----	0	0	0	0	0	0	0	0
Irondequoit Creek	882	302	245	119	714	354	465	140	273	----	2,190	829
Johnson Creek	373	78	337	----	228	99	65	26	65	----	286	----
Keg Creek	179	57	0	0	50	----	170	67	0	0	0	0
Lindsey Creek	0	0	46	----	***	***	0	0	0	0	***	***
Little Salmon River	25	9	0	0	0	0	0	0	188	----	0	0
Little Sandy Creek	33	11	296	----	***	***	0	0	98	----	***	***
Marsh Creek	199	72	0	0	***	***	0	0	0	0	***	***
Maxwell Creek	1,172	341	1,388	632	2784	1,146	1,048	1,048	0	0	6,705	2,728
Mill Creek	48	24	18	----	0	0	0	0	0	0	0	0
Niagara River	***	***	***	***	3017	1,469	***	***	***	***	1,247	213
Ninemile Creek	52	19	55	----			0	0	0	0	***	***
North Sandy Creek	493	307	393	262	340	----	482	191	0	0	1,009	----
Oak Orchard Creek	3,245	818	513	----	1180	493	1,019	319	65	----	1,776	1,087
Oswego River	1,146	291	742	311	1734	----	675	218	203	----	1,593	749
Salmon River	**19,682**	**3,280**	**18,598**	**2,735**	**38,760**	**5,692**	**12,158**	**2,026**	**7,399**	**1,088**	**52,498**	**7,710**
Sandy Creek	508	161	84	----	614	245	303	88	0	0	1,075	450
Skinner Creek	33	12	132	----	***	***	0	0	0	0	***	***
Slater Creek	1,157	335	869	745	0	0	902	580	318	----	0	0
South Sandy Creek	382	459	183	183	547	----	52	20	0	0	1,454	635
Sterling Creek	0	0	0	0	***	***	0	0	0	0	***	***
Stony Creek	0	0	0	----	33	----	110	44	0	0	0	0
Webster Park	135	41	151	130	0	0	101	101	28	----	205	75
Totals	**33,755**	**8,334**	**24,654**	**5,143**	**54,386**	**11,253**	**21,420**	**6,039**	**10,559**	**1,780**	**73,820**	**17,159**

---- = Insufficient interview data on trip lengths, **** = Creek not sampled

Table 2 cont. Estimated number of angler hours, angler trips on Lake Ontario tributaries by month and year.

	March						April					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
Tributary	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips	Hours	Trips
12 Mile Creek	1,641	2,051	0	0	1,397	----	3,234	6,063	1,358	----	1,365	1,050
18 Mile Creek	6,311	1,681	0	0	4,017	1,678	8,943	2,257	3,408	----	3,104	980
4 Mile Creek	***	***	0	0	***	***	****	****	0	0	***	***
Bear Creek	94	38	228	----	***	***	325	217	914	----	***	***
Black River	929	348	684	363	3,414	----	2,303	762	503	251	2,458	1,542
Catfish Creek	47	19	113	----	***	***	249	101	86	----	***	***
Genesee River	2,276	653	883	409	347	197	4,171	1,361	869	----	1,124	----
Grindstone Creek	59	24	0	0	442	204	151	106	271	----	121	----
Irondequoit Creek	1,592	935	1,221	1,039	1,811	1,622	8,856	3,242	8,459	5,372	7,331	4,924
Johnson Creek	208	83	57	----	399	182	606	247	1,122	----	0	0
Keg Creek	252	71	0	0	0	0	258	190	1,980	----	234	----
Lindsey Creek	0	0	0	0	***	***	0	0	289	----	***	***
Little Salmon River	136	55	259	----	385	385	376	215	521	----	735	----
Little Sandy Creek	343	183	271	167	***	***	589	240	608	209	***	***
Marsh Creek	242	98	0	0	***	***	0	0	0	0	***	***
Maxwell Creek	3,760	1,384	2,789	1,077	8,179	4,424	1,007	289	4,036	1,666	1,037	571
Mill Creek	0		0	0	1,628	----	307	283	407	70	662	----
Niagara River	***	***	***	***	3,677	800	***	***	***	***	5,122	1,600
Ninemile Creek	94	99	0	0	***	***	0	0	981	----	***	***
North Sandy Creek	621	242	183	53	1,388	592	1,201	667	314	292	411	658
Oak Orchard Creek	3,328	1,044	0	0	4,273	1,706	2,872	850	1,740	2,319	2,343	567
Oswego River	3,508	1,031	1,314	791	2,680	1,709	2,889	853	571	317	1,101	1,218
Salmon River	**38,385**	**6,398**	**25,461**	**3,744**	**85,184**	**12,511**	**51,564**	**8,594**	**24,230**	**5,409**	**87,777**	**12,891**
Sandy Creek	1,237	424	1,132	681	1,732	1,139	1,416	626	667	304	405	374
Skinner Creek	428	172	248	----	***	***	43	17	314	----	***	***
Slater Creek	1,918	630	579	467	0	0	3,308	1,921	674	346	0	0
South Sandy Creek	854	344	421	178	4,154	1,893	4,115	975	607	----	2,889	1,677
Sterling Creek	320	151	89	----	***	***	0	0	368	----	***	***
Stony Creek	553	222	157	----	1,060	----	522	167	343	181	1,061	----
Webster Park	537	537	998	932	247	----	499	203	470	528	0	0
Totals	**69,670**	**18,917**	**37,087**	**9,901**	**126,414**	**29,042**	**99,807**	**30,446**	**56,109**	**17,266**	**119,281**	**28,051**

---- = Insufficient interview data on trip lengths, ***= Creek not sampled

Table 3. Estimated angler hours on the Salmon River by time period and year.

Dates	2005-2006	2006-2007	2011-2012
Sept. week 1	***	***	9,352
Sept. week 2	19,987	7,385	27,585
Sept. week 3	33,341	29,781	42,486
Sept. week 4	54,461	42,766	68,376
Sept. week 5			114,039
Sept. Total	107,789	79,932	261,838
Oct. week 1	75,230	91,334	142,962
Oct. week 2	98,942	110,372	96,748
Oct. week 3	62,876	89,264	63,751
Oct. week 4	36,225	39,763	35,556
Oct. week 5	14,170	11,631	
Oct. Total	287,443	342,364	339,017
Nov. week 1	21,585	8,963	42,144
Nov. week 2	16,978	12,493	42,942
Nov. week 3	14,291	8,456	31,042
Nov. week 4	8,564	14,841	29,394
Nov. Total	61,418	44,753	145,522
December	23,220	36,783	59,603
January	19,682	18,598	38,760
February	12,158	7,399	52,498
March	38,385	25,461	85,184
April	51,564	24,230	87,777
May (through mid-month)	4,114	15,747	7,118
Totals	**605,772**	**595,267**	**1,077,316**

*** = Salmon River not sampled prior to Labor Day

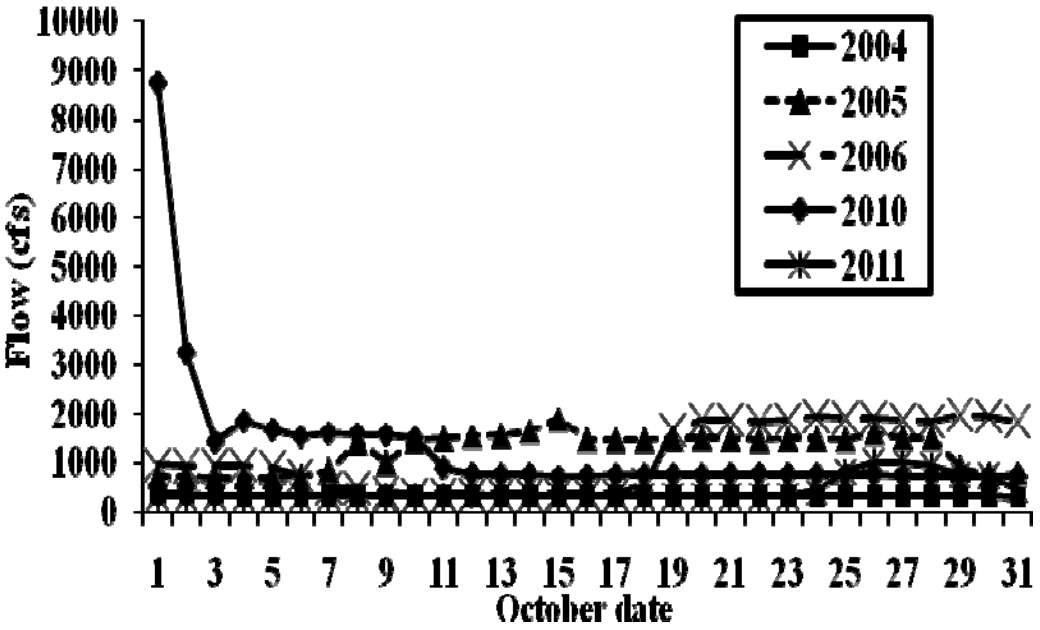

Figure 2. October water releases from the Lighthouse Hill Reservoir on the Salmon River by year (Brookfield Power Co. records).

Table 4. Summary statistics for creel surveys conducted on the Salmon River since 1984.

			Chinook salmon		Steelhead	
Year	Dates	Angler trips	Catch	Harvest	Catch	Harvest
1984	Sept-Nov	107,306	143,244	83,784	15,529	8,359
1984	Jan 1 to Dec 31	140,911	143,244	83,784	36,925	20,699
1989	Aug 17 to Dec 4	180,400	150,100	69,200	8,150	4,350
1992	Sept 3 to Nov 1	103,900	80,300	55,900		
1997	Oct 20 to Nov 30	7,061	----	----	1,543	554
1998	Oct 19 to Nov 29	7,009	----	----	2,830	523
1999	Oct 18 to Nov 28	11,372	----	----	4,751	1,010
2000	Oct 16 to Nov 26	11,231	----	----	2,870	806
2001	Oct 15 to Nov 25	12,563	----	----	3,660	746
2002	Oct 21 to Dec 1	9,381	----	----	2,743	555
2003	Oct 20 to Nov 30	6,183	----	----	1,960	357
2004	Sept 7 to Nov 28	90,825	85,251	24,360	6,924	1,314
2005	Sept 6 to Nov 30	75,985	89,448	25,998	7,738	1,441
2005-2006	Sept 6 to May 15	98,959	89,448	25,998	20,705	2,713
2006	Sept 9 to Nov 26	83,409	96,088	33,530	9,509	2,002
2006-2007	Sept 9 to May 16	87,539	96,088	33,530	21,489	3,869
2011	Sept 1 to Nov 30	112,109	85,106	31,516	39,697	3,657
2011-2012	Sept 1 to May 15	158,214	85,106	31,516	96,398	8,608

Table 5. Estimated angler effort by fishing type/area from the Salmon River creel surveys by year.

	2005-2006			2006-2007			2011-2012		
Fishing type	Effort (angler hours)	Mean trip length	Estimated angler trips	Effort (angler hours)	Mean trip length	Estimated angler trips	Effort (angler hours)	Mean trip length	Estimated angler trips
Shore access (conv. regs.)	449,520	6	74,966	436,096	6.8	64,607	842,074	6.5	129,351
Drift boat	42,598	7.7	5,520	35,213	7.7	4,549	88,720	7.4	11,973
Special regs. Fly	66,476	6.2	10,819	57,300	6.5	8,788	96,665	6.6	14,646
Estuary boat	9,368	4.6	2,032	10,407	6.3	1,657	16,503	5.9	2,778
Tributaries	37,809	5.8	6,551	56,251	6.5	8,614	33,354	4.9	6,779
Total	**605,772**	**6.1**	**98,959**	**595,267**	**6.8**	**87,539**	**1,077,316**	**6.8**	**158,214**

Table 6. Numbers of angler interviews by tributary and year from the Lake Ontario creel surveys.

	2005-2006 trip type			2006-2007 trip type			2011-2012		
Tributary	Completed	Incompeted	Total	Completed	Incompeted	Total	Completed	Incompeted	Total
12 Mile Creek	2	13	15	2	31	33	5	88	93
18 Mile Creek	90	375	465	33	188	221	151	546	697
4 Mile Creek	***	***	***	0	2	2	***	***	***
Bear Creek	10	15	25	7	20	27	***	***	***
Black River	14	34	48	38	135	173	26	344	370
Catfish Creek	22	32	54	14	23	37	***	***	***
Genesee River	144	34	178	84	56	140	41	70	111
Grindstone Creek	3	14	17	11	16	27	4	20	24
Irondequoit Creek	81	22	103	78	114	192	57	116	173
Johnson Creek	21	24	45	8	62	70	14	64	78
Keg Creek	9	31	40	2	27	29	0	3	3
Little Salmon River	26	36	62	21	65	86	14	66	80
Lindsey Creek	0	0	0	0	1	1	***	***	***
Little Sandy Creek	17	61	78	35	72	107	***	***	***
Marsh Creek	0	0	0	0	0	0	***	***	***
Maxwell Creek	55	123	178	226	320	546	139	185	324
Mill Creek	18	38	56	7	3	10	0	54	54
Niagara River	***	***	***	***	***	***	251	213	464
Ninemile Creek	11	8	19	21	101	122	***	***	***
North Sandy Creek	84	46	130	56	52	108	33	75	108
Oak Orchard Creek	201	45	246	34	160	194	93	139	232
Oswego River	256	626	882	328	818	1,146	69	1,059	1,128
Salmon River	**1,944**	**1,106**	**3,050**	**911**	**1,812**	**2,723**	**3,124**	**1,288**	**4,412**
Sandy Creek	112	60	172	55	74	129	95	93	188
Skinner Creek	2	2	4	1	15	16	***	***	***
Slater Creek	60	30	90	39	84	123	0	0	0
South Sandy Creek	59	92	151	83	38	121	118	227	345
Sterling Creek	11	10	21	2	33	35	***	***	***
Stony Creek	8	27	35	10	17	27	3	22	25
Webster Park	37	24	61	27	45	72	12	32	44
Totals	**3,297**	**2,928**	**6,225**	**2,133**	**4,383**	**6,516**	**4,249**	**4,704**	**8,953**

* - We interviewed parties (all of the anglers associated with a vehicle or boat) of anglers on the Salmon River and individual anglers on all other tributaries.

Catch and Harvest

Chinook Salmon

Seventeen of 21 tributaries surveyed had reported catches of Chinook salmon. The top tributaries producing Chinook salmon catches were the Salmon River, Eighteenmile and Oak Orchard creeks, and the Oswego and Black rivers (Table 7). Eleven of the 21 tributaries had an estimated 1,000 or more Chinook salmon caught.

The estimated catch and harvest of Chinook salmon on all tributaries surveyed in 2011 was 126,259 and 45,612, respectively (Table 7). Chinook catch declined from the 2005 and 2006 estimates of 170,441 and 152,155, respectively. Harvest also decreased from the 49,363 and 55,634 estimated in 2005 and 2006, respectively. Overall, tributary anglers harvested 36% of Chinooks caught. The Salmon River accounted for 68% (86,184) of the catch and 70% (31,915) of the harvest.

Salmon River anglers harvested from 58% to 70% of their catches in the 1984, 1989, and 1992 surveys, but only 28% to 37% in the 2004 to 2011 surveys (Table 4). In comparison, the open lake fishery harvested 47.3% (catch = 97,899; harvest = 46,333) of all Chinooks caught in 2011 (Lantry and Eckert 2012). The increased release rates observed in more recent tributary surveys may be related to the mid-1990s ban on snagging, and an increase in the popularity of catch and release fishing in the tributaries.

Seventy-three percent of the Chinook catch in all the tributaries occurred in October, followed by September (17%;Table 8). The salmon run typically starts earlier in the Salmon River than the other tributaries, often seeing substantial numbers of fish over Labor Day weekend. Peak Chinook catches on the Salmon River in 2011were the first and second week in October (Figure 3), with an overall catch distribution of 22% in September and 65% in October. As in past Salmon River surveys, the conventional regulations section yielded by far the most number of fish caught and harvested (73,187 and 26,470 respectively) (Table 9).

Coho Salmon

Coho salmon were a smaller component of the tributary fishery in 2011, only being caught in 11 of the 21 tributaries surveyed and totaling 30,857 fish (Table 10). The estimated catch increased markedly from the 2005 (18,163 fish) and 2006 (5,804 fish). The Salmon River accounted for 95% of the catch (29,295) and 97% of the harvest (10,218). Eighteenmile Creek was the only other tributary to have a substantial coho catch in 2011, an estimated 1,041 fish (Table 10). This compares to the 1984 study where an estimated 13,831 were caught and 10,608 harvested (NYSDEC 1984). Release rates for coho salmon increased on the tributaries from 23% in 1984 to 74% in 2006, but declined to 66% in 2011. In comparison, the 2011 open lake boat fishery had an estimated catch and harvest of 11,915 and 7,380 coho salmon, respectively (Lantry and Eckert 2012). October produced the highest monthly tributary catch of coho (Table 11).

Steelhead

Steelhead is the primary species sought by post-salmon run tributary anglers. Participation in this fishery builds in mid-October as fish enter the tributaries and the salmon runs begin to decline, and extends into April or May in some cases. As a result, steelhead are the most important species in the late fall through early spring fishery.

The estimated steelhead catch from all tributaries combined totaled 170,642 in 2011-2012 compared to 77,153 and 56,488 in 2005-2006 and 2006-2007, respectively (Table 12) The estimated catch in the 1984 survey was 90,037 (NYSDEC 1984). The Salmon River had the highest estimated number of steelhead caught with 96,398, greatly exceeding the approximately 20,000 fish caught in each of the previous two surveys (Table 12). Other waters producing high steelhead catches included Eighteenmile and Maxwell creeks, the lower

Table 7. Estimated catch and harvest and their respective rates (fish/angler hour) for Chinook salmon by tributary and year.

	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0	0	**	**	**	**	0	0	**	**
12 Mile Creek	0	0	0.004	8	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0.237	14,764	0.211	13,606	0.100	9,703	0.007	436	0.049	3,187	0.022	2,106
Bear Creek	0.03	31	0.077	55	**	**	0.03	31	0	0	**	**
Black River	0.928	16,199	0.359	4,373	0.154	3,824	0.313	5,467	0.233	2,842	0.082	2,029
Catfish Creek	0.474	1,641	0.158	255	**	**	0.304	1,053	0.12	194	**	**
Genesee River	0.184	2,573	0.227	2,331	0.132	1,318	0.067	936	0.106	1,089	0.048	478
Grindstone Creek	0.293	522	0.04	56	0.529	431	0.042	76	0.04	56	0.000	0
Irondequoit Creek	0.045	99	0.014	39	0.064	292	0	0	0.014	39	0.007	33
Johnson Creek	0.267	1,117	0.227	1,623	0.082	508	0.185	772	0.074	527	0.025	153
Keg Creek	0	0	0.113	215	0.000	0	0	0	0.041	78	0.000	0
Lindsey Creek	0	0	0	0	**	**	0	0	0	0	**	**
Little Salmon River	0.313	1,365	0.098	329	0.319	1,269	0.181	786	0.09	302	0.276	1,095
Little Sandy Creek	0.212	379	0.14	275	**	**	0.09	160	0.14	275	**	**
Marsh Creek	----	----	----	0	**	**	0	0	----	----	**	**
Maxwell Creek	0.044	398	0.035	460	0.124	2,466	0.013	121	0.018	236	0.015	305
Mill Creek	0.553	1,895	0.424	270	0.249	1,035	0.245	839	0.359	228	0.132	546
Niagara River	**	**	**	**	0.035	878	**	**	**	**	0.026	642
Ninemile Creek	0.478	470	0.185	476	**	**	0.083	82	0.104	268	**	**
North Sandy Creek	0.275	4,380	0.215	1,224	0.030	257	0.122	1,939	0.115	652	0.015	125
Oak Orchard Creek	0.113	6,829	0.427	18,943	0.237	9,674	0.012	741	0.143	6,340	0.056	2,299
Oswego River	0.131	7,987	0.085	3,749	0.083	4,088	0.065	3,928	0.038	1,690	0.024	1,212
Salmon River	**0.185**	**89,448**	**0.192**	**96,088**	**0.115**	**85,106**	**0.054**	**25,998**	**0.067**	**33,530**	**0.042**	**31,516**
Sandy Creek	0.148	1,759	0.031	127	0.095	1,506	0.068	806	0.003	14	0.056	884
Skinner Creek	0	0	0	0	**	**	0	0	0	0	**	**
Slater Creek	0.078	411	0.062	276	0.000	0	0.028	149	0.062	276	0.000	0
South Sandy Creek	0.799	16,885	0.287	5,965	0.061	2,706	0.226	4,785	0.162	3,369	0.039	1,747
Sterling Creek	0.458	873	0.284	400	**	**	0.043	83	0.122	172	**	**
Stony Creek	0.176	136	0	0	0.000	0	0.136	106	0	0	0.000	0
Webster Park	0.193	280	0.371	1,012	0.095	119	0.048	69	0.099	270	0.035	44
Totals		**170,441**		**152,155**		**126,259**		**49,363**		**55,634**		**45,612**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, **= Creek not sampled

Table 8. Estimated catch and harvest and their respective rates (fish/angler hour) for Chinook salmon by stream, month and year.

	September											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	----	----	**	**	**	**	----	----	**	**
12 Mile Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0.299	424	0.102	1,211	0.007	35	0.021	30	0.009	101	0.007	35
Bear Creek	0	0	----	----	**	**	0	0	----	----	**	**
Black River	0.701	1,746	0.356	1,293	0.000	0	0.176	439	0.167	606	0.000	0
Catfish Creek	0	0	0.171	26	**	**	0	0	0.171	26	**	**
Genesee River	0.01	19	0.063	229	0.103	269	0	0	0.05	180	0.024	104
Grindstone Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Irondequoit Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Johnson Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Keg Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Lindsey Creek	----	----	0	0	**	**	----	----	0	0	**	**
Little Salmon River	0	0	0.154	97	0.109	16	0	0	0.143	90	0.097	14
Little Sandy Creek	0.307	85	0.114	43	**	**	0.307	85	0.114	43	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0	0	0.007	6	----	----	0	0	0.007	6	----	----
Mill Creek	0.316	40	0	0	0.000	0	0	0	0	0	0.000	0
Niagara River	**	**	**	**	0.061	226	**	**	**	**	0.058	214
Ninemile Creek	0	0	0	0	**	**	0	0	0	0	**	**
North Sandy Creek	3.088	1,547	0	0	0.000	0	0	0	0	0	0.000	0
Oak Orchard Creek	0.55	1,026	0.809	7,784	0.227	406	0.026	49	0.115	1,106	0.028	51
Oswego River	0.23	2,479	0.081	1,718	0.096	1,891	0.102	1,098	0.029	614	0.022	426
Salmon River [1]	**0.215**	**39,431**	**0.118**	**20,228**	**0.072**	**18,915**	**0.046**	**8,425**	**0.029**	**4,917**	**0.022**	**5,834**
Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
South Sandy Creek	0.369	878	0.108	350	----	----	0.14	332	0.066	213	----	----
Sterling Creek	0	0	0	0	**	**	0	0	0	0	**	**
Stony Creek	0	0	----	----	----	----	0	0	----	----	----	----
Webster Park	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Totals		**47,675**		**32,984**		**21,757**		**10,458**		**7,902**		**6,678**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

1=Salmon River study began in early Sept., others mid-Sept.

Table 8 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for Chinook salmon by stream, month and year.

	October											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0	0	**	**	**	**	0	0	**	**
12 Mile Creek	0	0	0.008	7	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0.115	3,342	0.271	7,907	0.089	5,322	0.014	398	0.088	2,574	0.027	1,627
Bear Creek	0	0	0.112	55	**	**	0	0	0	0	**	**
Black River	1.103	14,199	0.386	2,784	0.179	3,482	0.371	4,777	0.291	2,098	0.101	1,960
Catfish Creek	0.438	1,269	0.238	230	**	**	0.252	731	0.174	168	**	**
Genesee River	0.273	2,410	0.345	2,104	0.140	668	0.106	933	0.149	905	0.044	208
Grindstone Creek	0.4	522	0.081	56	0.800	463	0.058	75	0.081	56	0.000	0
Irondequoit Creek	0.094	99	0.043	39	0.084	225	0	0	0.043	39	0.000	0
Johnson Creek	0.385	1,117	0.402	1,368	0.102	500	0.266	771	0.155	527	0.031	150
Keg Creek	0	0	0.189	205	0.000	0	0	0	0.072	79	0.000	0
Lindsey Creek	----	----	0	0	**	**	----	----	0	0	**	**
Little Salmon River	0.321	1,363	0.092	232	0.334	1,248	0.185	788	0.084	212	0.289	1,079
Little Sandy Creek	0.197	290	0.161	232	**	**	0.048	70	0.161	232	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0.079	282	0.076	388	0.498	4,059	0.02	71	0.042	213	0.069	560
Mill Creek	0.558	1,477	0.167	63	0.263	1,045	0.26	689	0.058	22	0.157	623
Niagara River	**	**	**	**	0.059	568	**	**	**	**	0.037	353
Ninemile Creek	2.042	228	0.173	332	**	**	0.731	82	0.096	184	**	**
North Sandy Creek	0.206	2,829	0.345	1,204	0.065	364	0.141	1,936	0.181	632	0.065	364
Oak Orchard Creek	0.147	5,650	0.424	10,378	0.354	7,339	0.018	678	0.214	5,222	0.079	1,643
Oswego River	0.127	5,084	0.099	1,957	0.101	1,900	0.065	2,622	0.054	1,078	0.037	696
Salmon River	**0.205**	**43,114**	**0.256**	**64,143**	**0.164**	**55,703**	**0.075**	**15,812**	**0.099**	**24,824**	**0.061**	**20,784**
Sandy Creek	0.271	1,498	0.112	116	0.366	2,259	0.146	808	0.013	14	0.231	1,429
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0.076	195	0.053	138	----	----	0.043	110	0.053	138	----	----
South Sandy Creek	0.942	16,015	0.369	5,376	0.197	6,678	0.262	4,458	0.2	2,917	0.110	3,717
Sterling Creek	0.537	671	0.373	400	**	**	0.025	31	0.16	171	**	**
Stony Creek	0.264	136	----	----	0.000	0	0.205	106	----	----	0.000	0
Webster Park	0.435	197	0.563	518	0.000	0	0.153	69	0.07	64	0.000	0
Totals		**101,987**		**100,235**		**91,823**		**36,015**		**42,371**		**35,193**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 8 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for Chinook salmon by tributary, month, and year.

	November											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0	0	**	**	**	**	0	0	**	**
12 Mile Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0.292	10,990	0.192	4,503	0.138	4,513	0	0	0.022	511	0.017	566
Bear Creek	0.066	31	0	0	**	**	0.066	31	0	0	**	**
Black River	0.121	252	0.223	296	0.102	318	0.121	252	0.103	137	0.021	64
Catfish Creek	0.467	372	0	0	**	**	0.405	323	0	0	**	**
Genesee River	0.043	142	----	----	0.372	327	0	0	----	----	0.327	288
Grindstone Creek	0	0	0	0	0.080	13	0	0	0	0	0.000	0
Irondequoit Creek	0	0	0	0	0.081	120	0	0	0	0	0.000	0
Johnson Creek	0	0	0.104	254	0.000	0	0	0	0	0	0.000	0
Keg Creek	0	0	0.013	10	0.000	0	0	0	0	0	0.000	0
Lindsey Creek	----	----	0	0	**	**	----	----	0	0	**	**
Little Salmon River	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Little Sandy Creek	0.112	4	0	0	**	**	0.112	4	0	0	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0.021	116	0.009	69	0.059	696	0.009	49	0.002	14	0.006	75
Mill Creek	0.577	378	0.8	206	0.000	0	0.231	151	0.8	206	0.000	0
Niagara River					0.007	86					0.007	86
Ninemile Creek	0.277	241	0.222	143	**	**	0	0	0.129	83	**	**
North Sandy Creek	0	0	0.013	21	0.024	64	0	0	0.013	21	0.000	0
Oak Orchard Creek	0.007	159	0.077	789	0 *	0 *	0	0	0	0	0 *	0 *
Oswego River	0.043	405	0.022	74	0.022	247	0.023	215	0.002	8	0.005	52
Salmon River	**0.026**	**1,668**	**0.094**	**4,195**	**0.009**	**1,347**	**0.004**	**240**	**0.023**	**1,009**	**0.002**	**350**
Sandy Creek	0.041	264	0.004	11	0.006	62	0	0	0	0	0.006	62
Skinner Creek	----	----	0	0	**	**	----	----	0	0	**	**
Slater Creek	0.082	218	0.096	138	0.000	0	0.015	39	0.096	138	0.000	0
South Sandy Creek	0	0	0.083	245	0.006	26	0	0	0.083	245	0.006	26
Sterling Creek	0.297	201	0	0	**	**	0.076	52	0	0	**	**
Stony Creek	0	0	0	0	----	----	0	0	0	0	----	----
Webster Park	0.09	83	0.301	495	0.148	122	0	0	0.125	205	0.049	41
Totals		**15,524**		**11,450**		**7,940**		**1,356**		**2,579**		**1,610**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, **= Creek not sampled in 2005-2006

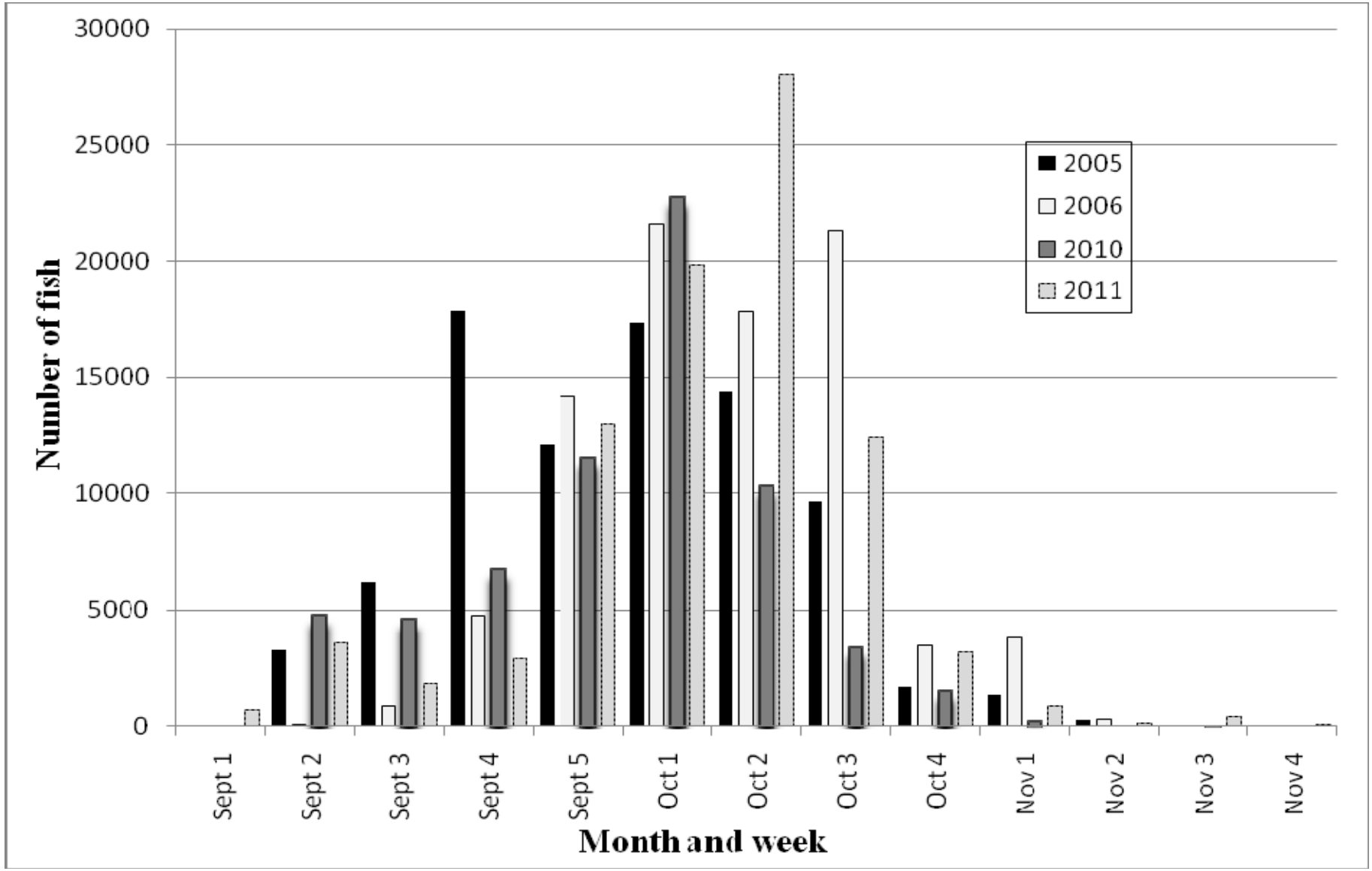

Figure 3. Estimated Chinook salmon catch on the Salmon River by month, week, and year.

Table 9. Estimated catch and harvest for trout and salmon by fishing type and year from the Salmon River creel surveys.

		2005-2006				2006-2007				2011-2012			
Species	Fishing type	Est. catch rate*	Est. catch	Est. harvest rate*	Est. harvest	Est. catch rate*	Est. catch	Est. harvest rate*	Est. harvest	Est. catch rate*	Est. catch	Est. harvest rate*	Est. harvest
Chinook salmon	Shore access-conv. regs	0.137	62,044	0.038	17,247	0.107	46,483	0.034	14,744	0.119	73,187	0.043	26,470
	Drift boat	0.096	4,089	0.027	1,152	0.042	1,470	0.021	732	0.057	1,849	0.026	839
	Special regs. Fly	0.076	5,071	0.000	0	0.049	2,832	0.000	22	0.099	5,766	0.000	0
	Estuary boat	0.008	76	0.007	65	0.455	4,736	0.117	1,216	0.058	954	0.043	703
	Tributaries	0.286	10,792	0.107	4,054	0.427	23,999	0.145	8,172	0.144	3,826	0.121	3,211
	All types[1]	0.139	84,311	0.040	24,396	0.150	89,034	0.052	30,990	0.115	85,106	0.042	31,516
Steelhead	Shore access-conv. regs	0.024	10,643	0.003	1,337	0.028	12,167	0.005	2,019	0.071	60,099	0.007	6,215
	Drift boat	0.098	4,193	0.025	1,064	0.155	5,448	0.045	1,578	0.196	17,378	0.025	2,216
	Special regs. Fly	0.075	5,018	0.000	4	0.051	2,905	0.002	122	0.147	14,224	0.000	14
	Estuary boat	0.000	0	0.000	0	0.072	746	0.000	0	0.055	908	0.002	28
	Tributaries	0.017	651	0.006	231	0.008	473	0.003	185	0.033	1,099	0.004	133
	All types[1]	0.034	20,705	0.004	2,713	0.036	21,489	0.007	3,869	0.089	96,398	0.008	8,608
Brown trout	All types	0.016	9,804	0.002	1,177	0.005	3,238	0.001	613	0.006	6,604	0.001	711
Coho salmon	All types	0.012	5,659	0.005	2,177	0.029	14,513	0.006	3,002	0.039	29,295	0.014	10,218
Atlantic salmon	All types	0.000	295	0.000	0	0.000	232	0.000	0	0.001	614	0.000	11

1 – The difference in the total catches and harvests and the sum of the fishing types are due to lacking interview data for some of the smaller strata
* = Rates are the number of fish caught or harvested per angler hour

Table 10. Estimated catch and harvest and their respective rates (fish/angler hour) for coho salmon by tributary and year.

	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0	0	**	**	**	**	0	0	**	**
12 Mile Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0	0	0.032	2,062	0.011	1,041	0	0	0.013	829	0.002	176
Bear Creek	0	0	0	0	**	**	0	0	0	0	**	**
Black River	0	0	0.003	36	0.004	98	0	0	0.003	36	0.001	15
Catfish Creek	0	0	0	0	**	**	0	0	0	0	**	**
Genesee River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Grindstone Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Irondequoit Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Johnson Creek	0.008	35	0.01	75	0.000	0	0.008	35	0	0	0.000	0
Keg Creek	0	0	0.012	23	0.000	0	0	0	0	0	0.000	0
Lindsey Creek	0	0	0	0	**	**	0	0	0	0	**	**
Little Salmon River	0	0	0	0	0.003	10	0	0	----	----	0.003	10
Little Sandy Creek	0	0	0	0	**	**	0	0	0	0	**	**
Marsh Creek	0	0	0	0	**	**	0	0	----	----	**	**
Maxwell Creek	0.007	63	0.002	25	0.010	189	0.005	47	0.001	10	0.002	49
Mill Creek	0	0	0	0	0.007	29	0	0	0	0	0.000	0
Niagara River	**	**	**	**	0.001	34	**	**	**	**	0.001	20
Ninemile Creek	0	0	0	0	**	**	0	0	0	0	**	**
North Sandy Creek	0.01	151	0	0	0.003	29	0.003	55	0	0	0.000	0
Oak Orchard Creek	0	0	0.025	1,126	0.002	85	0	0	0.015	660	0.000	0
Oswego River	0.001	59	0.002	105	**0.001**	**33**	0	19	0.001	42	0.000	6
Salmon River	**0.012**	**5,659**	**0.029**	**14,513**	**0.039**	**29,295**	**0.005**	**2,177**	**0.006**	**3,002**	**0.014**	**10,218**
Sandy Creek	0.003	39	0.006	24	0.000	0	0	0	0.006	24	0.000	0
Skinner Creek	0	0	0	0	**	**	0	0	0	0	**	**
Slater Creek	0.01	52	0.004	16	0.000	0	0.005	28	0	0	0.000	0
South Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Sterling Creek	0	0	0	0	**	**	0	0	0	0	**	**
Stony Creek	0	0	0.02	18	0.000	0	0	0	0.02	18	0.000	0
Webster Park	0.015	22	0.009	24	**0.012**	**15**	0.015	22	0.009	24	0.012	15
Totals		**6,080**		**18,047**		**30,857**		**2,383**		**4,645**		**10,507**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, **= Creek not sampled

Table 11. Estimated catch and harvest and their respective rates (fish/angler hour) for coho salmon by tributary, month, and year.

	September											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	----	----	**	**	**	**	----	----	**	**
12 Mile Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0	0	0.011	127	0.000	0	0	0	0.011	127	0.000	0
Bear Creek	0	0	----	----	**	**	0	0	----	----	**	**
Black River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Catfish Creek	0	0	0	0	**	**	0	0	0	0	**	**
Genesee River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Grindstone Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Irondequoit Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Johnson Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Keg Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Lindsey Creek	----	----	0	0	**	**	----	----	0	0	**	**
Little Salmon River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Little Sandy Creek	0	0	0	0	**	**	0	0	0	0	**	**
Marsh Creek	----	----	0	0	**	**	----	----	0	0	**	**
Maxwell Creek	0	0	0	0	----	----	0	0	0	0	----	----
Mill Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Niagara River	**	**	**	**	0.004	13	**	**	**	**	0.002	7
Ninemile Creek	0	0	0	0	**	**	0	0	0	0	**	**
North Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Oak Orchard Creek	0	0	0.023	220	0.057	101	0	0	0	0	0.000	0
Oswego River	0	0	0.004	82	0.001	14	0	0	0.002	50	0.000	0
Salmon River [1]	**0.022**	**4,002**	**0.065**	**11,095**	**0.062**	**16,314**	**0.007**	**1,331**	**0.011**	**1,911**	**0.016**	**4,303**
Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
South Sandy Creek	0	0	0	0	----	----	0	0	0	0	----	----
Sterling Creek	0	0	0	0	**	**	0	0	0	0	**	**
Stony Creek	0	0	----	----	----	----	0	0	----	----	----	----
Webster Park	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Totals		**4,002**		**11,523**		**16,442**		**1,331**		**2,088**		**4,309**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

1=Salmon River study began in early Sept., others mid-Sept.

Table 11 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for coho salmon by tributary, month, and year.

October												
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0	0	**	**	**	**	0	0	**	**
12 Mile Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0	0	0.047	1,364	0.015	872	0	0	0.024	713	0.003	156
Bear Creek	0	0	0	0	**	**	0	0	0	0	**	**
Black River	0	0	0.005	38	0.004	83	0	0	0.005	38	0.000	0
Catfish Creek	0	0	0	0	**	**	0	0	0	0	**	**
Genesee River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Grindstone Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Irondequoit Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Johnson Creek	0.012	35	0.022	75	0.000	0	0.012	35	0	0	0.000	0
Keg Creek	0	0	0.021	23	0.000	0	0	0	0	0	0.000	0
Lindsey Creek	----	----	0	0	**	**	----	----	0	0	**	**
Little Salmon River	0	0	0	0	0.003	11	0	0	0	0	0.003	11
Little Sandy Creek	0	0	0	0	**	**	0	0	0	0	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0.013	46	0.002	8	0.000	0	0.013	46	0.002	8	0.000	0
Mill Creek	0	0	0	0	0.065	256	0	0	0	0	0.000	0
Niagara River	**	**	**	**	0.002	19	**	**	**	**	0.001	12
Ninemile Creek	0	0	0	0	**	**	0	0	0	0	**	**
North Sandy Creek	0.011	149	0	0	0.000	0	0.004	51	0	0	0.000	0
Oak Orchard Creek	0	0	0.037	903	0.000	0	0	0	0.027	660	0.000	0
Oswego River	0.001	26	0.001	19	0.001	19	0	0	0	2	0.000	6
Salmon River	**0.007**	**1,558**	**0.008**	**2,099**	**0.038**	**12,771**	**0.004**	**844**	**0.003**	**808**	**0.016**	**5,420**
Sandy Creek	0.007	41	0.023	24	0.014	86	0	0	0.023	24	0.000	0
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0.011	28	0.006	15	0.000	0	0.011	28	0	0	0.000	0
South Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Sterling Creek	0	0	0	0	**	**	0	0	0	0	**	**
Stony Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Webster Park	0.048	22	0.026	23	0.000	0	0.048	22	0.026	23	0.000	0
Totals		**1,905**		**4,591**		**14,117**		**1,026**		**2,277**		**5,605**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 11 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for coho salmon by tributary, month, and year.

	November											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0	0	**	**	**	**	0	0	**	**
12 Mile Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0	0	0.024	567	0.001	32	0	0	0	0	0.000	0
Bear Creek	0	0	0	0	**	**	0	0	0	0	**	**
Black River	0	0	0	0	0.005	15	0	0	0	0	0.005	15
Catfish Creek	0	0	0	0	**	**	0	0	0	0	**	**
Genesee River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Grindstone Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Irondequoit Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Johnson Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Keg Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Lindsey Creek	----	----	0	0	**	**	----	----	0	0	**	**
Little Salmon River	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Little Sandy Creek	0	0	0	0	**	**	0	0	0	0	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0.003	16	0.002	14	0.019	223	0	0	0	0	0.005	57
Mill Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Niagara River	**	**	**	**	0.000	0	**	**	**	**	0.000	0
Ninemile Creek	0	0	0	0	**	**	0	0	0	0	**	**
North Sandy Creek	0	0	0	0	0.012	32	0	0	0	0	0.000	0
Oak Orchard Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Oswego River	0.002	18	0	0	0.000	0	0.002	18	0	0	0.000	0
Salmon River	**0.004**	**245**	**0.013**	**599**	**0.008**	**1,213**	**0.001**	**83**	**0.001**	**29**	**0.004**	**514**
Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Skinner Creek	----	----	0	0	**	**	----	----	0	0	**	**
Slater Creek	0.009	23	0	0	0.000	0	0	0	0	0	0.000	0
South Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Sterling Creek	0	0	0	0	**	**	0	0	0	0	**	**
Stony Creek	0	0	0.19	18	0.000	0	0	0	0.19	18	0.000	0
Webster Park	0	0	0	0	0.016	14	0	0	0	0	0.016	14
Totals		**302**		**1,199**		**1,529**		**101**		**47**		**599**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, **= Creek not sampled

Table 12. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary and year

	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
Tributary	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number
4 Mile Creek	***	***	0	0	***	***	***	***	0	0	***	***
12 Mile Creek	0	0	0.027	106	0.005	30	0	0	0.022	88	0.000	0
18 Mile Creek	0.25	21,828	0.164	11,836	0.183	21,834	0.049	4,298	0.042	3,048	0.005	601
Bear Creek	0.043	70	0.264	494	***	***	0.034	55	0.11	207	***	***
Black River	0.052	1,101	0.025	354	0.080	2,572	0.019	396	0.015	205	0.023	729
Catfish Creek	0.01	38	0	0	***	***	0	0	0	0	***	***
Genesee River	0.401	8,666	0.203	3,015	0.005	63	0.03	651	0.008	113	0.000	0
Grindstone Creek	0	0	0.011	19	0.055	76	0	0	0.011	19	0.000	0
Irondequoit Creek	0.1	1426	0.037	500	0.270	4,832	0.041	580	0.002	30	0.008	145
Johnson Creek	0.016	90	0.124	1,164	0.410	3,128	0.012	65	0.051	478	0.003	21
Keg Creek	0.152	189	0.248	1,086	0.000	0	0.152	189	0.028	122	0.000	0
Lindsey Creek	0	0	0	0	***	***	0	0	0	0	***	***
Little Salmon River	0	0	0.004	21	0.002	10	0	0	0.004	21	0.002	10
Little Sandy Creek	0.023	65	0.087	281	***	***	0.003	9	0.007	23	***	***
Marsh Creek	0	0	0	0	***	***	0	0	0	0	***	***
Maxwell Creek	0.125	2,213	0.105	2,553	0.305	13,413	0.076	1,347	0.034	821	0.022	977
Mill Creek	0	0	0	0	0.305	1,972	0	0	0	0	0.207	1,338
Ninemile Creek	0.009	10	0.138	522	***	***	0	0	0.042	159	***	***
Niagara River	***	***	***	***	0.147	6,105	***	***	***	***	0.028	1,163
North Sandy Creek	0.143	2,688	0.098	737	0.192	2,723	0.047	872	0.031	231	0.007	101
Oak Orchard Creek	0.139	9,707	0.131	6,442	0.104	5,789	0.023	1,603	0.048	2,329	0.001	55
Oswego River	0.035	2,433	0.032	1,562	0.082	4,851	0.014	950	0.014	697	0.015	910
Salmon River	**0.034**	**20,705**	**0.036**	**21,489**	**0.089**	**96,398**	**0.004**	**2,713**	**0.007**	**3,869**	**0.008**	**8,608**
Sandy Creek	0.088	1,392	0.058	955	0.075	1,645	0.023	365	0.001	18	0.001	28
Skinner Creek	0.038	35	0.051	55	***	***	0	0	0	0	***	***
Slater Creek	0.222	3,016	0.098	706	0.000	0	0.072	977	0.006	46	0.000	0
South Sandy Creek	0.015	408	0.059	1,346	0.088	4,916	0.008	214	0.003	69	0.007	383
Sterling Creek	0.01	23	0	0	***	***	0	0	0	0	***	***
Stony Creek	0.19	372	0.117	183	0.000	0	0.129	252	0.039	61	0.000	0
Webster Park	0.238	678	0.223	1,062	0.134	286	0.079	227	0.029	136	0.034	73
Total		**77,153**		**56,488**		**170,642**		**15,763**		**12,790**		**15,142**

*** = Creek not sampled

Table 13. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	September											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Number	Rate*	Num	Rate*	Num	Rate*	Number
4 Mile Creek	***	***	----	----	***	***	**	**	----	----	***	***
12 Mile Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
18 Mile Creek	0	0	0.011	128	0.041	207	0	0	0	0	0.020	103
Bear Creek	0	0	----	----	***	***	0	0	----	----	***	***
Black River	0	0	0	0	0.086	183	0	0	0	0	0.000	0
Catfish Creek	0	0	0	0	***	***	0	0	0	0	***	***
Genesee River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Grindstone Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Irondequoit Creek	0.771	335	0.128	87	0.221	94	0	0	0	0	0.000	0
Johnson Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Keg Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Lindsey Creek	----	----	0	0	***	***	----	----	0	0	***	***
Little Salmon River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Little Sandy Creek	0	0	0	0	***	***	0	0	0	0	***	***
Marsh Creek	----	----	0	0	***	***	----	----	0	0	***	***
Maxwell Creek	0	0	0.044	37	----	----	0	0	0.036	30	----	----
Mill Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Ninemile Creek	0	0	0	0	***	***	0	0	0	0	***	***
Niagara River	***	***	***	***	0.003	12	***	***	***	***	0.001	4
North Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Oak Orchard Creek	0	0	0	0	0.028	51	0	0	0	0	0.000	0
Oswego River	0.006	65	0.009	192	0.001	22	0	0	0.004	80	0.000	0
Salmon River [1]	**0.007**	**1,256**	**0.01**	**1,637**	**0.008**	**2,152**	**0**	**71**	**0.001**	**216**	**0.002**	**594**
Sandy Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Skinner Creek	0	0	----	----	***	***	0	0	----	----	***	***
Slater Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
South Sandy Creek	0.006	14	0.008	25	----	----	0.006	14	0.008	25	----	----
Sterling Creek	0	0	0	0	***	***	0	0	0	0	***	***
Stony Creek	0	0	----	----	----	----	0	0	----	----	----	----
Webster Park	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Totals		**1,670**		**2,106**		**2,721**		**85**		**351**		**702**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, *** = Creek not sampled

1=Salmon River study began in early Sept., others mid-Sept.

Table 13 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	October											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Number	Rate*	Num	Rate*	Num	Rate*	Number
4 Mile Creek	***	***	----	----	***	***	***	***	----	----	***	***
12 Mile Creek	0	0	0.018	18	0.000	0	0	0	0	0	0.000	0
18 Mile Creek	0.027	796	0.151	4,403	0.014	856	0.008	239	0.037	1,073	0.005	291
Bear Creek	0	0	0.924	452	***	***	0	0	0.422	206	***	***
Black River	0	0	0	0	0.012	225	0	0	0	0	0.002	45
Catfish Creek	0	0	0	0	***	***	0	0	0	0	***	***
Genesee River	0.011	93	0.046	279	0.000	0	0.005	47	0.014	85	0.000	0
Grindstone Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Irondequoit Creek	0.056	59	0	0	0.123	329	0	0	0	0	0.000	0
Johnson Creek	0	0	0.142	482	0.005	24	0	0	0.098	334	0.000	0
Keg Creek	0	0	0.148	161	0.000	0	0	0	0.077	83	0.000	0
Lindsey Creek	----	----	0	0	***	***	----	----	0	0	***	***
Little Salmon River	0	0	0	0	0.003	11	0	0	0	0	0.003	11
Little Sandy Creek	0	0	0	0	***	***	0	0	0	0	***	***
Marsh Creek	----	----	----	----	***	***	----	----	----	----	***	***
Maxwell Creek	0.026	93	0.024	124	0.096	779	0.014	51	0.015	76	0.019	152
Mill Creek	0	0	0	0	0.013	51	0	0	0	0	0.000	0
Ninemile Creek	0	0	0	0	***	***	0	0	0	0	***	***
Niagara River	***	***	***	***	0.013	123	***	***	***	***	0.004	43
North Sandy Creek	0.054	745	0.013	44	0.121	675	0.011	149	0.011	40	0.000	0
Oak Orchard Creek	0.024	904	0.09	2,200	0.035	717	0.006	226	0.027	662	0.000	0
Oswego River	0.004	160	0.027	542	0.012	226	0.003	128	0.011	223	0.001	24
Salmon River	**0.004**	**929**	**0.012**	**2,950**	**0.030**	**10,062**	**0.001**	**223**	**0.003**	**856**	**0.003**	**1,176**
Sandy Creek	0.015	81	0.085	89	0.072	443	0	0	0	0	0.000	0
Skinner Creek	0	0	----	----	***	***	0	0	----	----	***	***
Slater Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
South Sandy Creek	0	0	0	0	0.006	208	0	0	0	0	0.004	126
Sterling Creek	0	0	0	0	***	***	0	0	0	0	***	***
Stony Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Webster Park	0.336	152	0.242	223	0.210	89	0.132	60	0.082	76	0.159	67
Totals		**4,012**		**11,966**		**14,817**		**1,123**		**3,715**		**1,934**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, *** = Creek not sampled

Table 13 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	November											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.179	88	0.000	0	0.000	0	0.179	88	0.000	0
18 Mile Creek	0.181	6,814	0.293	6,867	0.048	1,581	0.017	659	0.084	1,963	0.007	225
Bear Creek	0.032	15	0.218	42	**	**	0.000	0	0.000	0	**	**
Black River	0.000	0	0.065	86	0.004	11	0.000	0	0.034	46	0.000	0
Catfish Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Genesee River	1.025	3,415	----	----	0.133	117	0.021	71	----	----	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.200	32	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.000	0	0.076	92	0.106	157	0.000	0	0.025	31	0.000	0
Johnson Creek	0.000	0	0.278	681	0.000	0	0.000	0	0.059	144	0.000	0
Keg Creek	0.000	0	0.473	361	0.000	0	0.000	0	0.050	38	0.000	0
Lindsey Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Little Salmon River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Little Sandy Creek	0.112	4	0.125	19	**	**	0.056	2	0.125	19	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0.052	286	0.126	907	0.296	3,480	0.014	77	0.024	170	0.034	401
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Ninemile Creek	0.012	11	0.390	252	**	**	0.000	0	0.076	49	**	**
Niagara River	**	**	**	**	0.065	760	**	**	**	**	0.043	509
North Sandy Creek	0.269	682	0.088	148	0.216	568	0.094	238	0.013	21	0.053	139
Oak Orchard Creek	0.266	5,736	0.325	3,327	0.122	2,224	0.007	159	0.163	1,672	0.000	0
Oswego River	0.109	1,033	0.087	290	0.089	987	0.010	99	0.026	85	0.005	57
Salmon River	**0.084**	**5,169**	**0.102**	**4,554**	**0.144**	**20,983**	**0.009**	**575**	**0.015**	**687**	0.010	1,522
Sandy Creek	0.032	204	0.086	222	0.121	1,178	0.000	0	0.007	19	0.000	0
Skinner Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Slater Creek	0.056	148	0.024	34	0.000	0	0.000	0	0.024	34	0.000	0
South Sandy Creek	0.000	0	0.083	245	0.274	1,183	0.000	0	0.000	0	0.012	52
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	0.952	92	----	----	0.000	0	0.381	37	----	----
Webster Park	0.132	122	0.212	0	0.276	227	0.047	44	0.037	60	0.110	91
Totals		**23,639**		**18,307**		**33,488**		**1,924**		**5,162**		**2,997**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, *** = Creek not sampled

Table 13 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	December											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
18 Mile Creek	0.000	0	0.103	433	0.180	1,476	0.000	0	0.000	0	0.000	0
Bear Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Black River	0.000	0	0.613	197	0.090	15	0.000	0	0.499	160	0.000	0
Catfish Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Genesee River	0.579	372	1.273	1,348	0.000	0	0.019	12	0.000	0	0.000	0
Grindstone Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Irondequoit Creek	0.054	12	0.187	110	0.416	535	0.000	0	0.000	0	0.021	27
Johnson Creek	0.000	0	----	----	0.152	72	0.000	0	----	----	0.000	0
Keg Creek	0.579	19	1.154	564	0.000	0	0.579	19	0.000	0	0.000	0
Lindsey Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Little Salmon River	0.000	0	0.123	21	----	----	0.000	0	0.123	21	----	----
Little Sandy Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Maxwell Creek	0.132	185	0.200	587	0.381	2,047	0.028	39	0.094	277	0.024	129
Mill Creek	0.000	0	0.000	0	0.822	21	0.000	0	0.000	0	0.822	21
Ninemile Creek	0.000	0	0.316	57	**	**	0.000	0	0.000	0	**	**
Niagara River	**	**	**	**	0.338	1,165	**	**	**	**	0.000	0
North Sandy Creek	0.000	0	0.357	335	0.576	1,486	0.000	0	0.173	163	0.000	0
Oak Orchard Creek	0.557	554	0.181	385	0.142	762	0.000	0	0.000	0	0.012	63
Oswego River	0.053	77	0.143	236	0.124	311	0.003	5	0.072	118	0.000	0
Salmon River	**0.116**	**2,692**	**0.139**	**5,125**	**0.188**	**11,182**	**0.012**	**272**	**0.011**	**418**	**0.013**	**775**
Sandy Creek	0.154	52	0.127	78	0.277	593	0.000	0	0.000	0	0.000	0
Skinner Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Slater Creek	0.263	263	0.455	168	0.000	0	0.024	24	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.900	901	0.643	1,749	0.000	0	0.000	0	0.000	0
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	0.165	25	----	----	0.000	0	0.165	25	----	----
Webster Park	1.929	250	0.331	126	0.349	152	0.000	0	0.000	0	0.000	0
Totals		**4,476**		**10,696**		**21,566**		**371**		**1,182**		**1,016**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, *** = Creek not sampled

Table 13 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	January											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	----	----	0.114	21	0.000	0	----	----	0.000	0
18 Mile Creek	0.000	0	----	----	0.107	347	0.000	0	----	----	0.009	29
Bear Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Black River	0.000	0	0.133	30	0.000	0	0.000	0	0.000	0	0.000	0
Catfish Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Genesee River	0.000	0	0.142	7	0.085	7	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Irondequoit Creek	0.148	131	0.000	0	0.220	157	0.000	0	0.000	0	0.000	0
Johnson Creek	0.000	0	0.000	0	0.497	113	0.000	0	0.000	0	0.000	0
Keg Creek	0.000	0	0.000	0	----	----	0.000	0	0.000	0	----	----
Lindsey Creek	----	----	----	----	**	**	----	----	----	----	**	**
Little Salmon River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Little Sandy Creek	0.000	0	0.073	22	**	**	0.000	0	0.000	0	**	**
Marsh Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Maxwell Creek	0.087	102	0.072	99	0.202	561	0.006	7	0.038	53	0.000	0
Mill Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Niagara River	**	**	**	**	0.237	714	**	**	**	**	0.000	0
Ninemile Creek	0.000	0	0.278	15	**	**	0.000	0	0.278	15	**	**
North Sandy Creek	0.000	0	0.400	157	0.265	90	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.000	0	0.000	0	0.196	231	0.000	0	0.000	0	0.000	0
Oswego River	0.036	41	0.120	89	0.094	163	0.000	0	0.082	61	0.000	0
Salmon River	**0.071**	**1,396**	**0.089**	**1,661**	**0.182**	**7,059**	**0.012**	**293**	**0.007**	**139**	**0.015**	**568**
Sandy Creek	0.370	188	0.027	2	0.120	74	0.000	0	0.000	0	0.000	0
Skinner Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Slater Creek	0.162	187	0.212	185	0.000	0	0.016	18	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.000	0	----	----	0.000	0	0.000	0	----	----
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Webster Park	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Totals		**2,045**		**2,267**		**9,539**		**318**		**269**		**597**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 13 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	February											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
18 Mile Creek	0.582	1,894	----	----	0.322	999	0.033	107	----	----	0.005	15
Bear Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Black River	0.000	0	----	----	----	----	0.000	0	----	----	----	----
Catfish Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Genesee River	0.432	195	0.526	920	0.059	4	0.000	0	0.009	16	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.025	12	----	----	0.199	437	0.000	0	----	----	0.000	0
Johnson Creek	1.071	70	----	----	0.233	67	0.000	0	----	----	0.000	0
Keg Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Lindsey Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Little Salmon River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Little Sandy Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Marsh Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Maxwell Creek	0.187	196	0.000	0	0.141	943	0.000	0	0.000	0	0.031	206
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.163	203	**	**	**	**	0.049	62
Ninemile Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
North Sandy Creek	0.000	0	0.000	0	0.171	173	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.206	210	----	----	0.202	359	0.027	28	----	----	0.006	11
Oswego River	0.010	7	0.104	21	0.087	138	0.000	0	0.104	21	0.042	66
Salmon River	**0.064**	**773**	**0.058**	**426**	**0.175**	**9,185**	**0.008**	**97**	**0.007**	**53**	0.014	744
Sandy Creek	0.000	0	0.000	0	0.262	281	0.000	0	0.000	0	0.035	37
Skinner Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Slater Creek	0.205	185	0.507	161	0.000	0	0.000	0	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.000	0	0.670	974	0.000	0	0.000	0	0.000	0
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Webster Park	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Totals		**3,542**		**1,528**		**13,763**		**232**		**91**		**1,141**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 13 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	March											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
18 Mile Creek	0.488	3,082	0.000	0	0.161	646	0.000	0	0.000	0	0.000	0
Bear Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Black River	0.075	70	0.032	22	0.136	466	0.000	0	0.000	0	0.040	137
Catfish Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Genesee River	0.613	1,396	0.521	460	0.000	0	0.032	73	0.013	11	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.000	0	0.062	75	0.134	242	0.000	0	0.000	0	0.000	0
Johnson Creek	0.114	24	----	----	0.252	100	0.000	0	----	----	0.068	27
Keg Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Lindsey Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Little Salmon River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Little Sandy Creek	0.178	61	0.554	150	**	**	0.020	7	0.000	0	**	**
Marsh Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Maxwell Creek	0.124	466	0.106	296	0.251	2,053	0.028	106	0.034	95	0.023	185
Mill Creek	0.000	0	0.000	0	0.180	294	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.135	495	**	**	**	**	0.129	476
Ninemile Creek	0.000	0	0.000	0			0.000	0	0.000	0		
North Sandy Creek	1.257	780	0.091	17	0.000	0	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.121	404	0.000	0	0.163	698	0.041	136	0.000	0	0.000	0
Oswego River	0.098	342	0.119	156	0.129	345	0.011	40	0.062	81	0.023	63
Salmon River	**0.072**	**2,761**	**0.076**	**1,930**	**0.164**	**30,370**	**0.012**	**461**	**0.019**	**472**	**0.013**	**1,140**
Sandy Creek	0.281	347	0.302	341	0.106	184	0.050	61	0.000	0	0.000	0
Skinner Creek	0.000	0	0.222	55	**	**	0.000	0	0.000	0	**	**
Slater Creek	0.155	297	0.129	75	0.000	0	0.017	33	0.019	11	0.000	0
South Sandy Creek	0.000	0	0.124	52	0.447	1,855	0.000	0	0.059	25	0.047	194
Sterling Creek	0.071	23	----	----	**	**	0.000	0	----	----	**	**
Stony Creek	0.190	105	0.019	3	0.000	0	0.190	105	0.000	0	0.000	0
Webster Park	0.101	54	0.366	366	----	----	0.042	22	0.000	0	----	----
Totals		**10,212**		**3,999**		**37,748**		**1,044**		**694**		**2,221**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 13 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead by tributary, month, and year.

	April											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
18 Mile Creek	0.882	7,889	----	----	0.051	158	0.019	171	----	----	0.000	0
Bear Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Black River	0.401	923	0.039	20	0.000	0	0.125	288	0.000	0	0.000	0
Catfish Creek	0.153	38	----	----	**	**	0.000	0	----	----	**	**
Genesee River	0.703	2,933	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	0.071	19	0.000	0	0.000	0	0.071	19	0.000	0
Irondequoit Creek	0.048	428	0.016	133	0.395	2,897	0.013	114	0.000	0	0.056	409
Johnson Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Keg Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Lindsey Creek	----	----	----	----	**	**	----	----	----	----	**	**
Little Salmon River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Little Sandy Creek	0.000	0	0.148	90	**	**	0.000	0	0.007	4	**	**
Marsh Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Maxwell Creek	0.065	65	0.124	500	0.519	538	0.027	27	0.029	115	0.098	102
Mill Creek	0.000	0	0.000	0	0.138	91	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.177	908	**	**	**	**	0.085	438
Ninemile Creek	0.000	0	0.202	198	**	**	0.000	0	0.096	94	**	**
North Sandy Creek	0.000	0	0.109	34	0.326	134	0.000	0	0.027	8	0.000	0
Oak Orchard Creek	0.376	1,079	0.303	527	0.000	0	0.023	65	0.000	0	0.000	0
Oswego River	0.014	42	0.079	45	0.000	0	0.006	16	0.045	26	0.000	0
Salmon River	**0.102**	**5,254**	**0.079**	**1,916**	**0.151**	**13,242**	**0.014**	**710**	**0.022**	**544**	**0.018**	**1,615**
Sandy Creek	0.150	213	0.335	223	0.000	0	0.000	0	0.000	0	0.000	0
Skinner Creek	0.814	35	0.000	0	**	**	0.000	0	0.000	0	**	**
Slater Creek	0.368	1,216	0.124	84	0.000	0	0.000	0	0.000	0	0.000	0
South Sandy Creek	0.083	343	0.202	123	0.145	419	0.036	148	0.030	18	0.013	39
Sterling Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Stony Creek	0.300	157	0.186	64	0.000	0	0.071	37	0.000	0	0.000	0
Webster Park	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Totals		**20,615**		**3,975**		**18,387**		**1,576**		**829**		**2,602**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 14. Estimated catch and harvest and their respective rates (fish/angler hour) for steelhead and brown trout on the Salmon River from May 1 to 15 by year.

	Catch						Harvest					
	2006		2007		2012		2006		2007		2012	
Species	Rate	Num	Rate	Num	Rate	Num	Rate	Num	Rate	Num	Rate	Num
Steelhead	0.088	363	0.081	1,281	0.182	1,295	0.013	55	0.031	485	0.012	85
Brown trout	0.008	31	0	0	0.012	88	0	0	0	0	0.000	3

Niagara River, and Oak Orchard Creek (Table 12). Peak steelhead catches were recorded in March (37,748) and November (33,488) (Table 13). This pattern is similar to prior results; however, steelhead catch remained high through the entire winter in 2011-2012 because of the mild winter and near ideal fishing conditions.

The May (1st through 15th) Salmon River steelhead catch was much higher in 2012 than in 2006 (1,295 versus 363), but nearly identical to 2007 (1,281) (Table 14).

Higher release rates in recent years (91 % in 2011-2012) are due, in part, to increased catch rates and anglers' desire to conserve steelhead to maintain the quality of the fishery.

The open lake boat fishery caught (36,533) and harvested (16,131) steelhead/rainbow trout in 2011 (Lantry and Eckert 2012). The release rate was 56%, far lower that in the tributaries.

Brown trout

Sixteen of 21 tributaries surveyed had reported catches of brown trout in this study. For all tributaries surveyed, estimated brown trout catches were 52,897 in 2011-2012, between the 68,313 and 39,065 caught the 2005-2006 and 2006-2007 surveys, respectively (Table 15). Harvest was estimated at 8,342, well below the 17,746 and 12,345 for the 2005-2006 and 2006-2007 surveys, respectively (Table 15). The brown trout catch from Maxwell Creek (10,330) was higher than for any other tributary in 2011-2012 and was over triple the number caught in the previous two surveys (3,324 and 2,549, respectively) (Table 15). Irondequoit Creek had the highest harvest at 1,932 fish, comparable to past results (Table 15). Sandy Creek (Monroe County) also produced a high brown trout catch (9,479), followed by the Oswego (8,899) and Salmon (6,604) rivers and Irondequoit (6,165) and Eighteenmile (5,368) (Table 15). The 2011-2012 Salmon River brown trout catch estimate fell between the previous two surveys (9,804 and 3,238, respectively).

The release rate of brown trout for all tributaries was 84% in 2011-2012, a noticeable increase from the 74% and 68% in the 2005-2006 and 2006-2007 surveys, respectively. The Salmon River release rate (89%) was very similar to past results (88% in 2005-2006 and 81% in 2006-2007). One explanation of the increased catches in the tributaries may very well be the "recycling" of released fish that are caught multiple times.

Approximately half (55%) of the total brown trout catch on the non-Salmon River tributaries occurred during November, consistent with prior results (57% in 2005-2006 and 47% in 2006-2007) (Table 16). On the Salmon River, however, only 18 % of the estimated brown trout catch occurred in November, compared to 21% and 6.4% during the 2005-2006 and 2006-2007 surveys, respectively.

The 1984 survey estimated 29,856 brown trout caught and 27,481 harvested on New York's Lake Ontario tributaries (NYSDEC 1984). As with other species, anglers kept a far larger proportion of the brown trout they caught in 1984 compared with recent surveys.

Brown trout catch and harvest estimates from the 2011 open lake boat fishery were 49,661 and 32,937, respectively. (Lantry and Eckert 2012). The boat fishery release rate was 34%, compared to the 84% for the tributary anglers.

Angler residency

Sixty percent of the anglers or parties surveyed on the Salmon River were non-New York State residents, which is identical to the previous two studies (Table 17). The other "high use" tributaries (Oswego River, Oak Orchard, South Sandy, and Eighteenmile creeks) ranged from 33 to 55% non-residents. By contrast, non-residents comprised approximately 21% and 25% of the anglers surveyed on "medium use" and "low use" tributaries, respectively. This is probably because the higher use and more well known tributaries attract angling attention from longer distances than the smaller waters.

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Table 15. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary and year.

	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
Tributary	Rate*	Number	Rate*	Number	Rate*	Number	Rate*	Number	Rate*	Number	Rate*	Number
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.010	41	0.002	10	0.000	0	0.010	41	0.000	0
18 Mile Creek	0.319	27,863	0.207	14,968	0.045	5,368	0.058	5,079	0.085	6,141	0.007	825
Bear Creek	0.124	203	0.132	248	**	**	0.106	173	0.121	227	**	**
Black River	0.113	2,379	0.013	176	0.026	825	0.075	1,576	0.008	108	0.006	194
Catfish Creek	0.017	65	0.000	0	**	**	0.009	34	0.000	0	**	**
Genesee River	0.021	452	0.009	137	0.003	39	0.021	452	0.000	0	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.510	7,251	0.487	6,620	0.344	6,165	0.146	2,079	0.103	1,399	0.107	1,923
Johnson Creek	0.051	283	0.112	1,053	0.001	4	0.028	155	0.090	843	0.000	0
Keg Creek	0.137	170	0.228	1,000	0.000	0	0.137	170	0.031	136	0.000	0
Lindsey Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Little Salmon River	0.000	0	0.005	23	0.009	49	0.000	0	0.005	23	0.000	0
Little Sandy Creek	0.005	15	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Maxwell Creek	0.188	3,324	0.105	2,549	0.235	10,330	0.081	1,435	0.037	905	0.037	1,616
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.020	828	**	**	**	**	0.003	137
Ninemile Creek	0.068	77	0.016	61	**	**	0.024	27	0.009	34	**	**
North Sandy Creek	0.032	602	0.006	42	0.104	1,474	0.028	533	0.006	42	0.000	0
Oak Orchard Creek	0.059	4,093	0.070	3,444	0.048	2,649	0.022	1,539	0.027	1,327	0.008	429
Oswego River	0.040	2,830	0.012	565	0.151	8,899	0.015	1,074	0.005	250	0.029	1,734
Salmon River	**0.016**	**9,804**	**0.005**	**3,238**	**0.006**	**6,604**	**0.002**	**1,177**	**0.001**	**613**	**0.001**	**711**
Sandy Creek	0.323	5,112	0.231	3,801	0.433	9,479	0.042	662	0.006	99	0.031	678
Skinner Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Slater Creek	0.226	3,060	0.024	174	----	----	0.086	1,169	0.000	0	----	----
South Sandy Creek	0.003	69	0.002	55	0.001	33	0.002	61	0.000	0	0.000	0
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.056	110	0.002	3	0.000	0	0.056	110	0.000	0	0.000	0
Webster Park	0.193	551	0.183	867	0.066	142	0.084	241	0.033	157	0.045	96
Total		**68,313**		**39,065**		**52,897**		**17,746**		**12,345**		**8,342**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 16. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and year.

	September											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	----	----	**	**	**	**	----	----	**	**
12 Mile Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
18 Mile Creek	0.033	47	0.022	256	0.016	81	0.033	47	0.000	0	0.000	0
Bear Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Black River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Catfish Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Genesee River	0.000	0	0.011	41	0.008	34	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.353	153	0.429	290	0.360	153	0.000	0	0.429	290	0.110	47
Johnson Creek	0.624	219	0.000	0	0.000	0	0.258	90	0.000	0	0.000	0
Keg Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Lindsey Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Little Salmon River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Little Sandy Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Maxwell Creek	0.000	0	0.000	0	----	----	0.000	0	0.000	0	----	----
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.001	4	**	**	**	**	0.001	4
Ninemile Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
North Sandy Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Oswego River	0.004	42	0.008	173	0.010	200	0.000	0	0.003	54	0.004	82
Salmon River [1]	**0.008**	**1,435**	**0.009**	**1,548**	**0.004**	**950**	**0.001**	**189**	**0.003**	**488**	**0.000**	**123**
Sandy Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.000	0	----	----	0.000	0	0.000	0	----	----
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	----	----	----	----	0.000	0	----	----	----	----
Webster Park	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Totals		**1,896**		**2,310**		**1,423**		**326**		**832**		**256**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled
1=Salmon River study began in early Sept., others mid-Sept.

Table 16 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and yea

	October											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
18 Mile Creek	0.027	796	0.161	4,686	0.088	5,239	0.008	239	0.057	1,676	0.023	1,345
Bear Creek	0.000	0	0.115	56	**	**	0.000	0	0.115	56	**	**
Black River	0.171	2,207	0.015	107	0.003	51	0.114	1,471	0.015	107	0.000	0
Catfish Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Genesee River	0.000	0	0.016	96	0.000	0	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.145	153	0.130	118	0.436	1,163	0.105	110	0.000	0	0.029	78
Johnson Creek	0.000	0	0.057	193	0.005	24	0.000	0	0.057	193	0.000	0
Keg Creek	0.000	0	0.099	108	0.000	0	0.000	0	0.071	77	0.000	0
Lindsey Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Little Salmon River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Little Sandy Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0.073	263	0.059	303	0.225	1,834	0.003	9	0.033	167	0.055	445
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.006	53	**	**	**	**	0.005	47
Ninemile Creek	0.086	10	0.005	9	**	**	0.086	10	0.005	9	**	**
North Sandy Creek	0.005	75	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.019	748	0.022	542	0.082	1,702	0.000	0	0.022	537	0.014	290
Oswego River	0.007	261	0.010	201	0.016	308	0.003	129	0.004	72	0.007	135
Salmon River	**0.004**	**982**	**0.003**	**630**	**0.004**	**1,241**	**0.001**	**194**	**0.000**	**93**	**0.000**	**98**
Sandy Creek	0.037	203	0.171	179	0.162	1,000	0.015	81	0.043	45	0.042	257
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0.103	261	0.059	153	----	----	0.080	205	0.000	0	----	----
South Sandy Creek	0.000	0	0.000	0	0.001	46	0.000	0	0.000	0	0.000	0
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Webster Park	0.555	251	0.119	110	0.452	191	0.308	140	0.000	0	0.293	124
Totals		**6,210**		**7,492**		**12,852**		**2,588**		**3,032**		**2,697**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 16 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and year.

	November											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.083	41	0.000	0	0.000	0	0.083	41	0.000	0
18 Mile Creek	0.618	23,299	0.417	9,782	0.184	5,999	0.041	1,539	0.191	4,482	0.035	1,156
Bear Creek	0.316	148	1.009	192	**	**	0.252	118	0.900	171	**	**
Black River	0.000	0	0.015	20	0.036	114	0.000	0	0.000	0	0.012	38
Catfish Creek	0.082	65	0.000	0	**	**	0.042	34	0.000	0	**	**
Genesee River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.734	537	0.126	153	0.174	258	0.000	0	0.000	0	0.020	30
Johnson Creek	0.000	0	0.351	860	0.000	0	0.000	0	0.265	648	0.000	0
Keg Creek	0.000	0	0.430	328	0.000	0	0.000	0	0.077	58	0.000	0
Lindsey Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Little Salmon River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Little Sandy Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	----	----	----	----	**	**	----	----	----	----	**	**
Maxwell Creek	0.303	1,659	0.156	1,127	0.493	5,793	0.053	292	0.036	257	0.071	838
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.004	51	**	**	**	**	0.002	25
Ninemile Creek	0.077	67	0.041	27	**	**	0.020	18	0.000	0	**	**
North Sandy Creek	0.020	51	0.025	42	0.000	0	0.020	51	0.025	42	0.000	0
Oak Orchard Creek	0.091	1,958	0.232	2,373	0.026	483	0.022	477	0.077	786	0.000	0
Oswego River	0.117	1,105	0.002	8	0.219	2,415	0.012	111	0.002	8	0.055	612
Salmon River	**0.033**	**2,015**	**0.005**	**208**	**0.008**	**1,173**	**0.003**	**184**	**0.000**	**0**	**0.001**	**201**
Sandy Creek	0.610	3,910	0.529	1,360	1.025	9,980	0.029	188	0.021	54	0.114	1,110
Skinner Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Slater Creek	0.057	150	0.000	0	0.000	0	0.020	53	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.000	0	0.006	25	0.000	0	0.000	0	0.000	0
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	0.000	0	----	----	0.000	0	0.000	0	----	----
Webster Park	0.156	144	0.307	503	0.246	203	0.000	0	0.067	109	0.194	160
Totals		**35,108**		**17,025**		**26,494**		**3,065**		**6,657**		**4,170**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 16 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and year.

	December											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0	0	**	**	**	**	0	0	**	**
12 Mile Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
18 Mile Creek	0	0	0.056	235	0.138	1,127	0	0	0	0	0.005	43
Bear Creek	0	0	----	----	**	**	0	0	----	----	**	**
Black River	0	0	0.133	43	0.048	8	0	0	0	0	0.000	0
Catfish Creek	0	0	----	----	**	**	0	0	----	----	**	**
Genesee River	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Grindstone Creek	0	0	----	----	0.000	0	0	0	----	----	0.000	0
Irondequoit Creek	0	0	0.024	14	0.132	170	0	0	0	0	0.000	0
Johnson Creek	0	0	----	----	0.049	23	0	0	----	----	0.000	0
Keg Creek	0	0	1.154	564	0.000	0	0	0	0	0	0.000	0
Lindsey Creek	----	----	0	0	**	**	----	----	0	0	**	**
Little Salmon River	0	0	0.132	23	----	----	0	0	0.132	23	----	----
Little Sandy Creek	0	0	0	0	**	**	0	0	0	0	**	**
Marsh Creek	----	----	0	0	**	**	----	----	0	0	**	**
Maxwell Creek	0.125	175	0.057	167	0.244	1,314	0.056	78	0.026	77	0.037	200
Mill Creek	0	0	0	0	0.000	0	0	0	0	0	0.000	0
Niagara River	**	**	**	**	0.038	131	**	**	**	**	0.000	0
Ninemile Creek	0	0	0	0	**	**	0	0	0	0	**	**
North Sandy Creek	0	0	0	0	0.025	64	0	0	0	0	0.000	0
Oak Orchard Creek	0	0	0.249	531	0.084	452	0	0	0	0	0.000	0
Oswego River	0.226	329	0.032	54	0.107	268	0.029	43	0.019	31	0.009	23
Salmon River	**0.064**	**1,493**	**0.013**	**483**	**0.014**	**823**	**0.009**	**210**	**0**	**13**	**0.001**	**42**
Sandy Creek	0.077	26	0.564	348	0.375	804	0	0	0	0	0.000	0
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0.117	117	0	0	0.000	0	0.01	10	0	0	0.000	0
South Sandy Creek	0	0	0	0	0.011	30	0	0	0	0	0.000	0
Sterling Creek	0	0	0	0	**	**	0	0	0	0	**	**
Stony Creek	0	0	0	0	----	----	0	0	0	0	----	----
Webster Park	0.214	28	0	0	0.160	70	0	0	0	0	0.000	0
Totals		**2,168**		**2,460**		**5,284**		**341**		**143**		**308**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 16 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and year.

	January											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	----	----	0.038	7	0.000	0	----	----	0.000	0
18 Mile Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Bear Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Black River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Catfish Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Genesee River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Irondequoit Creek	0.126	111	0.000	0	0.114	82	0.018	16	0.000	0	0.000	0
Johnson Creek	0.000	0	0.000	0	0.027	6	0.000	0	0.000	0	0.000	0
Keg Creek	0.000	0	0.000	0	----	----	0.000	0	0.000	0	----	----
Lindsey Creek	----	----	----	----	**	**	----	----	----	----	**	**
Little Salmon River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Little Sandy Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	----	----	0.000	0	**	**	----	----	0.000	0	**	**
Maxwell Creek	0.129	151	0.139	193	0.222	618	0.018	21	0.077	107	0.008	23
Mill Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Niagara River	**	**	**	**	0.000	0	**	**	**	**	0.000	0
Ninemile Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
North Sandy Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.000	0	0.000	0	0.235	277	0.000	0	0.000	0	0.000	0
Oswego River	0.157	180	0.053	39	0.241	419	0.022	26	0.027	20	0.051	88
Salmon River	**0.043**	**847**	**0.008**	**141**	**0.008**	**310**	**0.003**	**50**	**0.000**	**0**	**0.000**	**9**
Sandy Creek	0.476	242	0.511	43	0.172	106	0.000	0	0.000	0	0.000	0
Skinner Creek	----	----	----	----	**	**	----	----	----	----	**	**
Slater Creek	0.415	480	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.300	55	----	----	0.000	0	0.000	0	----	----
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Webster Park	0.000	0	0.095	23	0.000	0	0.000	0	0.000	0	0.000	0
Totals		**2,011**		**495**		**1,825**		**113**		**126**		**120**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 16 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and year.

	February											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
18 Mile Creek	0.192	625	----	----	0.038	117	0.000	0	----	----	0.000	0
Bear Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Black River	0.000	0	----	----	----	----	0.000	0	----	----	----	----
Catfish Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Genesee River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.000	0	----	----	0.155	339	0.000	0	----	----	0.016	36
Johnson Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Keg Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Lindsey Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Little Salmon River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Little Sandy Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Marsh Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Maxwell Creek	0.060	62	0.000	0	0.189	1,269	0.014	15	0.000	0	0.029	194
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.078	98	**	**	**	**	0.025	31
Ninemile Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
North Sandy Creek	0.000	0	0.000	0	0.343	346	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.000	0	----	----	0.012	22	0.000	0	----	----	0.000	0
Oswego River	0.231	156	0.000	0	0.121	193	0.000	0	0.000	0	0.015	24
Salmon River	**0.022**	**267**	**0.005**	**38**	**0.005**	**258**	**0.005**	**63**	**0.001**	**5**	**0.000**	**6**
Sandy Creek	0.331	100	0.000	0	0.144	154	0.000	0	0.000	0	0.000	0
Skinner Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Slater Creek	1.199	1,082	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Sterling Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Stony Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Webster Park	0.800	81	----	----	0.000	0	0.000	0	----	----	0.000	0
Totals		**2,373**		**38**		**2,796**		**78**		**5**		**291**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 16 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and year.

	March											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
18 Mile Creek	0.077	484	0.000	0	0.017	67	0.000	0	0.000	0	0.000	0
Bear Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Black River	0.075	70	0.008	6	0.028	97	0.000	0	0.000	0	0.008	29
Catfish Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Genesee River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.109	174	0.025	30	0.184	334	0.000	0	0.000	0	0.000	0
Johnson Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Keg Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Lindsey Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Little Salmon River	0.000	0	----	----	0.054	21	0.000	0	----	----	0.000	0
Little Sandy Creek	0.045	15	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Maxwell Creek	0.016	59	0.132	368	0.053	430	0.000	0	0.044	123	0.003	28
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.036	133	**	**	**	**	0.036	133
Ninemile Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
North Sandy Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.041	136	0.000	0	0.011	45	0.014	45	0.000	0	0.004	15
Oswego River	0.038	133	0.052	68	0.164	439	0.004	16	0.033	43	0.024	64
Salmon River	**0.025**	**962**	**0.005**	**127**	**0.012**	**1,022**	**0.003**	**134**	**0.000**	**8**	**0.002**	**155**
Sandy Creek	0.217	269	1.588	1,798	0.093	161	0.050	61	0.000	0	0.000	0
Skinner Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Slater Creek	0.232	445	0.036	21	0.000	0	0.000	0	0.000	0	0.000	0
South Sandy Creek	0.020	81	0.000	0	0.000	0	0.010	41	0.000	0	0.000	0
Sterling Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Stony Creek	0.000	0	0.019	3	0.000	0	0.000	0	0.000	0	0.000	0
Webster Park	0.050	27	0.093	93	----	----	0.000	0	0.047	47	----	----
Totals		**2,855**		**2,513**		**2,748**		**297**		**221**		**424**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 16 cont. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary, month, and year.

	April											
	Catch						Harvest					
	2005-2006		2006-2007		2011-2012		2005-2006		2006-2007		2011-2012	
	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num	Rate*	Num
4 Mile Creek	**	**	0.000	0	**	**	**	**	0.000	0	**	**
12 Mile Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
18 Mile Creek	0.000	0	----	----	0.019	60	0.000	0	----	----	0.019	60
Bear Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Black River	0.000	0	0.000	0	0.014	34	0.000	0	0.000	0	0.000	0
Catfish Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Genesee River	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Grindstone Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Irondequoit Creek	0.639	5,662	0.711	6,016	0.929	6,814	0.168	1,486	0.131	1,110	0.261	1,914
Johnson Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Keg Creek	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Lindsey Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Little Salmon River	0.000	0	----	----	0.000	0	0.000	0	----	----	0.000	0
Little Sandy Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Marsh Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Maxwell Creek	0.000	0	0.097	392	0.000	0	0.000	0	0.042	171	0.000	0
Mill Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Niagara River	**	**	**	**	0.003	14	**	**	**	**	0.000	0
Ninemile Creek	0.000	0	0.025	25	**	**	0.000	0	0.025	25	**	**
North Sandy Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Oak Orchard Creek	0.086	248	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Oswego River	0.029	84	0.054	31	0.000	0	0.029	84	0.011	7	0.000	0
Salmon River	**0.033**	**1,725**	**0.003**	**80**	**0.006**	**547**	**0.003**	**142**	**0.001**	**15**	0.001	79
Sandy Creek	0.112	159	0.113	75	0.000	0	0.020	28	0.000	0	0.000	0
Skinner Creek	0.000	0	0.000	0	**	**	0.000	0	0.000	0	**	**
Slater Creek	0.212	703	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
South Sandy Creek	0.000	0	0.000	0	0.003	9	0.000	0	0.000	0	0.000	0
Sterling Creek	0.000	0	----	----	**	**	0.000	0	----	----	**	**
Stony Creek	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0	0.000	0
Webster Park	0.000	0	0.312	146	0.000	0	0.000	0	0.000	0	0.000	0
Totals		**8,581**		**6,765**		**7,478**		**1,740**		**1,327**		**2,053**

* = Number of fish caught or harvested per hour, ---- = Effort data with no interview data for CPUE, ** = Creek not sampled

Table 17. Angler residency expressed as percentages of interviews of NYS and non-NYS residents from the Lake Ontario tributary angler surveys by year.

	2005-2006				2006-2007				2011-2012			
Tributary	Interviews	NYS	non-NYS	%Non	Interviews	NYS	non-NYS	%Non	Interviews	NYS	non-NYS	%Non
High-use tribs												
Salmon River	**3,050**	**1,219**	**1,831**	**60**	**2,717**	**1,089**	**1,628**	**60**	**4,412**	**1,781**	**2,631**	**60**
Oswego River	882	514	368	42	1,147	582	565	49	1,128	761	367	33
18 Mile Creek	246	154	92	37	221	148	73	33	697	463	234	34
South Sandy Creek	103	43	60	58	121	65	56	46	345	156	189	55
Oak Orchard Creek	179	102	77	43	194	121	73	38	232	193	39	17
Totals	**4,357**	**1,989**	**2,368**	**54**	**4,279**	**1,940**	**2,339**	**55**	**6,814**	**3,354**	**3,460**	**51**
Medium-use tribs												
Niagara River	*	*	*	*	*	*	*	*	464	332	132	28
Black River	78	66	12	15	173	137	36	21	370	295	75	20
Maxwell Creek	465	334	131	28	546	368	178	33	324	284	40	12
Sandy Creek	130	74	56	43	129	101	28	22	188	134	54	29
Irondequoit Creek	151	151	0	0	192	188	4	2	173	171	2	1
Genesee River	172	160	12	7	140	134	6	4	111	109	2	2
North Sandy Creek	90	42	48	53	108	48	60	56	108	42	66	61
Totals	**1,038**	**719**	**319**	**31**	**1,217**	**853**	**364**	**30**	**1,738**	**1,367**	**371**	**21**
Low-use tribs												
12 Mile Creek	16	13	3	19	33	30	3	9	93	90	3	3
Little Salmon River	62	32	30	48	86	44	42	49	80	50	30	38
Johnson Creek	50	37	13	26	70	49	21	30	78	49	29	37
Mill Creek	56	26	30	54	10	8	2	20	54	40	14	26
Webster Park	54	38	16	30	72	63	9	13	44	44	0	0
Stony Creek	19	6	13	68	27	18	9	33	25	3	22	88
Grindstone Creek	17	11	6	35	27	12	15	56	24	21	3	13
Keg Creek	21	17	4	19	29	12	17	59	3	3	0	0
Slater Creek	177	174	3	2	123	119	4	3	0	NA	NA	NA
4 Mile Creek	----	----	----	----	2	2	0	0	*	*	*	*
Bear Creek	25	19	6	24	26	21	5	19	*	*	*	*
Catfish Creek	56	14	42	75	37	11	26	70	*	*	*	*
Lindsey Creek	0	0	0	0	1	1	0	0	*	*	*	*
Little Sandy Creek	64	23	41	64	107	64	43	40	*	*	*	*
Marsh Creek	0	0	0	0	0	0	0	0	*	*	*	*
Ninemile Creek	35	33	2	6	122	110	12	10	*	*	*	*
Skinner Creek	4	3	1	25	16	15	1	6	*	*	*	*
Sterling Creek	40	21	19	48	35	27	8	23	*	*	*	*
Totals	**791**	**592**	**199**	**25**	**1,005**	**786**	**219**	**22**	**401**	**300**	**101**	**25**
Overall total	**6,186**	**3,300**	**2,886**	**46.7**	**6,501**	**3,579**	**2,922**	**44.9**	**8,953**	**5,021**	**3,932**	**44**

* = Not sampled

Appendix 1. Calculations and Formulas

Effort estimates for the <u>Salmon River</u>

Estimates of effort were done using "instantaneous" counts of anglers, vehicles, drift-boat trailers, and boats in the estuary. Means of the counts were used for days when multiple counts occurred. Effort data were stratified by week. Daily estimates of angler effort (angler hours) were calculated as follows:

$$\hat{H}_{j,h} = [A_t + A_e + (V_{sr} + V_{uf} + V_t - Db) * P_{sh} + Db * P_{db} + B_e * P_{be}]_{j,h} * daylength_{j,h}$$

where:

$\hat{H}_{j,h}$ = the number of angler hours on day *j* in stratum *h*

A_t = the number of anglers counted in Pulaski

A_e = the number of shore access anglers counted in the estuary

V_{sr} = the number of vehicles counted along the main stem of the Salmon River including those counted at the lower fly area in Altmar and excluding those counted in Pulaski, the upper fly fishing area and those attached to drift boat trailers

V_{uf} = the number of vehicles counted at the upper fly fishing area

V_t = the number of vehicles counted at the tributary access points

D_b = the number of drift boat trailers counted. Note: the (Vsr + Vuf + Vt - Db) term accounts for one pickup vehicle per drift boat being left in a downstream parking area

P_{sh} = the mean size of shore access parties (anglers/vehicle)

P_{db} = the mean size of drift boat parties

B_e = the number of boats counted in the estuary

P_{be} = the mean party size (anglers/boat) for boat access fishermen in the estuary

$daylength_j$ = the number of hours from ½ hour before sunrise to ½ hour after sunset on day *j*.

The estimator for mean angler hours for all days sampled in stratum h is:

$$\hat{H}_h = \frac{\sum_{j=1}^{n_h} \hat{H}_{j,h}}{n_h}$$

n_h = the number of days sampled in stratum *h*

and the stratum variance is:

$$s_h^2 = \frac{\sum_{j=1}^{n_h} (\hat{H}_{j,h} - \hat{H}_h)^2}{n_h - 1}$$

and the variance of $\hat{H}_h$ is:

$$V(\hat{H}_h) = \frac{s_h^2}{n_h}\left(\frac{N_h - n_h}{N_h}\right)$$

where N_h is the total number of days in the stratum h and $\left(\frac{N_h - n_h}{N_h}\right)$ is the finite population correction factor, and the standard error of $\hat{H}_h$ is:

$$SE(\hat{H}_h) = \sqrt{V(\hat{H}_h)}$$

The estimated total for all angler hours is:

$T_H = \sum_{h=1}^{L} N_h(\hat{H}_h)$ where L is the total number of stratum and the variance of the total is:

$$V(T_H) = \sum_{h=1}^{L} N_h^2 V(\hat{H}_h)$$

and the standard error of the total is:

$$SE(T_H) = \sqrt{V(T_h)}$$

The effort estimates were partitioned by fishing type into boat fishing in the estuary, shore access and drift boat fishing in the normal regulations portion of the main stem, fishing in the tributaries, and fishing in the special regulations catch and release fly fishing only areas. This was done to provide appropriate weighting factors for stratification of the catch data.

Drift boat effort was calculated by taking the number of drift boat trailers counted and multiplying by the mean size of drift boat party (from the interview forms). Special regulations fly fishing effort was estimated by multiplying the number of vehicles in the upper fly fishing parking area by the mean size of shore fishing parties (again, from the interview forms) and adding the number of anglers counted in the lower fly fishing area in Altmar. Note that the overall estimate of angler effort accounts for special regulations area fly fishermen with vehicle counts only. We had to count the anglers in the lower fly fishing area for the estimate of effort for the special regulations fly fishing areas, however, because there was no way to know whether vehicles parked in Altmar belonged to anglers fishing the fly fishing area or the conventional regulations area of the river. We also had to count anglers in Pulaski and in the estuary because they did not all park in designated lots. Similar partitions of the data allowed us to estimate boat effort in the estuary and effort in the tributaries. Angler trips were estimated by dividing the

estimates for angler hours by the mean lengths of completed trips for each fishing type and for the overall estimate.

Effort estimates for <u>Non-Salmon River</u> Tributaries

$$\hat{H}_{j,h} = [A_t + (V_{vc} * P_{vc}) + (B_e * P_{be})]_{j,h} * daylength_{j,h}$$

where:

$\hat{H}_{j,h}$ = the number of angler hours on day *j* in stratum *h*

A_t = the number of anglers counted on the stream

V_{vc} = the number of vehicles at sites on stream *i* where a direct angler counts were not possible

P_{vc} = the mean size of angler party on stream *i*

B_e = number of drift boats counted on stream *i*

P_{be} = the mean size of drift boat angler party on stream *i*

The remaining effort calculations are the same as for the Salmon River.

The total angling effort on a given day for the non-Salmon River tributaries is the sum of the direct count anglers plus the adjusted vehicle counts for those areas where direct counts were not readily obtainable. This adjusted value is simply the vehicle count multiplied by the stream specific mean angling party size, which comes from the interview data. Additionally for the Black and Oswego rivers the drift-boat angling effort is added to the total angler count. For these waters the number of drift-boats is counted and multiplied by the stream specific drift-boat party size, again coming from the interview data.

Catch and Harvest

These parameters were stratified for the Salmon River the same as the effort data (by week for Sept. through Nov. and month for Dec. through May) and additionally by five fishing types: shore access (conventional regulations section of the river), special regulations fly fishing, drift boat fishing, boat fishing in the estuary, and tributary fishing.

Catch and harvest data for the non-Salmon River waters were stratified by month only.

Mean catch rates were calculated as follows with the ratio of means estimator being used for the Salmon River survey. The ratio of means estimator is appropriate for access site creel surveys and the calculations followed Lockwood *et al*. 1999.

Both the ratio of means and mean of ratios estimators were used for the non-Salmon River tributary interviews for complete and incomplete trips, respectively. Since neither interview type was consistently predominant, a weighted mean catch rate formula was used to combine the two estimates into a single value (Lockwood 2005).

Ratio of Means Stratified Catch Rate Estimator for all Salmon River interviews and complete trip interviews on all other tributaries

y = fish caught or harvested, x = hours fished by angler i in stratum h and L is the total number of strata.

$\hat{R}_h = \frac{\bar{y}_h}{\bar{x}_h}$ is the rate in stratum h and $\hat{R} = \frac{\bar{y}_{st}}{\bar{x}_{st}}$ is the overall estimator

where:

$$\bar{y}_{st} = \frac{\sum_{h=1}^{L} N_h \bar{y}_h}{N} \quad \text{And} \quad \bar{x}_{st} = \frac{\sum_{h=1}^{L} N_h \bar{x}_h}{N}$$

and the variance of $\hat{R}_h$ is:

$$V(\hat{R}_h) = \left(\frac{N_h - n_h}{N_h} \right) \frac{\sum_{i=1}^{n_h} \left(y_{i,h} - \hat{R}_h x_{i,h} \right)^2}{n_h (n_h - 1) \bar{x}_h^2}$$

and the variance of $\hat{R}$ is:

$$V(\hat{R}) = \sum_{h=1}^{L} \left(\frac{N_h}{N} \right)^2 V(\hat{R}_h)$$

Mean of Ratios Stratified Catch Rate Estimator for Incomplete Trip Interviews on non-Salmon River tributaries

The catch rate estimator for stratum *h* is:

$$\overline{R}_h = \frac{\sum_{i,h=1}^{n_h} R_{i,h}}{n_h}$$

where:
i,h = interviewed angler *i* (sampling unit) in stratum *h*
n_h = the number of anglers interviewed in stratum *h*

$$R_{i,h} = \frac{y_{i,h}}{x_{i,h}}$$

$y_{i,h}$ = the number of fish caught or harvested by angler *i* in stratum *h*
$x_{i,h}$ = the number of hours fished by angler *i* in stratum *h*

And the combined catch rate estimator for all strata is:

$$\overline{R} = \frac{\sum_{h=1}^{L} N_h \left(\overline{R}_h\right)}{N}$$

where:
L = total number of stratum
N_h = total estimated anglers in stratum *h* (from interview data)
N = total estimated anglers in all strata (from interview data)

And the variance of $\overline{R}$ is:

$$V\left(\overline{R}\right) = \sum_{h=1}^{L} \left(\frac{N_h}{N}\right)^2 \frac{S_{R,h}^2}{n_h}$$

where:

$$S_{R,h}^2 = \left(\frac{1}{n_h - 1}\right) \sum_{i=1}^{n_h} \left(R_{i,h} - \overline{R}_h\right)^2$$

is the sample variance of catch or harvest rates in stratum *h*

Weighted Mean Stratified Catch Rate Estimator for analyses using both interview types

The within stratum catch/harvest rate estimator is:

$$\tilde{R}_h = \frac{\hat{R}_h n_{\hat{R}_h} + \overline{R}_h n_{\overline{R}_h}}{n_{\hat{R}_h} + n_{\overline{R}_h}}$$

The overall weighted catch/harvest rate estimator is:

$$\tilde{R} = \frac{\sum_{h=1}^{L} (\tilde{R}_h * T_{H_h})}{T_H}$$

And the variance of $\tilde{R}$ is:

$$V\left(\tilde{R}\right) = \frac{V(\hat{R}) n_{\hat{R}}^2 + V(\overline{R}) n_{\overline{R}}^2}{(n_{\hat{R}} + n_{\overline{R}})^2}$$

Overall catch and harvest estimates for all catch/harvest estimators

Overall total catch and harvest were estimated by:

$$T_{xy} = xy$$

Where: $x = \hat{R}$ for the Salmon River or $\tilde{R}$ for non-Salmon River tributaries and $y = T_H$ (total estimated angler hours)

Since all catch and harvest estimates are calculated by multiplying the rate by the number of hours, the variances of the estimates were calculated using the formula for variance of a product from Mood et al. (1963).

$$V(T_{xy}) = x2V(y) + y2V(x) + V(x)V(y)$$

and the standard error of the estimated catch/harvests is:

$$SE(T_{xy}) = \sqrt{V(T_{xy})}$$

The 95% confidence interval is:

$$1.96 \times SE(T_{xy})$$

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Important Changes

- Surveillance transects established, whole depth distribution (8 – 170m) sampled with bottom trawls four times a year
- New shallow draft, aluminum *R/V Kaho* replaces aging steel *Kaho*

History and Description

Lake Ontario is the most downstream of the Laurentian Great Lakes and has a mean depth of 86 m (282 ft) and a maximum depth of 244 m (801 ft) (Herdendorf 1982). The southern, New York portion of the lake has the deepest water (Figure 1). In New York waters, about 67% of the lake is <160 m (525 ft) deep and about 82% of the lake is <180 m (591 ft) deep. The U.S. Geological Survey (USGS) and New York State Department of Environmental Conservation (NYSDEC) have cooperatively assessed Lake Ontario prey fishes each year since 1978. Bottom trawl assessments were initially focused on alewife *Alosa pseudoharengus* (April), rainbow smelt *Osmerus mordax* (June), and slimy sculpin *Cottus cognatus* (October). Seasonal survey timing corresponded to the peak catches in 1972 when collections were made every month May to October (Owens et al. 2003). Twelve transects were established at approximately 25-km (15.5 mi) intervals along the U.S. shoreline (Figure 2). Alewife assessment was conducted at all transects, rainbow smelt assessment at all transects except Fair Haven, and six transects representing eastern, southern, and western lake areas were sampled for slimy sculpin (Figure 2). Changes in the Lake Ontario ecosystem (e.g., dreissenid invasion, oligotrophication, native species recovery) required redistribution of trawl effort, sampling designs, and gear changes. For instance, the spring alewife assessment

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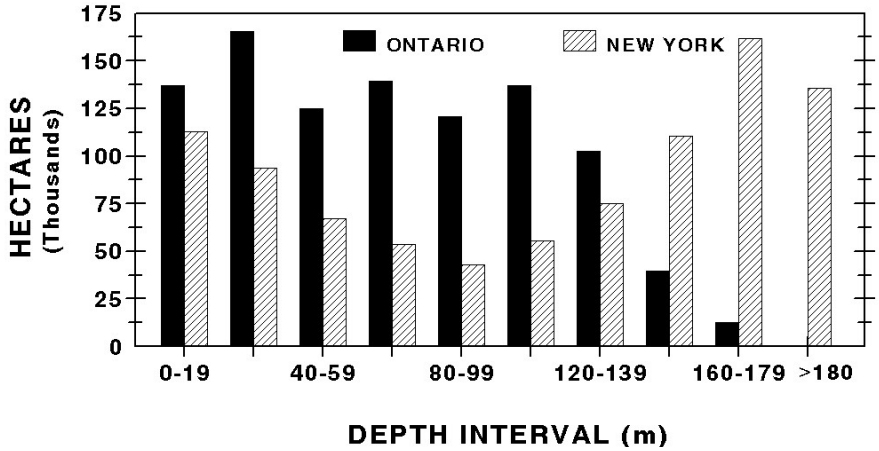

Figure 1. Area of Lake Ontario in various depth strata in the province of Ontario and the state of New York. 1 m = 3.28 ft and 1 hectare = 2.47 acres.

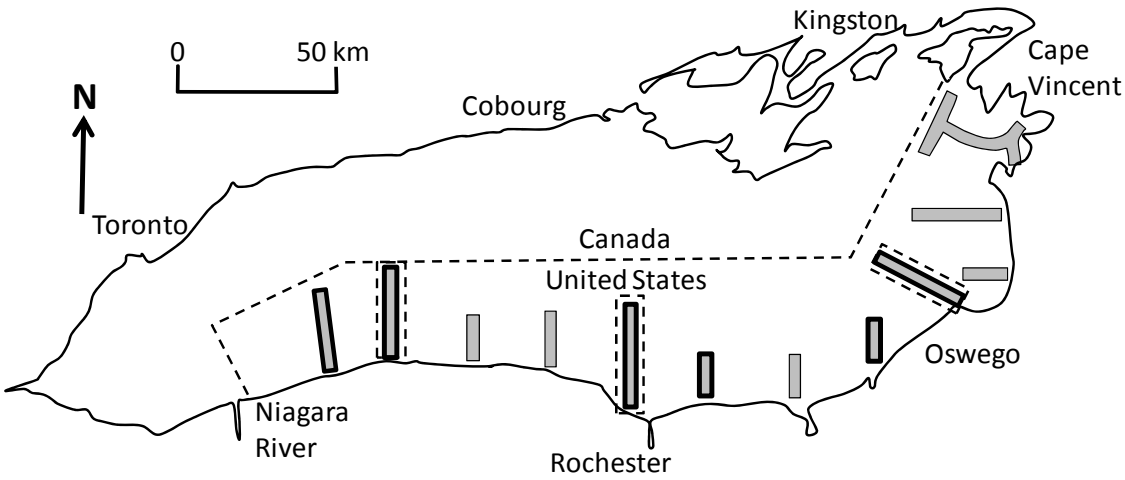

Figure 2. Lake Ontario showing 12 transects sampled by USGS and NYSDEC with bottom trawls. Transect names, from west to east: Olcott, Thirty Mile Point, Oak Orchard, Hamlin, Rochester, Smoky Point, Sodus, Fair Haven, Oswego, Mexico Bay, Southwick, and Cape Vincent. Six benthic prey fish assessment transects (sculpin) are denoted by the thicker outline. The dashed outline denotes the three surveillance transects.

is now used to assess invasive round goby *Neogobius melanostomus* population dynamics and the fall benthic fish assessment (formerly sculpin assessment) tracks dynamics of the recovering native, deepwater sculpin *Myoxocephalus thompsonii* population, the apparent declining population of slimy sculpin, and the fall distribution of round goby.

Sampling Design

Abundance indices for alewife, rainbow smelt, and round goby are depth-stratified mean catch per 10 minute tow. Fixed-station sampling designs are commonly used for assessing fish populations in the Great Lakes and in northern Europe (ICES 2004). The underlying assumption is that changes in relative abundance at the fixed stations are representative of the whole population. Mean abundance from fixed-station surveys will not be biased if the fish are randomly distributed. Hydroacoustic sampling conducted during the 2004-2006 alewife bottom trawl assessments confirmed our assumption of random distribution within geographic areas. Furthermore, differences among geographic areas in densities of alewife-strength targets measured with hydroacoustics were reflected in the densities of alewife measured by bottom trawl. However, there is no assurance that this has always been true given the large-scale shifts in fish distribution observed over recent decades. Although random sampling is preferable for estimating precision, the systematic, fixed-station sampling that we employ in Lake Ontario will often be optimal for generating the most precise estimate of relative abundance even though the variance of the estimated relative abundance will be biased (ICES 2004).

Estimates of trawl area swept have been used to improve our understanding of slimy sculpin and deepwater sculpin density changes over the course of the entire time series. Previous depth stratified slimy sculpin abundance indices were invalidated because changes in the population's depth

distribution resulted in large areas of the lake that were not sampled but contained most of the population. Current assessments continue to use a fixed station sampling design, however, density for both species is calculated as the mean of all tows from the fall prey fish assessment. Deepwater sculpin density is based on tows from 8m to 150m (26.2 to 492.1 ft) and slimy sculpin density is based on tows from 55m to 175m (180.4 to 574.1 ft).

Surveillance Transects

In 2012, surveillance transects were established at three locations (Thirty Mile Point, Rochester, and Oswego) in Lake Ontario to provide more complete sampling of available depths. Four times a year, bottom trawl samples are collected from 8 m to 175 m. The original sampling designs for prey fish and juvenile lake trout bottom trawl assessments concentrated sampling effort in depths where the target species were most abundant. Although this approach reduced variability in specific species abundance indices, large areas of the lake and specific depths were not regularly sampled, and reduced our ability to quantify changes in the fish community. For instance, effort on the spring alewife assessment is concentrated at depths greater than 70 m. As round goby proliferated in the early 2000's, the spring distribution of round goby was poorly understood due to a lack of sampling in shallower depths. Similarly, the benthic fish assessment that specifically targeted slimy sculpin originally sampled to 150 m, impeding our understanding of how deepwater sculpin were increasing at deeper depths over the past 10 years. Establishing surveillance transects will efficiently maximize the potential for bottom trawl samples to illustrate future and unexpected changes in the Lake Ontario fish community.

Vessels

Vessels used in prey fish assessments have been relatively consistent over time. Two vessels participated in prey fish surveys during 1978-1982, the 19.8-m (65 ft), steel hull R/V *Kaho* (USGS) and the 12.8-m (42 ft), fiberglass hull R/V *Seth Green* (NYSDEC). During 1983-1985, all assessment trawling was conducted by the *Kaho* (the fiberglass *Seth Green* was permanently retired in fall

Figure 3. RV Kaho, a new 21.2m (70-ft), aluminum-hull research vessel has replaced the aging, steel-hull Kaho 19.8-m (65-ft). This new vessel has a shallower draft and enhanced sampling capabilities. The image is R/V Kaho during sea trials on Lake Erie.

1982). In 1985, the NYSDEC accepted delivery of a new R/V *Seth Green* and this 14m (46 ft), steel hull vessel participated with the *Kaho* in prey fish surveys during 1986-2002 and in 2004-2012. Catch comparisons between vessels indicated that, for alewife and rainbow smelt, the fishing power of the *Kaho* did not differ from that of either the fiberglass or steel *Seth Green*. In 2012 the USGS received a new 21.3 m (70 ft), state-of-the-art aluminum hull research vessel. This new vessel, named the "*RV Kaho"*, will be used during 2013 bottom trawl assessments. Fishing power comparisons between the old steel hull and new aluminum hull *RV Kaho* will be conducted.

Bottom Trawls

The original bottom trawl used on all the assessments was a nylon Yankee bottom trawl with a 11.8-m (39 ft) headrope and flat, rectangular wooden trawl doors (2.12m x 0.95m). In 1997 overly abundant catches of dreissenid mussels forced a change to a polypropylene 3-in-1 bottom trawl with an 18m (59 ft) headrope and slotted, metal, cambered V-doors. Paired tows were made to calibrate catches between the two sets of gears for alewife and rainbow smelt. From 2004 – 2010, alternate bottom trawls and configurations were used to assess slimy sculpin, although shallow depths where dreissenid density was highest were avoided. Comparison trawling in 2011 between the most promising alternate trawl design and the original Yankee trawl indicated that alternate trawls had extremely low catchability for benthic fishes and were ineffective at capturing the full size ranges of benthic prey fish known to be present. Since 2011, we returned to using the standard 11.8m Yankee trawl for the benthic fish assessment and reduced tow times to reduce dreissenid catches (from 10 minutes to 5 or 3 minutes).

In 2012, the number of trawl hauls made for assessment of alewife, rainbow smelt, and benthic prey fish totaled 275. During the alewife assessment survey, 114 bottom trawl tows were conducted, 105 during the rainbow smelt assessment, and 56 tows during the fall benthic fish assessment including tows at 180m (590.6 ft) depth at Oswego (also known as Nine Mile Pt.). Effort among cruises has been consistent in recent years (Figure 4).

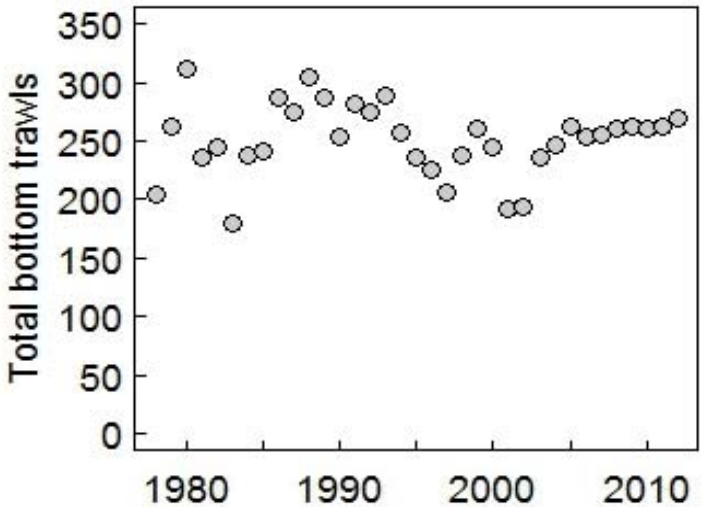

Figure 4. Total number of bottom trawls collected by USGS and NYSDEC cooperative surveys in US Waters of Lake Ontario, 1978-2012.

Trawl mensuration gear using remote sensors has been used over the past 5-10 years to understand how the shape of the bottom trawl changes as it is being deployed and fished. These sensors are attached at various points of the trawl or trawl doors and relay data back to the ship such as the trawl wing spread, trawl door spread, or trawl headline height. Using these data in conjunction with the 11.8 m Yankee bottom trawl we have established estimates for the amount of time and area swept by the trawl according to fishing depth. Surprisingly, the data suggest the trawl is in contact with lake bottom and being pulled at effective speeds to capture fish for longer periods of time than previously thought. This additional time and area swept increases with fishing depth such that the area covered by a trawl towed at 170 m (557.7 ft) is three times greater than that at 8 m when towed for the same amount of time. The relationships between area swept and fishing depth allow us to calculate more precise estimates of fish density over different depth habitats. Additional information about trawl shape and its effect on fish density estimates is included in a following report entitled "Morphometry and fishing behavior of the 11.8m Yankee bottom trawl in Lake Ontario."

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Status of Alewife in the U.S. Waters of Lake Ontario, 2012

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Abstract

The adult alewife abundance and weight indices in 2012 both increased from 2011 levels. Condition of adult alewives remained high and was similar to recent years. Yearling abundance was above average for the third consecutive year, and represents the strongest year class since 1998. The number of spawners increased from 2011 and the summer temperature index in 2012 was well above average, so the predicted 2012 year class could be above average under warm winter conditions, but will more likely be near average. Because of moderate year classes in 2007-2008 and above average year classes in 2009-2011, we expect adult alewife abundance and biomass to continue to increase in 2013.

Status of Alewife

The sampling frame for alewife was last modified in 2004, when it was expanded to include the 160-179 m (525-587 ft) depth stratum in subsequent years; calculation of the indices were concurrently modified. See Walsh and Connerton (2011) and previous years for more detailed explanation of analytical methods for the sampling frame expansion, index calculations, and catch estimates for 2001, when the spring assessment could not be completed due to mechanical difficulties. All indices are expressed as depth stratified catch per unit effort for a 10-min bottom trawl tow.

In April – May 2012, both the abundance (number) and weight (kg) indices for adult alewife (age-2 and older) in U.S. waters of Lake Ontario increased from 2011 values (Figure 1). The 2012 abundance index (965) was equal to 56% of the long-term mean (1723), 26% of the record high of 1989 (4247), and is 8 times higher than the record low from 2010 (128). The 2012 biomass index (30) was equal to 68% of the long-term mean (44), 26% of the record high of 1981 (114), and is 6 times higher than the record low from 2010 (5). We use the relative standard error (RSE; RSE = 100 * {standard error of the index / the index}) as a measure of variability in abundance and weight indices. The RSE of the both the adult weight (37%) and yearling number index (46%) were above the long term means in 2012, (23% and 28%, respectively, Figure 2) indicating more variable catches. Factors that could be contributing to this increased variability are not clear.

The age-1 alewife abundance index in spring 2012 (719) was well above the long term mean (350) and represents the largest year class observed since the 1998 year class collected in 1999 (Figure 3). The year class exceeded predictions from our recruitment model (O'Gorman et al. 2004, Walsh et al. 2012). With moderate year classes in 2007 and 2008, and above average year classes in 2009-2011, the adult stock should be rebuilding.

Our index of adult alewife condition is the wet weight of a 165-mm (6.5-in) alewife predicted from annual length-weight regressions collected in spring and fall. The predicted weight in spring and fall 2012 remained high and in a similar range as recent years (Figure 4). For the

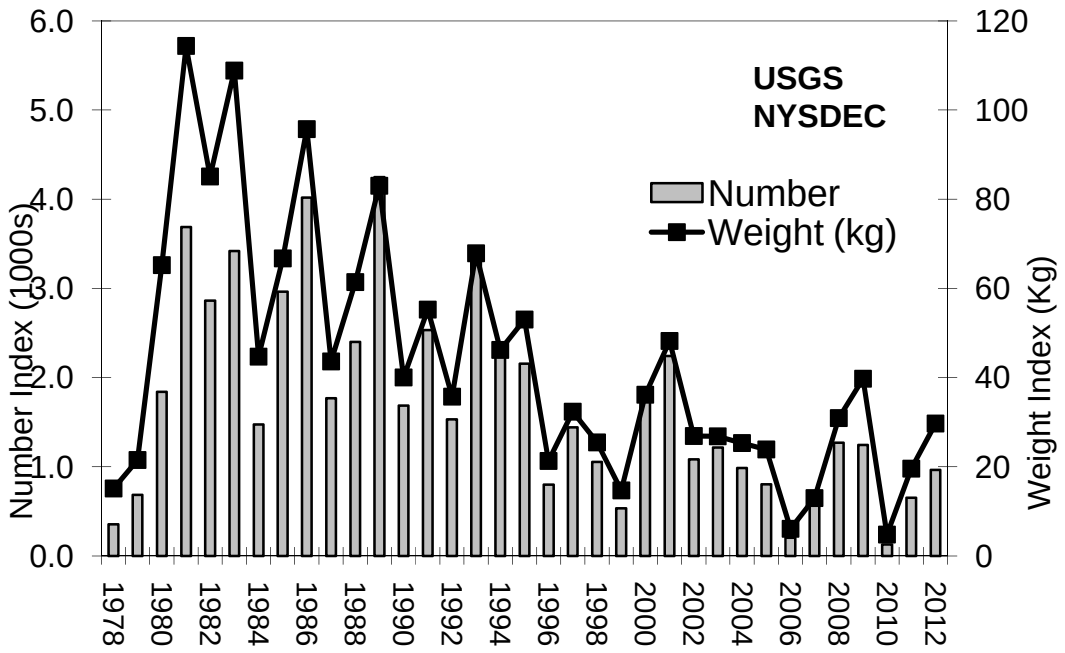

Figure 1. Abundance and weight indices for adult (age-2 and older) alewife in the U.S. waters of Lake Ontario during late April – early May, 1978-2012. 1 kg = 2.205 lbs.

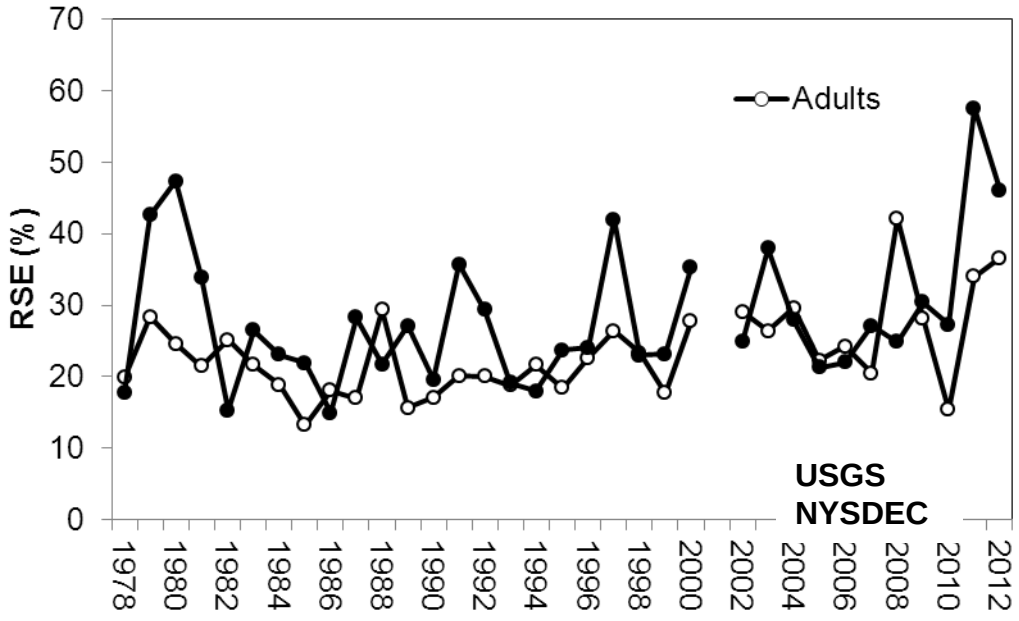

Figure 2. Relative standard error (RSE) for the yearling number index and adult alewife biomass index in U.S. waters of Lake Ontario, 1978-2012. The RSE (RSE = 100 * {standard error of the index / the index}) is a measure of variability in the indices.

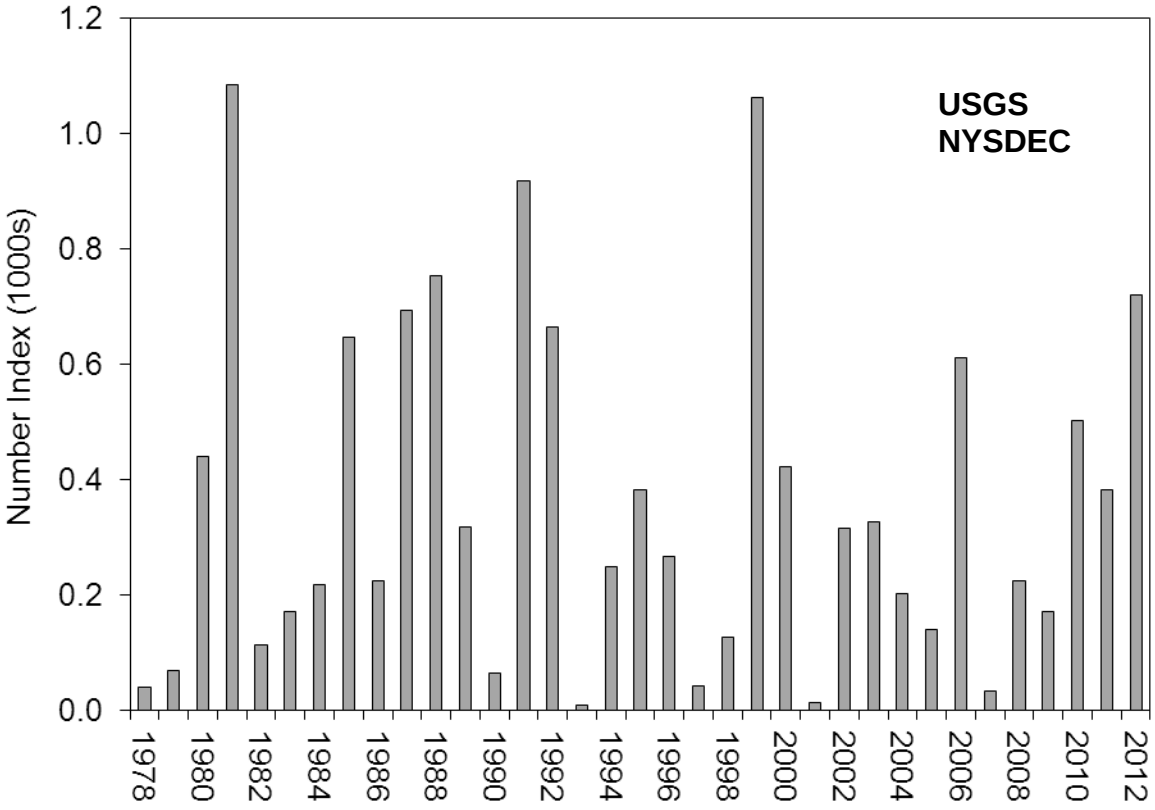

Figure 3. Abundance index for yearling (age-1) alewife in the U.S. waters of Lake Ontario during late April – early May, 1978-2012.

most part, since 2004 condition in spring and fall had been higher than in any other period since the late 1970's. Persistent high condition of adult alewives would indicate that food availability is not limiting the population.

Strength of alewife year classes at age 1 is related to a summer temperature index (heating degree days >10° C (50° F) before 1 August), a winter duration index (the number of days nearshore water is < 4° C (39° F) during the first winter after hatch, and the number of spawners (adults >150 mm, O'Gorman et al. 2004). In 2012, the summer temperature index (496) was well above the long average (355), indicating excellent conditions for reproduction and larval survival. Spawning stock has increased the last two years following low levels in 2010. With increased spawning stock and a warm summer, our model predicts a 2012 year class that could be at best 1.4 times larger than the long term average, but could be below average under severe or average winter conditions.

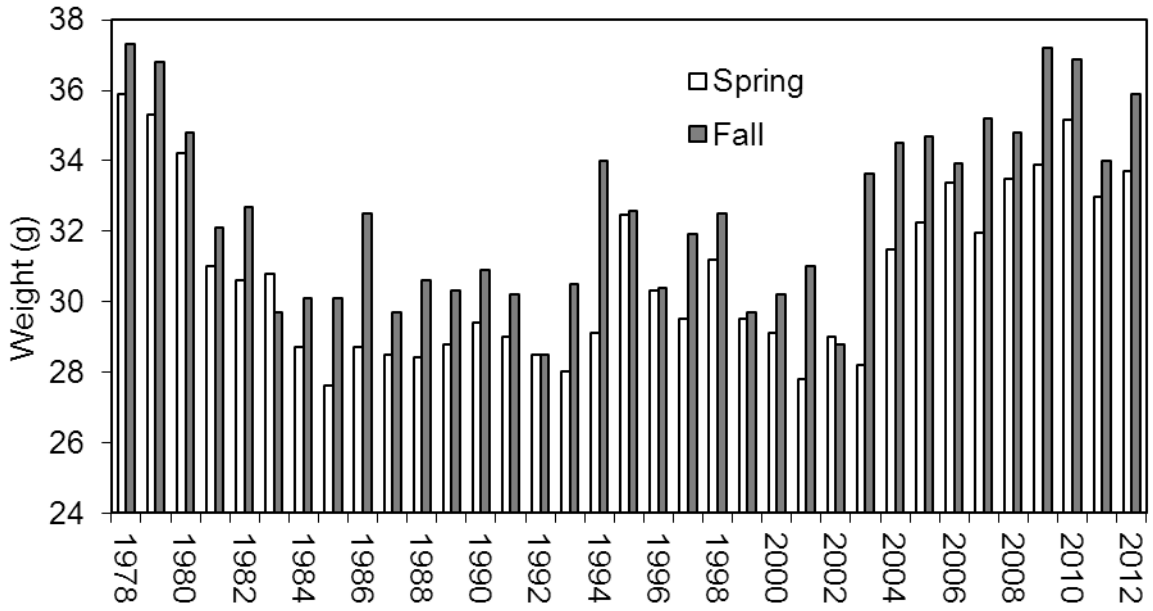

Figure 4. Wet weight of a 165-mm (6.5 in) alewife (predicted from annual length-weight regressions) in spring and fall, Lake Ontario, 1978-2012. 1 gram = 0.035 ounce.

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Status of Rainbow Smelt in the U. S. Waters of Lake Ontario, 2012

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Abstract

Rainbow smelt Osmerus mordax *are the second most abundant pelagic prey fish in Lake Ontario after alewife* Alosa pseudoharengus. *The USGS-NYSDEC rainbow smelt assessment conducted in June 2012 consisted of 105 bottom trawls at 11 transects extending from Olcott, NY into the eastern basin and covered a depth range of 8 - 140m. Assessment results indicated the abundance of age-1 and older rainbow smelt increased by 47% relative to 201l, however, the weight index decreased (~25%). The increased abundance but decrease in weight was driven by a large abundance of age-1 rainbow smelt resulting from higher than average reproductive success in 2011. Length frequency-based age analysis indicated that age-1 rainbow smelt constituted 85% of the population and the index of age-1 abundance in 2012 was 2.5 times higher than the 10-year average. While rainbow smelt continue to be a substantial part of the Lake Ontario fish community, combined data from all bottom trawl assessments suggest the percent of rainbow smelt in the fish community has declined over the past 30 years. Rainbow smelt constituted approximately 30% of all fish caught in all bottom trawls in the 1980's and 1990's. Over the past five years that figure has declined to an average of less than 9% of the total. In contrast, the percentage of alewife in the catch has increased from approximately 60% of the catch in the 1980's to an average of 87% of the total catch during the past five years. Various community diversity indices applied to bottom trawl observations suggest Lake Ontario fish community diversity has declined over the past 34 years as alewife have become a more dominant component of the fish community.*

Rainbow Smelt

In 2012, the abundance index for age-1 and older rainbow smelt increased slightly relative to 2011 (Figure 1). The abundance index was 77% higher than the 10-year average and the weight index was 35% higher than the 10-year average. The percentage of large rainbow smelt greater than or equal to 150 mm (approximately 6 inches) in the 2012 population (0.6%) was the lowest in the time series. The percentage of rainbow smelt over 150 mm varied from 6-28% during the period 1978-1985, however, since 1986 the percentage of rainbow smelt over 150 mm has been consistently low, averaging slightly higher than 2% of the population.

The relative standard error (RSE =100*[standard error of abundance index/abundance index]) of the rainbow smelt abundance index increased in value and variability over the past 20 years (Figure 2). Reduced rainbow smelt abundance and increased variability coincides with reduced lake productivity, dreissenid mussel colonization, and a shift by rainbow smelt to deeper depths. Bottom trawling effort was shifted to deeper lake areas in 2000 and again in 2006 to reduce variability in trawl catches after it was observed that rainbow smelt inhabited deeper depths than when the survey began in 1978 (O'Gorman et al. 2000; Walsh et al. 2007). Bottom trawl effort allocation has been and is continually evaluated to adequately sample all available depths and minimize the abundance index variability.

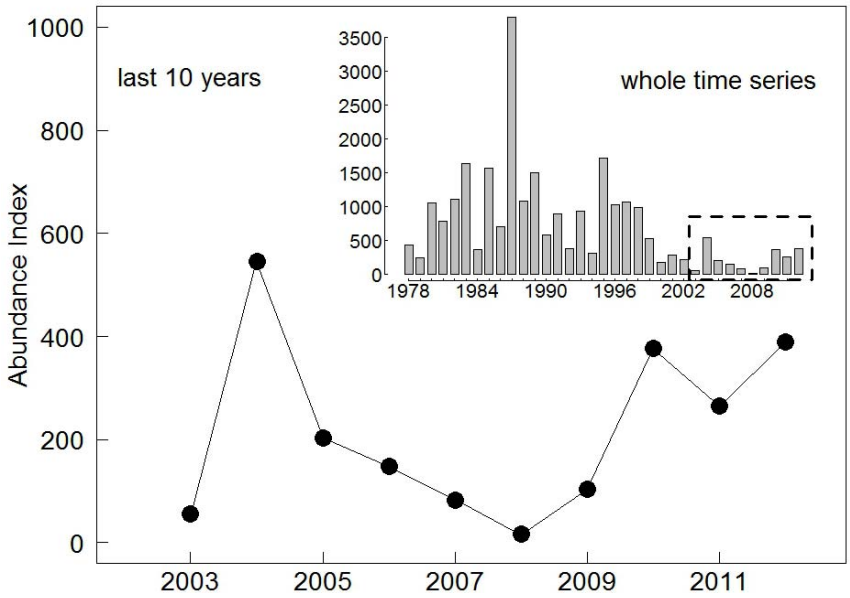

Figure 1. Stratified mean catch of rainbow smelt (age-1 and older) from bottom trawls in U.S. waters of Lake Ontario shoreward of the 140-m (459-ft) bottom contour in late May-early June, 1999 - 2012. The inset shows the entire time series (1978-2012) and the dashed rectangle delineates the last 10 years depicted in the main figure.

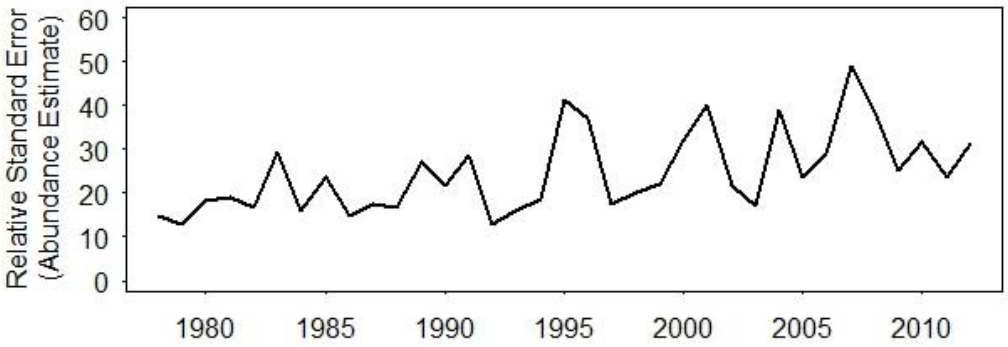

Figure 2. Relative standard error (RSE) for age-1 and older rainbow smelt abundance index (Figure 1) in U.S. waters of Lake Ontario, 1978 - 2012.

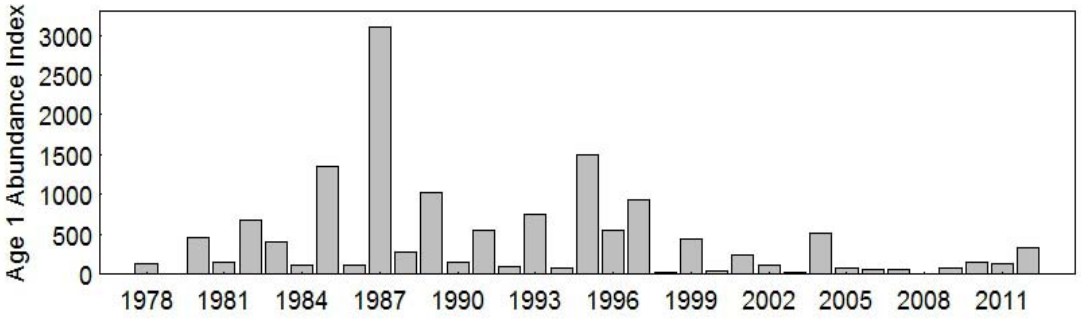

Figure 3. Stratified mean catch of age-1 rainbow smelt from bottom trawls in U.S. waters of Lake Ontario shoreward of the 140-m (459-ft) bottom contour in late May-early June, 1978 - 2012.

Based on the length frequency distribution mixture analysis, age-1 rainbow smelt abundance increased in 2012 relative to 2011 (Figure 3). The 2012 age-1 abundance was the second highest age-1 abundance observed over the past 10 years of assessment. Rainbow smelt year-class strength in Lake Ontario is indexed with age-1 fish caught in the June bottom trawl assessment. The index is calculated as the product of the proportion of age-1 rainbow smelt and the stratified mean abundance index. Previously the proportion of age-1 fish has been estimated by assorted methods, including scale and fin ray age interpretations as well as using average proportions of age-1 fish calculated from previous year fin ray interpretations. In an effort to standardize age proportioning methods, the proportions of age-1 fish were estimated by statistically fitting age-specific size distributions to the length frequency data for every year in the time series using distribution mixture analyses. On average, 4,300 randomly sampled rainbow smelt are measured each year, providing robust sample sizes for these analyses. Age-1 abundance index estimates from aging structure methods and length frequency distribution mixture analysis, were significantly correlated (adjusted r^2= 0.96, n=28, Weidel et al. 2011).

Bottom trawl observations suggest the proportional importance of rainbow smelt in the Lake Ontario fish community has declined over time (Figure 4). The annual percentage of rainbow smelt in the total fish catch (including benthic species) from all prey fish assessment bottom trawls has declined from approximately 30% during the 1980's to less than 9% of the total catch in the past five years. In contrast, the proportional importance of alewife has steadily increased from an average of 60% to now comprising over 87% of the all fish caught in bottom trawls.

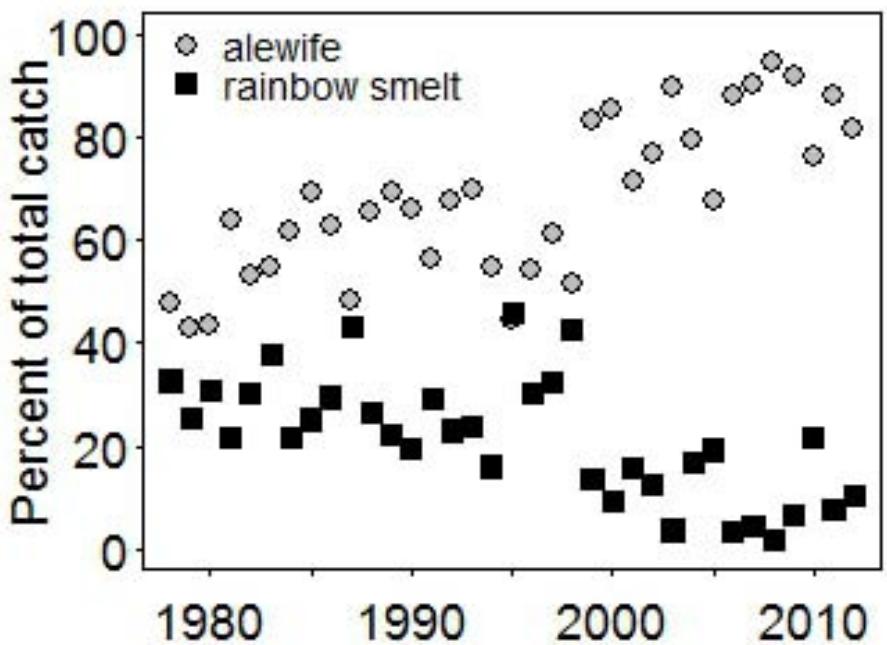

Figure 4. Annual percentages of alewife and rainbow smelt in total bottom trawl catch from three prey fish cruises conducted in April, June, and October in Lake Ontario, 1978-2012.

We used this aggregate of bottom trawl observations to understand how Lake Ontario fish community diversity has changed over the three decades of assessments. Data for the proportional catch and diversity index figures are based on the total catch of all fishes captured during the three prey fish assessments conducted each year (April, June, October) in Lake Ontario, 1978-2012. Total effort in a given year over this time period was consistent and ranged from 200-320 bottom trawls per year with an average of 251 tows per year. Both diversity indices are based on the proportional catch (by number) for all species collected in a given year. In a given year the Shannon index is calculated as:

$$-\sum_{i=1}^{R} p_i \log p_i$$

The inverse Simpson index is calculated as:

$$\frac{1}{\sum_i^R p_i^2}$$

Where p_i represents the proportion of the ith species in a year's total catch and R represents the total number of species caught in a given year.

Bottom trawl data suggest Lake Ontario fish community diversity has been declining over the three decades of the assessments (Figure 5). These trends account for the declines in slimy sculpin abundance as well as the increased abundance of round goby and deepwater sculpin. The decline in community diversity appears to be driven by the increasing dominance of alewife. It is important to recognize potential bias in these observations as these data represent bottom trawl observations from a geographically limited section of Lake Ontario and do not include species associated with near shore habitats (depths < 8m).

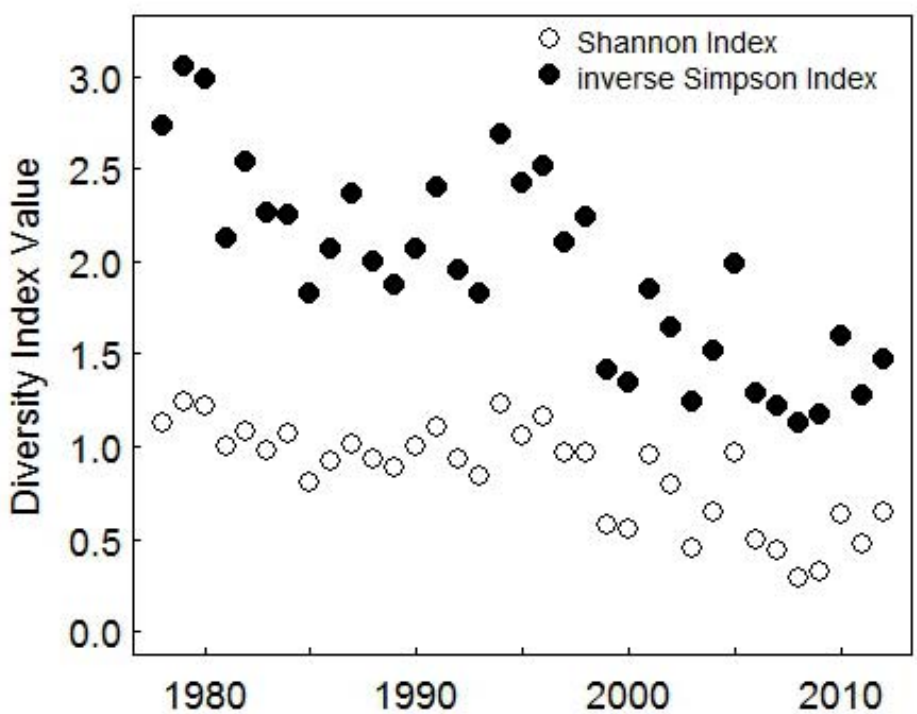

Figure 5. Diversity indices calculated for fish caught in bottom trawls during from three prey fish cruises conducted in April, June, and October in Lake Ontario, 1978-2012. Bottom trawl effort samples depths from 8-175m along the southern shoreline of Lake Ontario.

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Sculpin and Round Goby Assessment, Lake Ontario 2012

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Abstract

Historically slimy sculpin Cottus cognatus *were the most abundant native, benthic prey fish in Lake Ontario and important prey for juvenile lake trout. Over the past 34 years, slimy sculpin abundance has fluctuated, but generally decreased, with a substantial decline occurring in the past 10 years. The 2012 slimy sculpin mean density (0.005 ind.·m^{-2}, sd=0.012, n=62) and mean biomass density (0.058 g·m^{-2} , s.d= 0.120, n=62) were the lowest recorded in the 27 years of sampling using the original bottom trawl design. An absence of slimy sculpin less than 50mm (age-0) in the past 10 years suggests population declines are the result of reduced recruitment potentially due to predation or reduced reproductive effort. Over the entire time series, the depth of maximum slimy sculpin abundance has steadily increased from 65m to 125m. Depth-associated sculpin behavior may be a result of water clarity changes that intensify predation risk at shallower depths or a food related response where sculpin have moved deeper to habitats that still support low densities of Diporeia, a favored food source. In the fall of 2012, round goby density (0.526 individuals·m^{-2}) was two orders of magnitude greater than slimy sculpin, suggesting round goby are now the dominant benthic prey fish in Lake Ontario. Invasive species, piscivory, and declines in native benthic invertebrates are likely important drivers of slimy sculpin population dynamics.*

Deepwater sculpin *Myoxocephalus thompsonii*, considered rare or absent from Lake Ontario for 30 years, continue to increase in density. Exponential models estimate deepwater sculpin density has increased by 10% per year over the past eight years and biomass density has increased by 75%. In 2012, deepwater sculpin were caught at all depths from 55-180 m (180.4-590.6 ft) with maximum catches of large adult fish at the deepest depths sampled (150-180 m or 492.1 to 590.6 ft)) and abundant juvenile catches between 75-95 m (246-311.7 ft). Based on declines in the minimum depth of capture (85 m (278.9 ft) in 2006, 75 m in 2008-2011, 55 m in 2012) the depth range inhabited by deepwater sculpin is expanding to shallower depths. The continued presence of juvenile deepwater sculpins in trawl catches indicates favorable conditions for survival of young fish, perhaps due to reduced abundance of pelagic prey fish such as alewife *Alosa psuedoharengus* that may consume the pelagic deepwater sculpin larvae.

Nonnative round gobies *Neogobius melanostoma* were first detected in the US Geological Survey (USGS) Lake Ontario spring alewife assessment in 2002. Since then their population has expanded and they are now found along the entire south shore of

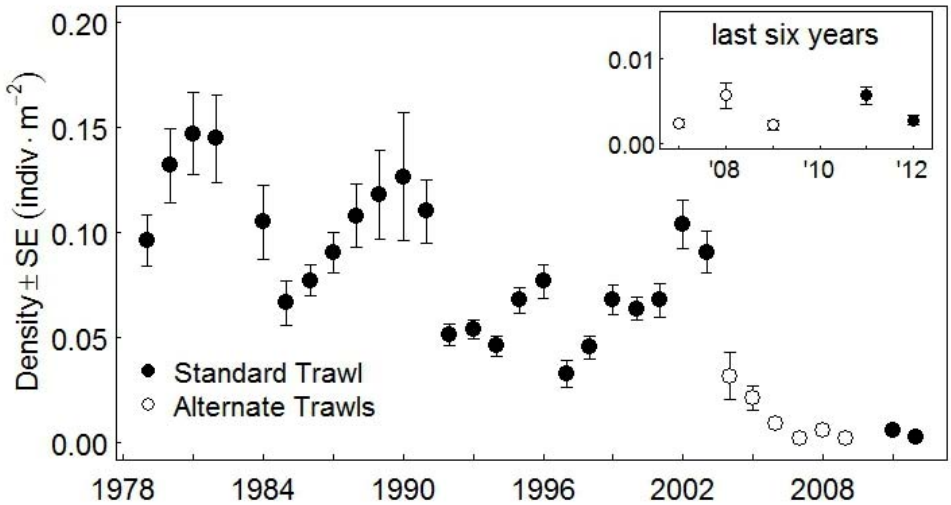

Figure 1. Slimy sculpin density (individuals·m^{-2}) for U.S. waters, of Lake Ontario, covering depths from 8-175m, as assessed by the USGS fall benthic prey fish survey(1978–2012). Error bars represent one standard error. The inset figure denotes the most recent six years. The y-axes differ from prior reports. Abundance is now expressed as simple mean density from all bottom trawls rather than previously reported area-weighted "index values". Open circles denote years when alternative bottom trawls were used in an effort to reduce mussel catches.

Lake Ontario, with the highest population densities in the U.S. waters just east of the Niagara River confluence. In 2012, both the abundance and weight indices decreased threefold from 2011 estimates. Bottom trawl catches from all three surveys (April, June, October) suggest the highest round goby densities in winter and early spring are found at depths ranging from 70-120 m (229.7-393.7 ft), but by June most round goby have moved inshore (< 20 m or 65.6 ft) to spawn. We estimated this seasonal movement represented an offshore to inshore biomass transfer of up to 3 kilograms per meter (2 lb per ft) of shoreline in 2008 when goby density was highest. Estimates for 2011 and 2012 were 1.5 (1 lb pet ft) and 0.9 kilograms (0.3 lb per ft) per meter of shoreline, respectively. These are among the first estimates for fish-based energy transfer from offshore regions to inshore habitats.

Slimy Sculpin

Slimy sculpin were historically the most abundant native, benthic prey fish in Lake Ontario and have been shown to be an important diet component for native juvenile lake trout (Elrod and O'Gorman 1991; Owens and Bergstedt 1994). The USGS bottom trawl assessment, which occurs in October in depths from 8-175 m (26.2-574.1 ft), suggests slimy sculpin abundance in Lake Ontario has fluctuated, but generally decreased over time, with a substantial decline within the past 10 years (Figure 1). *Dreissena* mussel invasion and proliferation in the 2000's forced the assessment to use alternate bottom trawls from 2004-2010, however, benthic fish catchability was greatly reduced with these trawls as compared to the original 11.8m Yankee trawl. In 2011, the assessment returned to the original sampling gear used during the first 24 years of the assessment. The low slimy sculpin density observed in 2012 (0.005 per m^2 or 0.05 per ft^2) was

consistent with the 2011 estimate (0.009 per m^2 or 0.097 per ft^2), providing additional evidence that Lake Ontario sculpin abundance likely declined by two orders of magnitude over the past 34 years.

Evidence exists for both top-down and bottom-up forces driving the slimy sculpin density changes. Multiple studies suggested that predation by ever-increasing numbers of stocked juvenile lake trout accounted for sculpin declines in the early 1980's (Elrod and O'Gorman 1991; Owens and Bergstedt 1994). At that time, stocked lake trout were prevalent at depths <70 m (229.7 ft) where sculpin declines were greatest, while at depths greater than 70m few stocked lake trout were captured and slimy sculpin density did not decline (Owens and Bergstedt 1994). It is likely that lake trout predation has influenced slimy sculpin populations over short time periods, however, during the past 20 years juvenile lake trout abundance has declined (Lantry and Lantry 2010) concurrently with slimy sculpin declines. Alternatively, Owens and Weber (1995) suggested the slimy sculpin density decrease between 1991 and 1992 was attributed to a collapse in their preferred food resource, the burrowing amphipod *Diporeia*. This bottom-up effect was most evident in southeastern Lake Ontario which contained the highest densities of slimy sculpin in poor physiological condition. Sharp sculpin density declines in this region coincided with a collapse in the local *Diporeia* population in 1990's (Owens et al. 2003). When abundant, energy rich *Diporeia* were the primary slimy sculpin forage item, however, in 1992 following *Diporeia* decline this item was rare in sculpin diets (Owens and Dittman 2003).

Length frequency information can provide insight into the declining slimy sculpin population. Over the past 10 years, very few slimy sculpin less than 50 mm (1.97 in) total length have been caught during the fall assessment, yet in prior years, 10-50% of the total sculpin catch by number was comprised of this size individuals (Figure 2). These small sculpin correspond to age-0 fish caught in the fall. This truncation of the size and age structures suggests age-0 slimy sculpin are experiencing elevated mortality, reduced adult reproductive capacity, or a combination of both. The observed increased density of deepwater sculpin and round goby support a top-down, predation based mechanism, while dwindling *Diporeia* densities and increasing *Dreissena* densities at deeper depths suggest a bottom-up based influence.

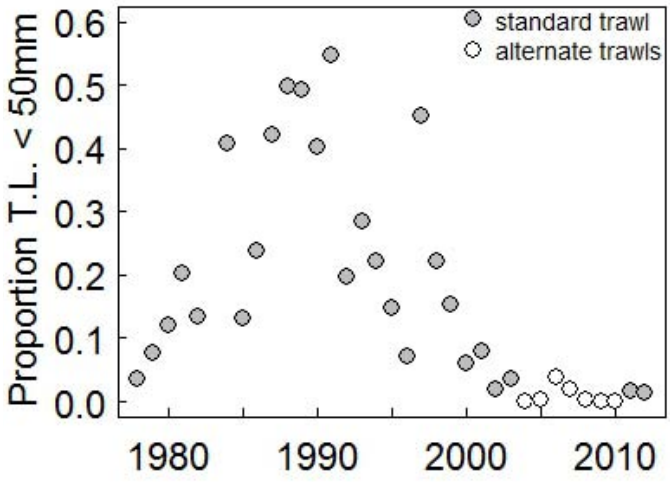

Figure 2. The proportion of slimy sculpin in the total catch with a total length less than 50mm. Bottom trawl catches are from the fall USGS benthic prey fish assessment in U.S. waters of southern Lake Ontario (1979-2012).

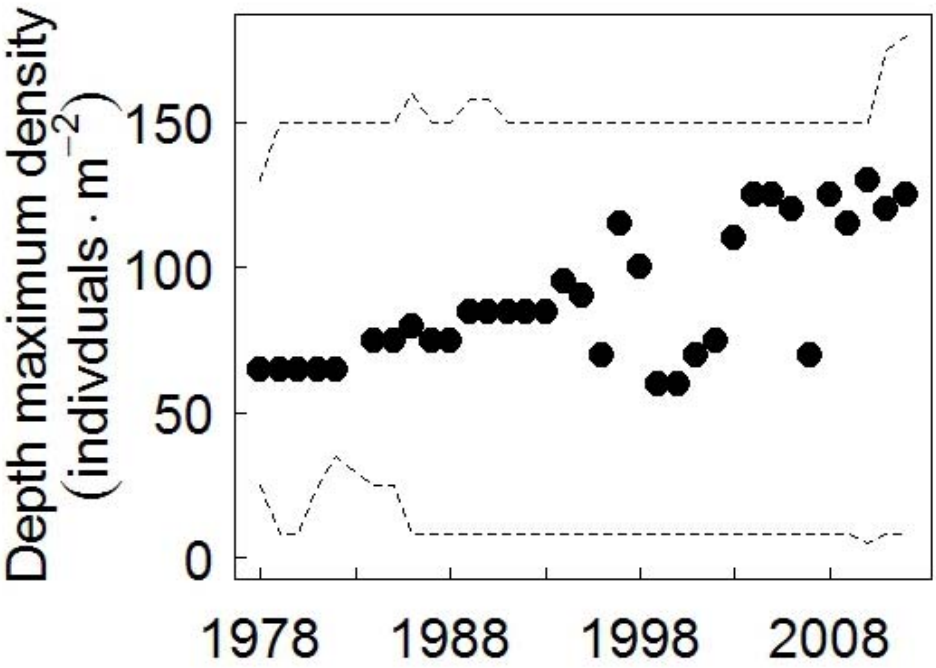

Figure 3. Depth of maximum slimy sculpin abundance during the fall USGS benthic prey fish assessment in U.S. waters of southern Lake Ontario (1979-2012). The dashed lines represent the maximum and minimum depths (m) sampled each year

More surprising than the declines in slimy sculpin density are the observations of slimy sculpin depth distribution. Over the course of the 34 year time series, the depth of maximum slimy sculpin abundance has steadily increased from approximately 65 m to 125 m (213.3 to 410.1 ft) (Figure 2). Owens and Bergstedt (1994) documented a shift in sculpin depth distribution towards water greater than 70 m (229.7 ft) in the 1980's and attributed the shift to increased predation from stocked lake trout. In contrast, both abundance and stocking densities of lake trout have declined from their peaks in the 1980's (Lantry and Lantry 2010) so it is unlikely that juvenile lake trout predation is responsible for the continued change in sculpin distribution. Alternatively, slimy sculpin may be responding to changes in prey abundance. The decline of *Diporeia* was slowest at deeper depths and slimy sculpin may have moved to deeper habitats to take advantage of this remaining food source (Figure 3).

Deepwater Sculpin

Deepwater sculpin, once considered extirpated from Lake Ontario, have increased substantially over the past seven years. These native, deep water prey fish were absent or rare in all USGS and NYSDEC bottom trawls surveys from 1979-2004 and were first captured on the fall prey fish assessment in 2005 (Lantry et al. 2007). In 2012 the USGS fall benthic assessment, as described above, yielded a new maximum density of 0.001 indivduals·m^{-2} (0.01 per ft^2) and biomass density of 0.014 g·m^{-2}(4.9 X 10^{-4} oz per ft^2)(Figure 4). In comparison, Lake Michigan deepwater sculpin density ranged from 0.005 to 0.015 indivduals·m^{-2} (0.05 to 0.16 per ft^2) and biomass density ranged from 0.05 to 0.2 g·m^{-2} (1.8 X 10^{-3} to 7.1 X 10^{-3}oz per ft^2)over the past 4 years (Madenjian et al. 2012).

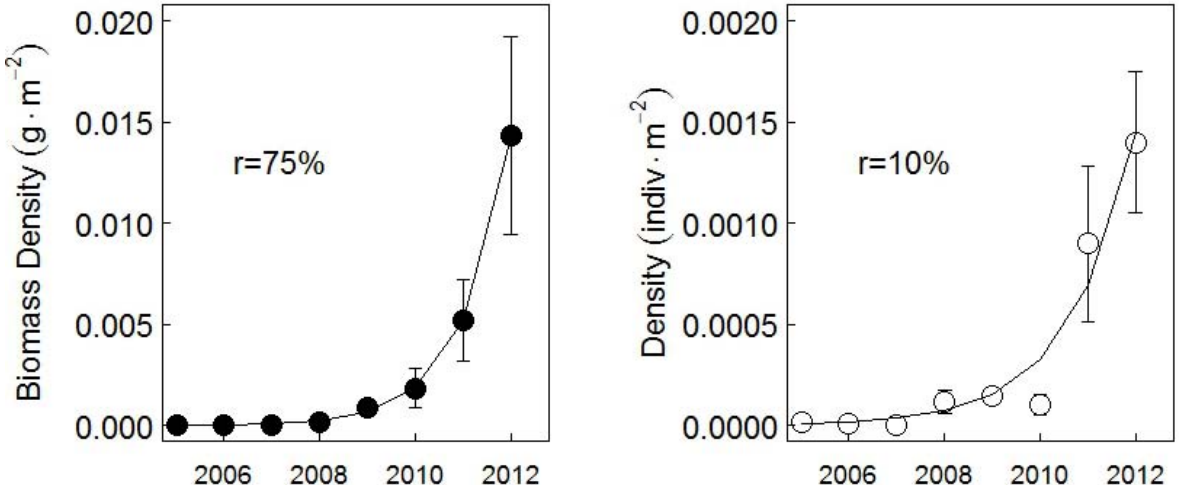

Figure 4 Deepwater sculpin biomass density and density observations for U.S. waters of Lake Ontario at depths from 8-150m, as assessed by the USGS fall benthic prey fish survey(2005–2012). Exponential growth models fit to the observations are denoted by the black line and the rate of population increase (r) from that model is represented on each figure.

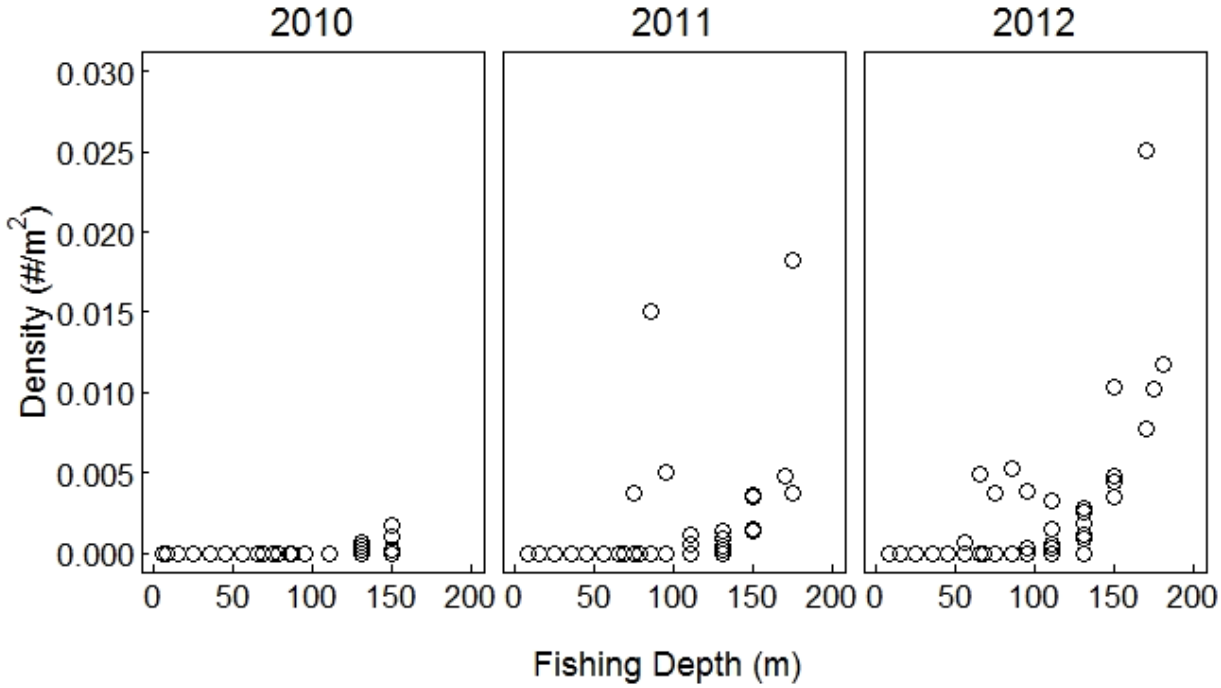

Figure 5 Deepwater sculpin density based on fishing depth. Increased bottom trawls at depths greater than 150 m in 2011 and 2012 indicate greater density at these depths

Yearly deepwater sculpin density and biomass density calculations are based on the fall benthic prey fish assessment bottom trawls, collected at depths from 60 m to 150 m (196.9 to 492.1 ft), at six transects along the south shore of Lake Ontario extending from Olcott, NY to Oswego, NY. Since 2005, the number of trawls in these depths for a given year have ranged from 35 to 45. The current deepwater sculpin densities are not weighted by specified lake areas as with other Lake Ontario prey fish assessments. To better understand the depth distribution of deepwater sculpins, the assessment collects additional bottom trawls at depths greater than 150m. These additional trawls are not included in the standardized yearly abundance calculations since these depths were not sampled from 2005 to 2010, however, deepwater sculpin densities are highest at depths greater than 150 m (Figure 5). From 2004-2010 various bottom trawls were used on this survey in an attempt to reduce *Dreissena* mussel catch. Deepwater sculpin catchability likely differed between these alternate gears and the standard Yankee bottom trawl. This gear change limits our confidence in estimating the rate of deepwater sculpin increase for these years, however, the continued increasing catches are strong evidence the population is increasing.

This species has been described as an "indicator of well being of the deepwater ecosystem" (COSEWIC 2006). The continued presence of juvenile deepwater sculpins in assessments indicates favorable conditions for survival of young deepwater sculpins, perhaps because of reduced abundance of alewife which has been linked to depression of deepwater sculpin in Lake Michigan (Madenjian et al. 2005), and benthic piscivores such as burbot *Lota lota* and lake trout *Salvelinus namaycush* (Lantry et al. 2007). We will continue to assess the recovery of the population and the effect it may have on the Lake Ontario food web.

Round Goby

Round goby, a likely ballast water introduction, was first detected in the Great Lakes Basin in the St. Clair River between Lakes Huron and Erie in 1990 (Jude et al. 1992). Round goby was first reported in southwestern Lake Ontario in 1998 near the entrance to the Welland Canal (Owens et al. 2003). The first collection of round gobies in the standard USGS/NYSDEC spring assessment trawling occurred in 2002. Since then, the round goby population has expanded substantially and round gobies 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 mouth (Walsh et al. 2006, 2007)

Given the growing importance of round goby as a member of the offshore and nearshore fish communities in Lake Ontario, depth-stratified and area weighted abundance and weight indices were developed. (Walsh et al. 2006). Round goby number and weight indices showed an exponential increase through 2005, followed by an apparent plateau in abundance but a continued increase in the weight index during 2005 - 2006 (Figure 6). Both indices peaked in 2008, followed by a sharp drop in both abundance and weight indices (Figure 6). In 2012, the round goby abundance decreased approximately four fold from 2011estimates. This pattern of exponential growth followed by a population crash is characteristic of expanding populations, and suggests that the round goby population may have exceeded carrying capacity. Mechanisms driving the sharp reductions between 2008 and 2009 are unknown, however, round goby can be affected by botulism and VHS, so it is also possible that diseases impacted the species as density increased. We believe that the

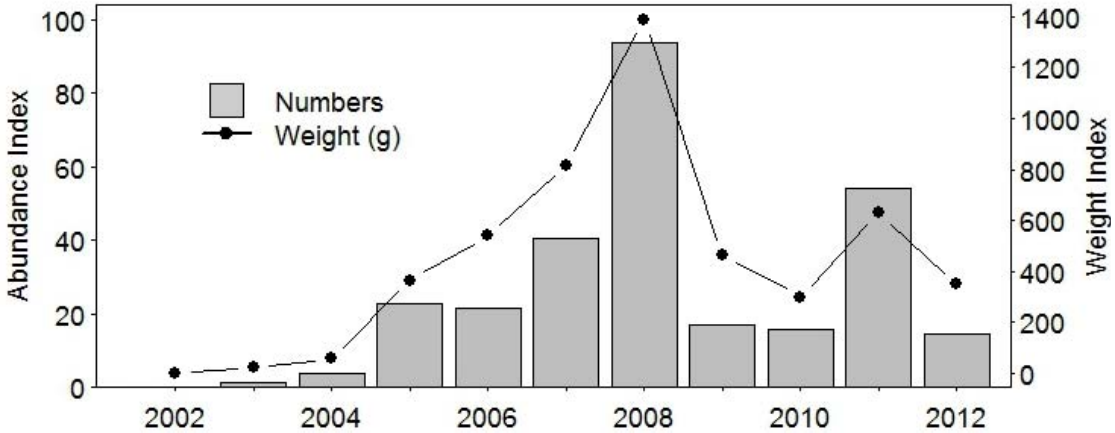

Figure 6.- Area-stratified, round goby abundance and weight indices based on spring bottom trawl assessment in U.S. waters of Lake Ontario shoreward of the 160-m bottom contour (no round gobies were caught prior to 2002). The weight index is calculated as the product of the numbers index and the average weight of all round gobies measured.

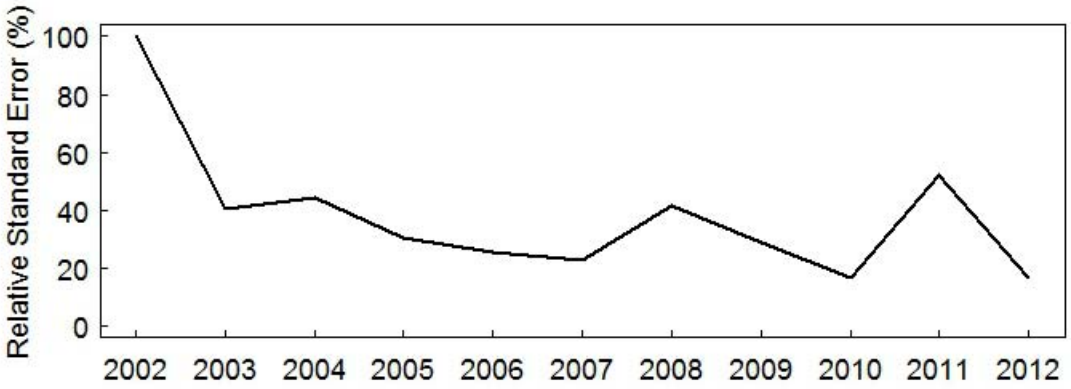

Figure 7. Relative standard error (RSE) for round goby abundance index in U.S. waters of Lake Ontario, 2002-2011 (no round goby were collected before 2002). RSE is calculated as 100*(standard error of the index/the index) and represents abundance index variability.

round goby population will vary between levels observed in 2008 and 2009, and the peak abundance observed in 2008 may represent the maximum density for round goby in Lake Ontario. The relative standard error of the abundance index was initially high when catches were sporadic but has since decreased and remained relatively stable indicating the species is more uniformly, distributed (Figure 7).

Round goby are often encountered in littoral habitats during the summer season and are often considered a nearshore species, however, a large proportion of the population moves to depths of 70-120 m (229.7-393.7 ft) during winter months (November – April). Round goby biomass density observations from three bottom trawl assessments in Lake Ontario conducted in April, June, and October illustrate how the species colonized Lake Ontario from west to east and how goby depth distribution changes seasonally (Figure 8). Each year the early spring bottom trawl assessment finds round goby

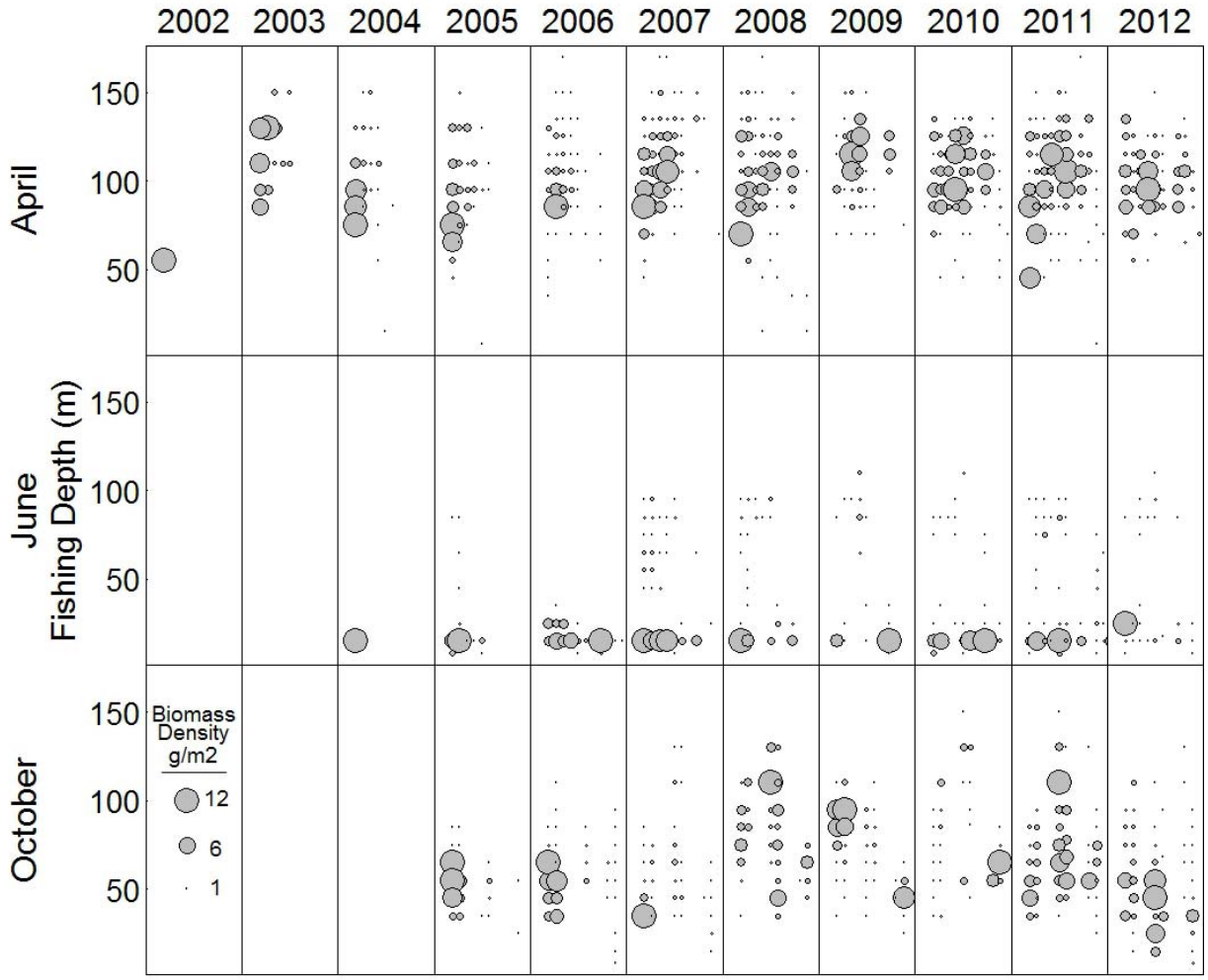

Figure 8.- Round goby biomass density across the season in bottom trawl surveys of U.S. waters of Lake Ontario(2002-2012). Each box represents a single survey in a given year. The vertical axis is trawl depth (m) and the horizontal axis represents the general position of transects from west (Olcott) to east (Eastern Basin) along the southern shore of Lake Ontario. The size of the bubble represents the biomass density (~kg/ha) of round goby captured in the trawl. Zero catches are not displayed.

abundant in depths from 70-120 m, yet by June most of that biomass has moved inshore to spawn (Figure 8). This seasonal movement represents an offshore to inshore energy vector. To estimate the magnitude of how much fish biomass moves inshore we calculated the yearly average April round goby biomass density for depths ranging from 8-170 m (26.2-557.7 ft) and multiplied these means by the total lake area represented by those depths (16325 km^2 or 6303 mi^2) to estimate total lake wide round goby biomass. We divided this number by the total shoreline distance (1146 km or 712 mi) and estimated that at peak abundance in 2008 the inshore movement of round goby was over 3 kilograms per meter (2.0 lb per ft) of shoreline. More recently density has declined and estimates for biomass movement in 2011 and 2012 were 1.5 and

kilograms per meter (1.0 and 0.06 lb per ft) of shoreline, respectively. These estimates represent some of the first standardized estimates for fish-based energy transfer from the offshore region to inshore Lake Ontario habitats. These estimates can inform dialog about sources that maintain high nearshore nutrient levels while offshore nutrients are in apparent decline. Future research should estimate how much of this round goby biomass is retained in the near shore environment and compare this offshore to near shore energy transfer to other Lake Ontario fishes with seasonal inshore movements such as alewife and Pacific salmon.

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Estimating the area-swept by the 11.8 m Yankee bottom trawl in Lake Ontario

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Background

Historically United States Geological Survey (USGS) Lake Ontario Biological Station (LOBS) researchers have used bottom trawl observations to calculate annual prey fish abundance indices. Uncertainty with respect to area and volume swept by bottom trawls resulted in the practice of reporting indices rather than density or biomass density estimates. Time series of these indices have been critical for fisheries management and for insight into a changing fish community, yet these indices are less applicable for analyses requiring prey fish densities, such as quantifying behavioral changes with respect to depth, ecosystem mass balance modeling, or making comparisons to other lakes. Reporting bottom trawl catches in units of fish density requires an understanding of how trawl geometry and trawl bottom contact vary with the total depth of water where the trawl is fishing, herein referred to as "fishing depth". The goal of this analysis is to estimate the area-swept by the 11.8 m (39 ft) Yankee bottom trawl across the range of fishing depths frequently sampled in Lake Ontario (8 - 175 m or 26.2-574.1 ft).

History

In its simplest form, the area of lake bottom swept by a trawl is the product of three components: bottom contact time, wing spread, and net speed. Historically, researchers using the 11.8 m Yankee trawl in Lake Ontario have attempted to measure one or more of these three parameters, however results have been variable. A letter in 1973 suggested the original bottom area-swept calculation for the 39 foot (11.8 m) Yankee trawl was 1.31 acres in a 10 minute trawl assuming a wing spread of 2/3 the headrope length (26 feet) and a speed of 2.5 mph. That letter also pointed out two analytical errors: 1) the rate was 2.5 nautical miles per hour or knots rather than miles per hour and 2) the wing spread was believed to be 21 feet (6.4 m) as measured by divers who held on to the net while it was fished. The resulting area measurement was 1.22 acres in 10 minutes, or 4937 m^2. These calculations are reported in O'Gorman and Schneider (1986) where they express the theoretical area-swept during a 10 minute tow as 0.5 hectares (5000 m^2). Biologist notes from 1988 reported gear mensuration equipment attached to the Yankee trawl measured mean "wingtip spread as 8.7, 9.4, 10.3 and 13.4 meters at fishing depths from 15, 25, 35 45 meters, respectively, and estimated the extra time on the bottom during haul back from 1 minute to at 25 m to 3.75 minutes at 95 m. Notes from 1992 suggested the mean wing spread at 25 m was 7.7 m and these scientists indicated that they believed the trawl was pulled off the lake bottom between 30 and 45 seconds after trawl haul back was initiated. Where possible, we included these historical trawl geometry estimates with our own results.

Methods and Results

We used vessel and gear mensuration data from the 2012 USGS benthic fish survey to create models that describe how bottom contact time, wing spread, and net speed vary as functions of fishing depth of the 11.8 m Yankee bottom trawl. For some of these components we compare our results to those of Madenjian et al. (2012), who conducted

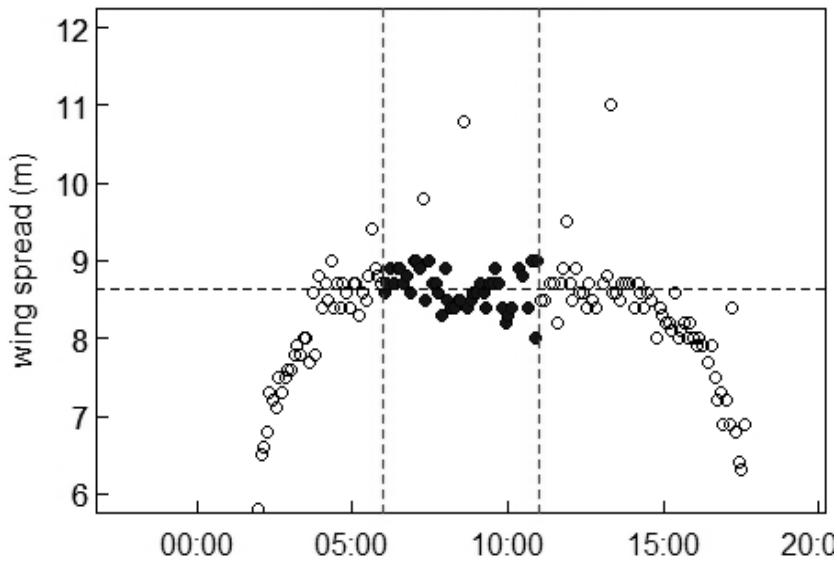

Figure 1. Gear mensuration wing spread data (m) on the 11.8 m Yankee bottom trawl fishing at 150 m. Dashed vertical lines are the targeted start and end times of the tow. Note the wing spread is stabilized at constant value before and after the dashed lines; interpreted as the extra time the trawl is fishing on the lake bottom.

similar research with the 11.8 m Yankee trawl in Lake Michigan prey fish surveys over a depth range of 8-110 m.

Bottom Contact Time

Our understanding of how long a bottom trawl is in contact with the lake bottom is complicated by the fact that a trawl can settle quickly and fish earlier than expected and that most bottom trawls exhibit "liftoff lag" where the net fishes effectively while the trawl is being hauled back (Wathne 1977). These additional times are known to increase as fishing depth increases (West and Wallace 2006). Wallace and West (2006) also note that concerns about bottom contact time are heightened when short (15 minute) tow durations are used. This increases the importance of understanding bottom contact time in the Lake Ontario benthic fish survey where depths from 8 to 170 meters are fished and trawl times were reduced from 10 to 5 minutes to avoid loading the trawl with unsafe quantities of Dreissenid mussels.

In this analysis we assume that the data from the wing spread sensors stabilize when the trawl is in contact with the bottom. While we recognize the potential bias associated with this assumption, determining bottom contact time via stabilization has been previously used when a bottom contact sensor is not available (von Szalay 2004). At this time, we do not have independent evidence to corroborate this assumption, but are developing a suite of approaches, including underwater video, to validate bottom time estimates. We inspected the wing spread trajectory such as shown in Figure 1, and chose those points where we interpreted the trawl as being in contact with the bottom.

Using a series of these estimates and quadratic models we predicted the extra time on bottom before and after the the targeted vessel-based set and haul times as functions of bottom depth (Figure 2). The vessel-based set time is defined as when the depth-specific amount of trawl warp has been deployed. Haul back time is a pre-deterimined number of minutes after set time. We estimated the

model parameters with the nonlinear minimization function *optim* (R Development Core Team 2010).

The equations for our fitted models were:

$$BST = |-0.011 * FD^2 + 0.228 * FD + 0.368|$$

and

$$AST = |-0.001 * FD^2 - 1.239 * FD + 1.120|$$

where *BST* is before set time in seconds, *AST* is after set time in seconds, *FD* is fishing depth in meters.

We fit the same model structure to both time data sets for consistency with Madenjian et al. (2012) although it appears a linear function may be sufficient for the time after haul back (Figure 2). We combined the extra bottom contact time estimates from the models in Figure 2 with a targeted 5-minute tow to estimate the total time the trawl is in contact with the bottom and found our estimates to be similar to the model from Madenjian et al. (2012) (Figure 3).

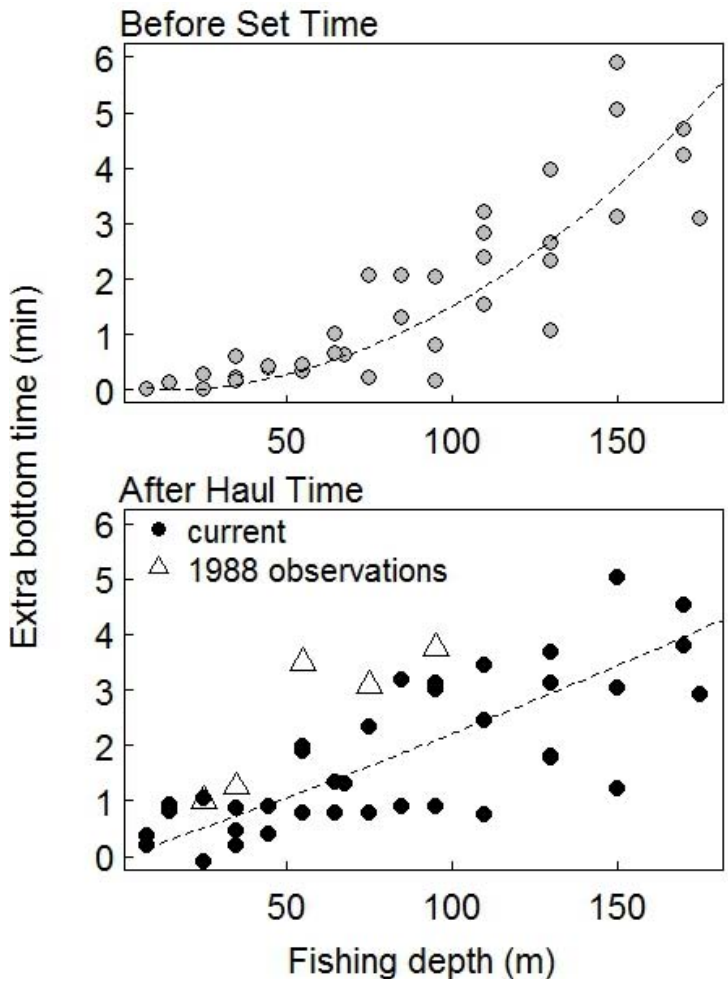

Figure 2. Observed (points) and modeled (line) data for additional time the 11.8 m Yankee trawl is in contact with the lake bottom. Data are from the 2012 Lake Ontario benthic prey fish survey. Open triangles represent extra time on bottom based on notes from 1988.

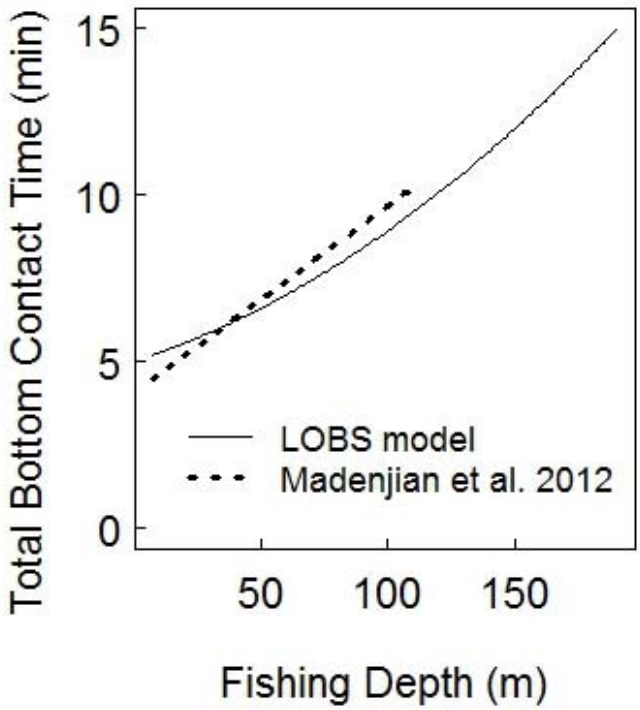

Figure 3. Total bottom contact time in minutes for a targeted 5-minute tow using the 11.8 m Yankee bottom trawl. Dashed line represents a model from Lake Michigan (Madenjian et al. 2012).

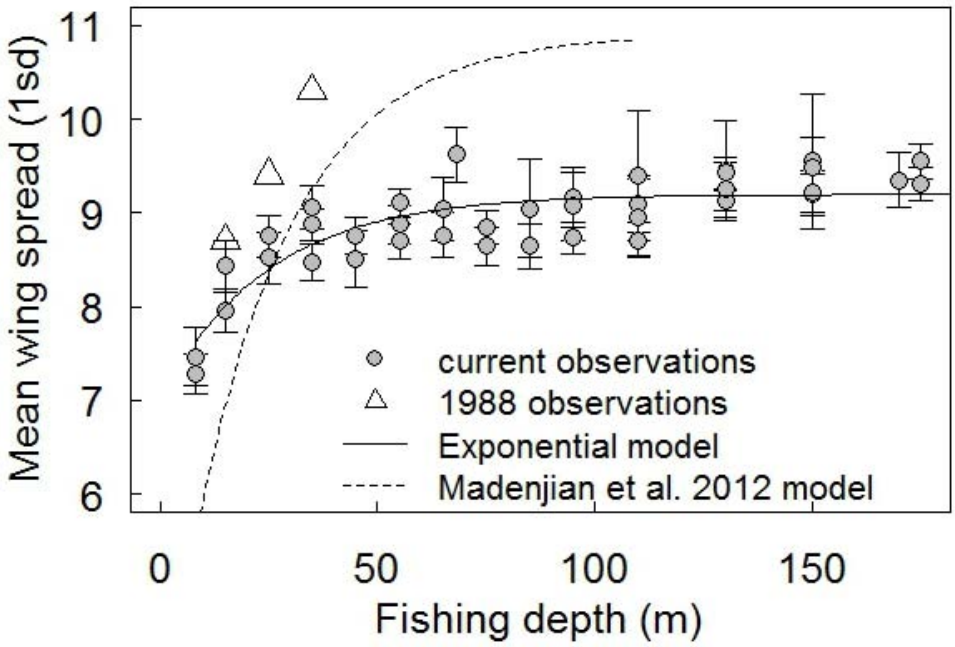

Figure 4. Wing spread observations and model predictions for a targeted 5-minute tow of the 11.8 m Yankee trawl when in contact with the bottom.

Wing Spread

Average wing spread while the net was fishing on the bottom was calculated from the sensor data bounded by the visually delineated contact time (Figure 4).

We modeled wing spread with respect to fishing depth and compared results to Madenjian et al. 2012, with a three parameter exponential model. The fitted exponential model for Ontario wingspread was:

$$WS = 7.009 + 2.188 * (1 - e^{-0.040*FD}).$$

For comparison, the parameterized model for the Lake Michigan trawl geometry (Madenjian et al. 2012) was:

$$WS = 3.23 + 7.68 * (1 - e^{-0.04*FD}).$$

In both equations WS represents wing spread in meters and FD represents fishing depth in meters.

Net Speed

The standard vessel speed during a bottom trawl tow is 1.25 meters per second (mps) or 2.8 miles per hour (mph) however during the additional time the bottom trawl contacts the lake bottom relative to the on-board set time, we account for the speed of the winches as well as the boat. Figure 5, depicts observations for the winch speed during payout and haul back in the closed circles and linear regressions fit to these data. The vessel speed is 1.79 mps (4.0 mph) when the net is being set and approximately 0.67 mps (1.5 mph) during haul back.

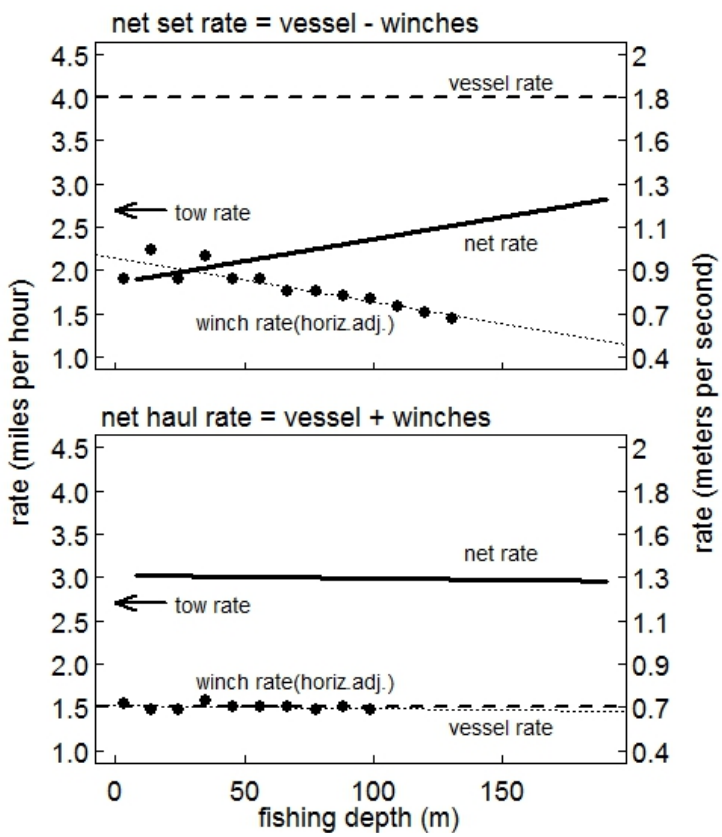

Figure 5. Vessel rates, winch rates, and calculated horizontal net rates for the 11.8 m Yankee bottom trawl.

Area-swept

To calculate the area-swept at each depth, we multiplied the estimated net speed and tow duration for the set, tow, and haul back periods, then summed these three products. Our calculated area-swept by the 11.8 m Yankee trawl increases substantially with bottom depth and is very similar to Lake Michigan based estimates, but quite different from historic estimates for the Yankee trawl (Figure 6). Over the entire range of depths sampled in Lake Ontario, the area-swept differs by more than three fold. This suggests that previous estimates of fish densities at the deepest depths sampled may be biased high.

This relationship for depth based change in area-swept can now be used to estimate fish densities from the 11.8 m Yankee bottom trawl, however, this relationship does not propagate the error assocated with each of the sub models.

To visualize what kind of effect this change in area-swept has on our understanding of fish ecology in Lake Ontario, we plotted the slimy sculpin density time series using a historic measure of area-swept (0.5ha in 10 minutes, O'Gorman and Schneider 1986) and our current estimates for area-swept (Figure 7).

In both cases the density plotted represents the overall mean for all tows and is not weighted by lake area or depth. The new area-swept estimates reduced the mean yearly slimy sculpin density by approximately 50% as compared to an area-swept calculation from the 1980's. While we recognize the uncertainty in our estimates, the corroraboration between our measurements and those from Lake Michigan and previous Lake Ontario studies is encouraging.

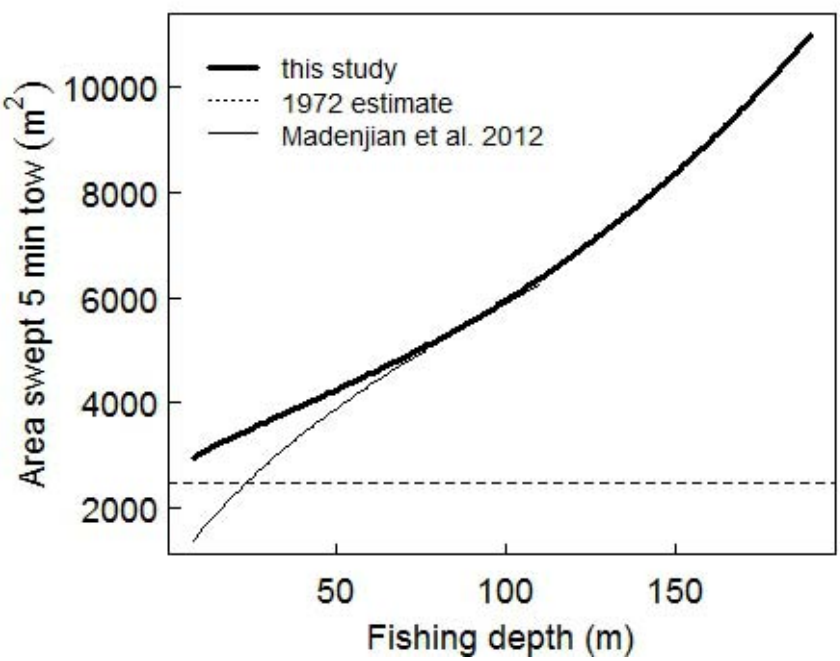

Figure 6. Model based area swept estimates across a range fishing depths for a targeted 5-minute bottom trawl tow.

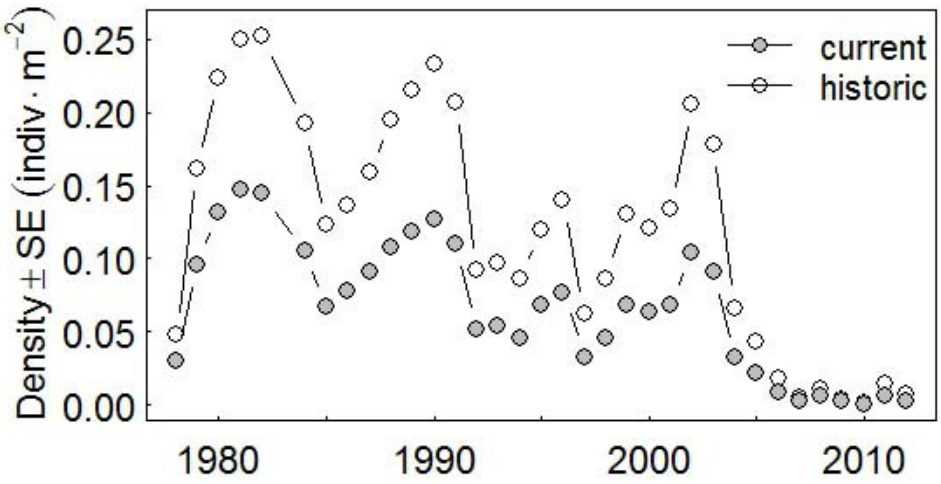

Figure 7. Slimy sculpin density in Lake Ontario using the current and historic estimates of area swept. The data are from the benthic prey fish survey, 1978-2012.

Future Work

While this analysis improves our understanding of area-swept by the 11.8 m Yankee trawl, it is imperative that we evaluate our assumption that visual inspection of wing spread times series is an accurate representation of the time the trawl is in contact with the bottom. Net-based cameras should provide a simple verification of this process. Alternatively, if smaller or lighter commercially made bottom contact sensors were available these would be indespensible pieces of equipment for USGS bottom trawl surveys. In addition to evaluating our assumptions, it will be important to quantify the error associated with the fishing depth to area-swept relationship. This relationship is critical for expressing previously collected trawl data in terms of density, however in the future, if gear mensuration data can be equipped to every trawl, it would be possible to estimate the area swept directly from those measurements and not rely on the generalized model. Once an accepted method is in place for estimating area-swept, these procuedures should be applied to other bottom trawls used in Lake Ontario and Great Lake assessments.

Comparisons across space is one of the four critical approaches to ecosystem science, the others being: theory, experiments, and long term study (Carpenter 1998). Without area-swept estimates and data expressed in density and biomass density units, we limit our ability to compare bottom trawl data across the Great Lakes Basin and other ecoysystems. We suggest such comparisons are critical for understanding the larger scale drivers influencing these important lake food web components.

Acknowledgements

We thank T. Lewchanin, S. Furgal, T. Strang, M. Cooper, E. Taber, B. Lantry, A. Fairbanks and R. O'Gorman for data collection and guidance throughout this process. We thank Jean Adams and Steve Farha for careful and thoughtful comments on previous drafts.

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Cormorant Management Activities in Lake Ontario's Eastern Basin

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Double-crested cormorants (*Phalacrocorax auritus*) on the Great Lakes have undergone large population changes in the past half century (Hatch 1995). The Great Lakes population had declined throughout the 1960s and early 1970s, from about 900 nests in 1950 to 114 in 1973 (Weseloh and Collier 1995, Weseloh et al. 1995, Weseloh and Pekanik 1999). This decline, along with that of other fish-eating birds, was associated with high levels of toxic contaminants, particularly DDE and PCBs, found in the Great Lakes ecosystem (Miller 1998). Due to pollution control programs, contaminant levels were reduced and cormorant numbers made a remarkable recovery in the Great Lakes and elsewhere (Price and Weseloh 1986). In 2004, there were over 9,800 pairs of cormorants in Lake Ontario's eastern basin, on six active Canadian sites and Little Galloo Island (nests were removed from three other potentially active American sites).

Little Galloo Island, in the eastern basin of Lake Ontario, was first colonized by cormorants in 1974. It currently supports the largest cormorant colony (and one of two Caspian tern (*Sterna caspia*) colonies) in New York State. Concerns about the impacts cormorants have on fish populations, other colonial waterbird species, private property and other ecological values followed this population and range expansion

Research by the New York State Department of Environmental Conservation (NYSDEC) and the U.S. Fish and Wildlife Service (USFWS) to determine the impacts of cormorants began in 1992. In 1998, research conducted by the NYSDEC and the United States Geological Survey (USGS) identified a connection between cormorant numbers and increased mortality of young smallmouth bass (*Micropterus dolomieui*) (Adams et al. 1999, Lantry et al. 2002).

Implementation of a cormorant management plan for U.S. waters of the eastern basin of Lake Ontario began in 1999. The goal of this management plan was to improve the benefits people derive from Lake Ontario's eastern basin ecosystem primarily by reducing the negative impacts of highly abundant double-crested cormorants on the structure and function of the warmwater fish community, and on nesting habitats and other colonial waterbird species.

The plan's major objective required reaching and maintaining a target cormorant population associated with 1,500 breeding pairs, including chicks and non-breeding birds, on Little Galloo Island. This was the maximum cormorant population level prior to the increase in mortality of young bass. It is important to note that this objective doesn't focus on numbers of nesting birds only, but on reducing the total number of cormorant feeding days, a measure by which fish consumption is assessed (Weseloh and Casselman unpublished report). The feeding day target (which involves nesters, chicks, and non-breeding birds) is 780,000.

Methods

Cormorant management in the New York waters of Lake Ontario's eastern basin has focused on Bass, Calf, Gull and Little Galloo Islands. These islands are located in Jefferson County, New York. Gull and Little Galloo Islands are owned by the NYSDEC. Bass and Calf Islands are privately owned. The islands contain several colonial waterbird colonies (Table 1), some, but not all, of which were monitored annually. Management and monitoring activities were carried out by Region 6 NYSDEC staff, sometimes with assistance of U.S. Department of Agriculture, Wildlife Services personnel.

Nest removal began on Gull and Bass Islands in 1994. Calf Island was included in removal activities following an attempt by cormorants to establish a colony there in 1997. Nest removal and culling teams included two to four people. Ground nests were removed by hand while tree

nests were removed with a telescoping pole or shotgun. Each nest removed was scattered as much as possible to discourage rebuilding. Cormorants that nested too high in trees for nest removal or repeatedly rebuilt destroyed nests were culled (Table 2).

Annual treatment of accessible cormorant nests on Little Galloo Island with food grade vegetable oil began in spring 1999 following methods similar to those of a study conducted in Ontario (Shonk 1998). Vegetable oil was applied from a backpack sprayer unit in sufficient volume to cover the exposed surface of each egg, approximately 0.2 oz (6 ml)/egg. The oiling process was conducted three to five times per season, at roughly two week intervals. Application of oil at two week intervals ensured that each nest would be treated at least twice during the incubation period. Each nest or group of nests treated was marked with spray paint to ensure treatment of all nests accessible from the ground. Two or three teams of two to three persons each completed the spraying in three hours or less (not including travel time). Each team effectively oiled 500 to 700 nests per hour, depending on nest density. Oiling teams recorded the number of nests treated, the number of eggs in each nest, the number of chicks observed and the number of nests not treated (tree or control nests).

Limited culling of cormorants was conducted in 2004 in order to determine the efficacy of the technique, assess non-target species disturbance and add to the effect of non-lethal removal efforts. Beginning in 2005 culling was used as a full scale management technique. Most culling was done using .22 or .17 caliber rimfire rifles. Culling teams consisted of at least two people. Carcasses were disposed of by burial or composting.

In addition to nest removal, oiling and culling activities, the NYSDEC continued cormorant diet studies, begun in 1992, by collecting regurgitated pellet samples at Little Galloo Island from mid-April through mid-October. All samples were analyzed by the U. S. Geological Service Great Lakes Science Center (Johnson et al. 2013).

Colony feeding days for Little Galloo Island cormorants were calculated according to the Casselman-Weseloh model (1992) modified for culling where:

Colony Feeding Days = N Adults x 158 + N Subadults x 112 = N Chicks x 92

and:

N Adults = (peak nest count x 2)-(N birds culled/2)

N Subadults = peak nest count/5

N Chicks = untreated nests x nest productivity rate

No correction was made for in-season bird movements or mortality**.**

Results

After the nest removal program began in 1994, there was no successful double-crested cormorant reproduction on Gull, Bass and Calf Islands until 2003 when 35 nests high in trees produced young. Twelve nests produced young on Bass Island in 2004. Nesting attempts (including re-nests) on these islands have varied from year to year with a dramatic peak of 1,367 nests in 2000 (Table 2).

Since 2007 greatly increased landowner activity on Bass Island has prevented significant waterbird production and made active cormorant management unnecessary. On Gull Island a total of 711 nests were removed over seven visits between May and August 2012, and 29 birds were culled. Peak one day nest removal was 391 (Table 2). The total and peak counts of nests removed increased slightly relative to 2011. No cormorant nesting attempts were observed on Calf Island this year (Table 2.)

Eggs were oiled on three occasions at Little Galloo Island between May and July 2012. The peak number of nests oiled on Little Galloo Island was 1,829 (Table 2). This year 362 cormorants were culled. There were 398 unoiled tree and control nests. Peak nest count was 2,227, including control subcolonies, tree, and “empty” but apparently occupied, nests (Table 1). Both total and peak nest counts were approximately 600 nests lower than in 2011. Note that peak nest counts do not necessarily correspond to nest numbers reported in Canadian Wildlife Service trend reports, which may or may not represent peak nesting. Hatching success (number of chicks hatched per number of eggs counted) for oiled nests was estimated to be less than 1%. We

estimated that approximately 700 cormorants fledged on Little Galloo Island this year, mostly from a control (unoiled) subcolony, some from tree nests, and a few from incidentally untreated ground nests.

Estimated feeding-days in 2012 were 817,972, above the target of 780,000 but well below the 999,400 estimate in 2011 (Figure 1). Since nest counts and feeding day estimates were relatively moderate this year, we expect management effort to remain at the current level in 2013.

Discussion

In April 2000, NYSDEC accepted a Final Environmental Impact Statement (NYSDEC 2000) regarding eastern Lake Ontario cormorant management. The statement outlined a five year process of reducing the Little Galloo Island cormorant population to a target level described as a population associated with 1,500 nesting pairs. This target population would produce approximately 780,000 feeding days, including contributions of sub-adults and young-of-the-year. It was expected that less intensive control would then maintain the population at or near the target level. Because of constraints on available techniques, population objectives were not reached within the five years projected. Under the management authority provided by the U.S. Fish and Wildlife Service 2003 Federal Public Resource Depredation Order (USFWS 2003), lethal control (culling) was used to reduce cormorant numbers more rapidly, beginning in 2004. The population has been near the feeding-day target since 2006 and dropped below the target for the first time in 2010. The project has been operating at maintenance level since 2007.

Reduced population levels at Little Galloo Island, probably related to egg oiling, became noticeable in 2002. Johnson et al. (2004) reported a substantial decline in fish consumption at this colony due to lack of consumption by chicks and lower numbers of feeding adults resulting from reduced recruitment. This reduction has continued (Johnson and Farquhar 2008). Radiotelemetry studies indicated that nest oiling also reduced the residence time of nesting adults on the colony, further reducing consumption (Mazzocchi 2003).

Managing by nest oiling only, nesting pairs of cormorants on Little Galloo Island were reduced by about 15% annually due to attrition. The use of adult culling reduced the breeding population more quickly, by increasing the rate at which adults are removed from the population (Figure 1). In addition to the direct effect of removing adults, experience with culling at Presqu'ile Provincial Park (Ontario), the Niagara River, and on Bass Island in the eastern basin of Lake Ontario, suggests that about half of nests will be abandoned and not re-occupied after removing one adult, increasing the overall rate of population reduction.

Impacts on fish species of interest have declined faster than fish consumption as a whole, because cormorant diet has become dominated by round goby (*Neogobius melanostomus*) (Johnson et al. 2009). Management, along with the major dietary shift, has moved the system towards meeting objectives for protecting fish communities by substantially reducing consumption of smallmouth bass by cormorants on Little Galloo Island (Johnson et al. 2006).

Many variables can influence the results of cormorant management over time (NYSDEC 2000). Immigration and emigration rates to and from sites within the eastern basin are perhaps the most likely factors to consider. Although eastern basin cormorant numbers have generally declined, at times immigration has appeared to exceed emigration within New York waters of the basin.

Site-specific management is a moderately labor intensive undertaking, although not particularly expensive in comparison to other predation management projects, such as sea lamprey (*Petromyzon marinus*) management (Schiavone and Adams 1995). These management actions can be effectively implemented to resolve conflicts on the local scale. The efforts undertaken in New York over the past few years have successfully met objectives for limiting production of cormorants on New York's Lake Ontario eastern basin islands.

Cormorant management, whether implemented locally, regionally, or rangewide, should be considered in a broad, long term context to ensure that management actions remain sound, integrated

and effective.

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Table 1. Estimated breeding pair numbers for colonial waterbirds on eastern basin Lake Ontario islands. Numbers for cormorants are for active nests after management activity and may not match Canadian Wildlife Service trend numbers (dash indicates not checked for given species).

Species	Island	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Double-crested Cormorant	Little Galloo Isl	5,681	5,119	5,440	4,780	4,251	3,967	3,401	2,692	2,959	2,492	2,751	1,758	2,831	2,227
	Gull Island	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Bass Island	0	0	0	0	35	12	5	5	5	0	0	0	0	0
	Calf Island	-	-	-	-	-	0	-	-	-	0	0	0	0	0
Ring-billed Gull	Little Galloo Isl	53,000	-	-	-	60,000	-	-	-	-	37500	-	-	-	43324
	Gull Island	0	-	-	-	0	-	-	-	-	0	-	0	-	0
	Bass Island	2,300	-	-	-	2,500	-	-	-	-	0	-	0	-	0
Herring Gull	Little Galloo Isl	275	-	-	-	313	-	-	367	0	375	356	364	459	512
	Gull Island	45	-	-	-	42	-	-	40	67	58	42	89	91	52
	Bass Island	10	-	-	-	10	-	-	10	16	0	0	0	0	0
Great Black-backed Gull	Little Galloo Isl	8	-	19	15	12	-	-	4	1	1	0	0	0	0
	Gull Island	0	-	0	1	0	-	-	0	0	9	0	0	0	0
	Bass Island	0	-	0	0	0	-	-	0	0	9	0	0	0	0
Caspian Tern	Little Galloo Isl	1,445	1,350	1,590	1,585	1,658	1,560	1,788	1,589	1,580	1,376	1,499	1,472	1,934	2,332
Black-crowned Night Heron	Little Galloo	1	1	1	1	3	3	4	0	0	1	0	0	0	0
	Gull Island	41	20	50	24	35	78	81	77	127	78	78	105	151	44
	Bass Island	9	36	13	36	47	17	46	32	0	0	0	0	0	0
	Calf Island	6	-	0	-	-	0	-	-	-	-	13	0	0	0

Table 2. Number of cormorant nests removed or oiled and adults culled; nests with no intact eggs were not oiled.

Island	Activity	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Little Galloo Island	Peak nests oiled	5,627	4,301	3,865	3,707	3,389	3,359	2,896	2,275	2,502	1,804	2,166	1,104	2,000	2,227
	Nests removed	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	DCCO culled	-	-	-	-	-	18	686	620	709	382	798	145	569	362
Bass Island [2]	Peak nests oiled	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nests removed	37 (37)	793 (757)	0 (0)	986 (279)	260 (117)	959 (348)	935 (600)	477 (174)	470 (110)	0 (0)	0(0)	0(0)	0(0)	0 (0)
	DCCO culled	-	-	-	-	-	167	281	200	124	0	0	0	0	0
Gull Island [2]	Peak nests oiled	0	0	0	0	0	0	0	0	0	0		0	0	0
	Nests removed	146 (111)	574 (478)	21 (21)	157 (77)	1,427 (486)	485 (188)	0 (0)	113 (110)	273 (137)	671 (266)	741 (261)	604 (275)	659 (302)	711 (391)
	DCCO culled	-	-	-	-	-	3	0	0	20	2	0	0	0	29
Calf Island [2]	Peak nests oiled	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Nests removed	0	0	0	0	0	415 (539)	0	0	0	161 (111)	55 (52)	0	0	0
	DCCO culled	-	-	-	-	-	37	0	0	0	6	2	0	0	0

[2]Cumulative nests removed. Number in ( ) is peak one day count.

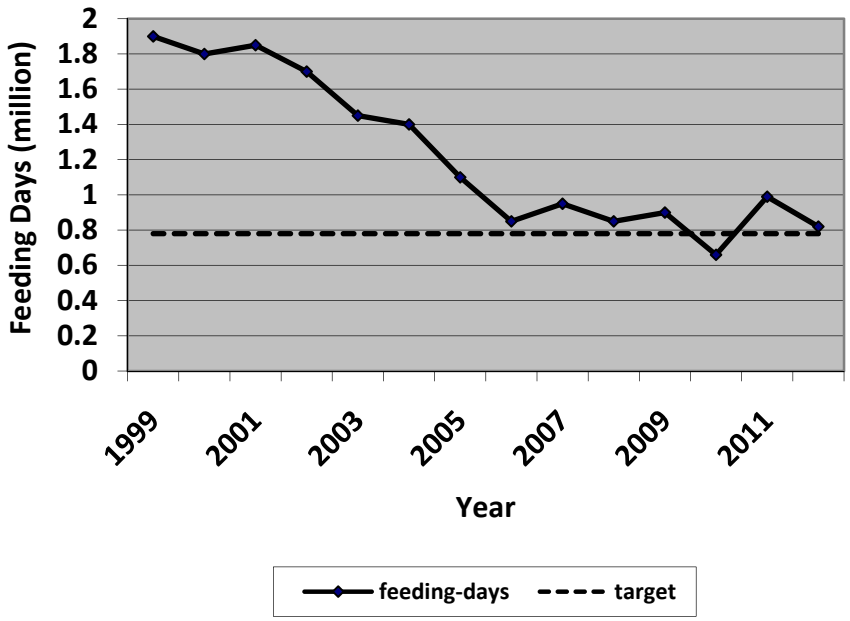

Figure 1. Trend in cormorant feeding days for the Little Galloo Island colony.

Double-Crested Cormorant Studies at Little Galloo Island, Lake Ontario in 2012: Diet Composition, Fish Consumption and the Efficacy of Management Activities in Reducing Fish Predation

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For almost two decades Little Galloo Island (LGI) has supported a large colony of double-crested cormorants (*Phalacrocorax auritus*) in the eastern basin of Lake Ontario. Cormorant nest counts on the island since the early 1990's have averaged 4,384 per year. However, less than 2,000 pairs have nested on the island in three of the past four years. The highest count was reached in 1996 with 8,400 nesting pairs on the island. Johnson et al. (2012) estimated that cormorants from LGI alone have consumed 481 million fish since 1992. The proliferation of cormorants in the eastern basin of Lake Ontario coincided with declines in two important recreational fish species, smallmouth bass and yellow perch. Lantry et al. (2002) and Burnett et al. (2002) provide convincing evidence linking cormorant population increases to declining eastern basin smallmouth bass (*Micropterus dolemieu*) and yellow perch (*Perca falvescens*) stocks. Decline of these fish stocks was evident only in the eastern basin, suggesting a localized problem, which is consistent with the halo effect where large piscivorous waterbird colonies may deplete local fish stocks (Birt et al. 1987).

The year 2012 marked the twenty first consecutive year of study of the food habits and fish consumption of LGI cormorants and the fourteenth consecutive year evaluating the efficacy of management activities to control the reproductive success of cormorants nesting at LGI. The program consists mainly of spraying cormorant eggs with food grade vegetable oil as well as the culling of adult and immature birds. This paper reports the findings of work carried out in 2012 at LGI.

Methods

Diet Examination

Diagnostic prey remains recovered in regurgitated pellets were used to describe the diet of double-crested cormorants on LGI in 2012. A total of 270 pellets were collected during the pre-chick feeding period (4/18/12 and 5/9/12), chick feeding period (6/20/12 and 7/10/12) and post-chick feeding period (8/22/12). In the laboratory, diagnostic bones, all otoliths, and representative scales were removed from the pellets and identified under magnification. Eye lenses were also enumerated and, although they could not be used in species identification, their total number (i.e. number of lenses/2) generated fish counts that exceeded those based on bones or otoliths in some pellets. For prey species identified, diagnostic fish material recovered from cormorant pellets were compared with bones, scales, and otoliths from known specimens defleshed in a concentrated potassium hydroxide solution. Species were identified to the lowest practical taxonomic level.

Fish Consumption Estimation

To estimate number of fish consumed by cormorants from the LGI colony, we used a model similar to that of Weseloh and Casselman (1992). This model incorporated cormorant age-class, population size, and seasonal residence time (time spent feeding in area) to estimate the number of cormorant feeding days, mean daily fish ingestion

rates, and a fecal pathway correction factor for fish not detected in pellets (Johnson and Ross 1996). To estimate the number of cormorants feeding we used annual nest counts (all nests counted) provided by the New York State Department of Environmental Conservation (NYSDEC) and assumed that (1) residence time for breeding adults, immatures, and young-of-year (YOY) was 158, 112, and 92 days, respectively (Weseloh and Casselman, unpublished report); (2) number of immatures was about 10% of the adult population which was taken as twice the number of nests; and (3) the number of YOY cormorants is the product of the fledgling productivity estimate for the year and the number of active nests. Residence times at LGI may actually be shorter because of annual management activities at the colony. Mazzocchi et al. (2003) found that the departure date of cormorants was 16 days later for a sub-colony of cormorants at LGI where no management activities occurred, compared to a sub-colony in the managed area. We did not account for bird mortality during the time of residence or the migrant double-crested cormorant population (transient birds that stay an unknown amount of time on Lake Ontario). Incorporating bird mortality estimates into the model would reduce fish consumption estimates, whereas including migrant birds would increase estimated consumption. Although YOY cormorants are generally present for about 113 days, consumption by chicks during the first three weeks post-hatch is considered minimal, and for the remainder of the season their daily food intake approximates that of adults (Weseloh and Casselman, unpublished report). Although immature cormorants are essentially fully grown, they are non-reproductive birds.

Because of the apparent differences in feeding patterns of cormorants over the season, we identified three separate feeding phases, pre-chick (prior to chick hatch), chick (chicks present and being fed by adults), and post-chick (cessation of feeding chicks by adult) feeding. These phases were characterized by differences in diet composition and daily fish consumption (i.e. the number of fish per pellet). Pre-chick feeding was from late April to early June, the chick feeding period from mid June to late July, and the post-chick feeding period from early August to early October. To examine cormorant fish consumption by feeding period (i.e. pre-chick, chick, and post-chick) we further broke down the number of cormorant feeding days by age-class as follows:

	Days			
	Pre-chick	Chick	Post-chick	Total
Adults	64	42	52	158
Immatures	18	42	52	112
YOY	0	42	50	92

To estimate the number of fish consumed by cormorants during each feeding period we multiplied the number of double-crested cormorant feeding days by mean daily ingestion rates for that period. For estimates of mean daily ingestion rates, we used the mean number of fish per pellet multiplied by a fecal correction factor of 1.042 (Johnson and Ross 1996). Although variation in pellet production rates have been observed in cormorants (Carss et al. 1997) many researchers consider that a single pellet is typically produced by adult cormorants each day (Craven and Lev 1987, Orta 1992, Derby and Lovvorn 1997). Pellet production rates greater than one per day would increase our fish consumption estimates for the LGI colony whereas rates less than one per day would reduce our estimates. Fish consumption estimates for each of the three feeding periods were summed to provide an annual fish consumption estimate. Specific fish consumption was estimated by multiplying the percent composition by number for a species in the diet for each feeding period by the total fish consumption estimate for that period. Consumption estimates were then summed for all three periods to provide annual consumption estimates for each species or taxon. The use of the Weseloh and Casselman model, which did not include variance estimates associated with the number of feeding days for each life stage, precluded us from generating standard error estimates for fish consumption estimates. To estimate the biomass of fish eaten, we assumed that cormorants consumed 0.47 kg (approximately 1 pound) of fish per day (Schramm et al. 1984, 1987; Weseloh and Casselman 1992), representing

about 25% of their body weight (Dunn 1975).

We estimated the size (total length) of key species including yellow perch, rock bass (*Ambloplites rupestris*) and pumpkinseed sunfish (*Lepomis gibbosus*) consumed during each cormorant feeding period by measuring otoliths from each species/period to the nearest 3.9 X 10^{-3} in (0.1 mm) with calipers (Burnett et al. 2001, Ross et al. 2005). Broken or chipped otoliths were not considered for measurement. To estimate the weight of these species consumed by cormorants we used length-weight regressions for eastern Lake Ontario populations (unpublished data).

Control Measures

NYSDEC staff began treating accessible double-crested cormorant nests on LGI with corn oil beginning on May 9 and ending July 10, 2012. The oiling process was conducted four times over the season on each reachable nest with eggs except for a small sub-colony of approximately 300 ground nests that were not included in the oiling. Oil was applied from a backpack sprayer unit in sufficient volume to cover the exposed surface of each egg (approximately 6 ml/egg or 0.2 oz/egg). The number of eggs treated per nest was recorded and each nest or group of nests was marked with spray paint to facilitate efficient movement throughout the colony as well as complete nest coverage. Also recorded were the number of nests not treated and the number of chicks present per visit. We adjusted the number of cormorant feeding days and total number of fish consumed to account for362 cormorants culled at LGI on June 13.

We estimated reductions in cormorant feeding days and fish consumption annually from egg oiling. For chicks, these estimates were determined from 1999-2012; for immature cormorants, from 2000-2012; and for adult cormorants, from 2002-2011. These time periods assume that the effects on chicks began immediately (1999), the effects on immature birds began one year post initial treatment (2000), and effects on adult cormorants began when they reach maturity at age 3 (2002). To derive projected estimates, a standard of 5,681 nests from 1999 when egg oiling was first started was used. For each subsequent year, that nest count was subtracted from 5,681 (example: 2005 was 5,681-3,401=2,280 fewer nests). That nest count figure was then used to derive adult, immature, and YOY reductions in both feeding days and fish consumption using the standard Weseloh and Casselman model. This estimate plus the annual estimated reduction in feeding days from chicks alone and the actual number of feeding days for each year for the entire colony were summed to provide the projected estimate. Projected feeding day estimates were multiplied by the annual number of fish per pellet (i.e. daily fish consumption) to provide the projected estimate for fish consumption.

Results

Diet Composition

Round goby (*Neogobius malanostomus*) (88.3%) were the major prey of LGI cormorants in 2012 and dominated the diet during all feeding periods (Table 1). Yellow perch (5.4%), alewife (2.1%), and rock bass (1.2%) were the next most abundant species in the diet. For the entire season forage species (i.e. round goby, alewife (*Alosa pseudoharengus*), cyprinids, etc.) contributed 90.7% of the diet of LGI cormorants, while panfish (i.e. yellow perch, pumpkinseed, rock bass, etc.) and gamefish (smallmouth bass), composed 9.2% and 0.1%, respectively.

Fish Consumption

The number of fish per pellet (adjusted for fecal loss) was highest during the post-chick feeding period (51.2) and averaged 29.4 for the season (Table 1). The number of fish per pellet was the second highest observed in the 21 years of investigations at LGI and was the result of cormorants consuming small round gobies. A peak count of 2,227 cormorant nests was observed on LGI in 2012 and chick productivity was estimated at about 0.31 chicks per nest. To account for birds that were shot on June 13 in the fish consumption model, the adult bird estimate was reduced by 15,204 and 18,824 feeding days, respectively for the chick and post-chick feeding periods. Using the Weseloh and Casselman model we estimate about 0.76 million cormorant feeding days for the LGI colony in 2012 and about 0.76

million pounds of fish consumed (Figure 1). Numbers of fish consumed by feeding period in 2012 included 5.16 million during the pre-chick feeding period, 4.30 million during the chick feeding period, and 13.90 million during the post-chick feeding period.

In 2012, LGI cormorants consumed 21.16 million forage fish including 20.58million round goby and 0.50 million alewife (Figure 2). About 2.15 million panfish were eaten, including 1.26 million yellow perch, 0.58 million pumpkinseed, and 0.28 million rock bass. Cormorants consumed about 0.05 million game fish, smallmouth bass and esocids (Figure 2).

Size of Fish Consumed

A total of 374 otoliths recovered from cormorant pellets were measured in 2012. The size of yellow perch consumed by LGI cormorants in 2012 declined over the season. The average weight of yellow perch, rock bass, and pumpkinseed (computed from length-weight regression) for each feeding period is provided in Table 2. For the entire feeding season on LGI cormorants consumed an estimated 45,000 pounds of yellow perch, 44,000 pounds of pumpkinseed, and 18,000 pounds of rock bass.

Effects of Control Measures

The removal of 362, mostly adult, cormorants from the LGI population reduced the number of cormorant feeding days by about 34,028 and reduced total fish consumption by an estimated 1.2 million. Consequently, these feeding days and number of fish were not considered in estimating the effects of egg oiling. Chicks accounted for 64,400 cormorant feeding days from early June to mid-October (Table 3). The total number of cormorant feeding days by the LGI colony in 2012 was estimated at 0.76 million (Table 3). We estimated that 4,009 chicks would have been produced on LGI from 2,227 nests in 2012 in the absence of reproductive suppression (i.e. egg oiling) by using the chick productivity estimate of 1.8 chicks per nest. Egg oiling limited cormorant chick production to about 700 chicks, which is an 83% reduction. The number of chick feeding days by the LGI colony was reduced by 83%. For the entire LGI colony in 2012, reproductive suppression reduced the total number of cormorant feeding days from 1.12 million to 0.76 million (32.7%) and the number of fish consumed from 35.2 million to 23.4 million (33.3%) (Table 3). The relative magnitude of the reduction in fish consumption caused by reproductive suppression at LGI in 2012 was consistent with what was achieved in the previous six years (Figure 3).

We estimate that the 700 cormorant chicks produced on LGI in 2012 consumed about 2.38 million fish (Table 4). If egg oiling was not carried out and 4,009 cormorant chicks were produced on LGI in 2012, we estimate that these chicks would have consumed 13.2 million fish (Table 4). Consequently, egg oiling reduced fish consumption by 10.8 million fish in 2012. Using diet composition information for the chick and post-chick feeding periods, the reduced fish consumption represented 10.28 million round goby, 0.26 million alewife, 0.18 million yellow perch, and 0.01 million rock bass (Table 4).

Discussion

Since the egg oiling program was initiated in 1999 the number of cormorant nests at LGI has been lower than the pre-control level (5,681). Results achieved by the double-crested cormorant reproductive suppression program on LGI since 1999 have been remarkably consistent. Chick productivity has been reduced from an average of about 2.00 chicks per nest (1992-1998) to 0.17 chicks per nest (1999-2012), a 92% reduction. Since initiated in 1999, egg oiling has resulted in: (1) a 91.0% (annual range 76.0% to 98.0%) reduction in cormorant chick production, (2) a 29.0% (annual range 23.9% to 32.7%) reduction in cormorant feeding days, and (3) a 27.9% (annual range 19.1% to 34.8%) reduction in total fish consumption (Johnson et al. 2006, 2007, 2008, 2009, 2010, 2011). A double-crested cormorant milestone was reached in 2010 when, for the first time, the number of feeding days (650,000) was below the management target of 780,000 that has been set for the LGI colony (McCullough et al. 2011).

We estimate that the cormorant reproductive suppression program on LGI has reduced fish

consumption by chicks at the colony by 96.6 million fish since it was initiated in 1999. Included in this estimate are approximately 9.9 million yellow perch and 2.6 million smallmouth bass that were not consumed by cormorants. These two species are especially important since declines in their abundance in the eastern basin of Lake Ontario have been associated with cormorant population increases (Burnett et al. 2002, Lantry et al. 2002).

Cumulative Effects of Egg Oiling

The annual reduction in chick productivity at LGI provides only partial insight into the overall cumulative effects in terms of the reduction in both cormorant feeding days and fish consumption at the colony. Full consideration of the effects of egg oiling on these parameters should include projections for the immature and adult birds that would have been produced annually at the colony in the absence of egg oiling. Since egg oiling was initiated at LGI in 1999, about 6,090 chicks have been fledged compared to an estimated 81,412 if egg oiling had not occurred. If these 75,322 chicks had survived we estimate that fish consumption by chicks alone would increase by153.2million (Figure 4). In addition, the number of cormorant feeding days declined by 72% (3% attributed to cull; 2.71 million to 1.01 million from 1999 to 2012) (Figure 5) and actual annual fish consumption decreased by 8%(3% attributed to cull; 23.6 million to 21.7 million) during the same period (Figure 6). This increase was due to dominance of small round gobies consumed by cormorants at LGI in 2012.

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Table 1: Seasonal and total percent diet composition of double-crested cormorants from Little Galloo Island, 2012. Sample dates were 4/18/12 and 5/9/12 (pre-chick feeding period,) 6/20/12 and 7/10/12 (chick feeding period), and 8/22/12 (post-chick feeding period).

	Pre-chick	Chick	Post-chick	Total
No. of pellets	90	90	90	270
Fish/pellet (adjusted x 1.042)	17.6	19.5	51.2	29.4
Round Goby	67.0	84.5	97.6	88.3
Yellow Perch	17.0	2.1	1.6	5.4
Pumpkinseed	10.1	0.3	0.1	2.6
Alewife	1.3	11.4	0.1	2.1
Rock Bass	3.0	1.6	0.4	1.2
Cyprinids	0.8	0.1	---	0.2
Catosomids	0.4	---	0.1	0.1
Escoids	0.2	---	---	0.1
Smallmouth Bass	0.1	---	0.1	0.1
White perch	0.1	---	---	<0.1
Total	100.0	100.0	100.0	100.0

Table 2. Estimated total length (TL, inches), mean weight (Wt., pounds), and number examined (No.), of yellow perch, rock bass, and pumpkinseed consumed by double-crested cormorants during each feeding period on Little Galloo Island in 2012. (SD = standard deviation).

	Feeding Period								
	Pre-chick			Chick			Post-chick		
	TL(SD)	Wt.	No.	TL(SD)	Wt.	No.	TL(SD)	Wt.	No.
Yellow Perch	4.7 (1.2)	0.04	100	4.1 (1.3)	0.03	28	4.0 (1.2)	0.03	67
Rock Bass	4.9 (1.3)	0.08	41	4.3 (1.2)	0.06	22	4.9 (1.1)	0.08	16
Pumpkinseed	4.6 (1.3)	0.08	100	----	----	----	----	----	----

Table 3. Estimated number of chicks produced, chick feeding days, total cormorant feeding days, and the number of fish eaten based on chick productivities of 0.31 (control = egg oiling) and 1.8 chicks per nest (no control) on Little Galloo Island in 2012.

Action	No. of chicks	No. of chick feeding days	Total cormorant feeding days	No. of fish eaten
No control	4,009	368,791	1,122,408	35,188,548
Control (egg oiling)	700	64,400	764,388	23,430,945
Difference	3,309	304,391	358,020	11,757,603

Table4. Fish consumption estimates for double-crested cormorant chicks based on chick productivities of 0.31 (control = egg oiling) and 1.8 chicks per nest (no control) on Little Galloo Island in 2012.

	Number of fish consumed		
Species	Control	No. control	Difference
Round Goby	2,263,559	12,543,398	10,279,839
Yellow Perch	40,525	224,511	184,046
Alewife	56,423	312,666	256,243
Rock Bass	15,272	84,631	69,359
Cyprinid	478	2,647	2,169
Smallmouth Bass	1,905	10,557	8,652
Ictalurid	1,905	10,557	8,652
Pumpkinseed	3,351	18,508	15,157
	2,383,418	13,207,535	10,824,117

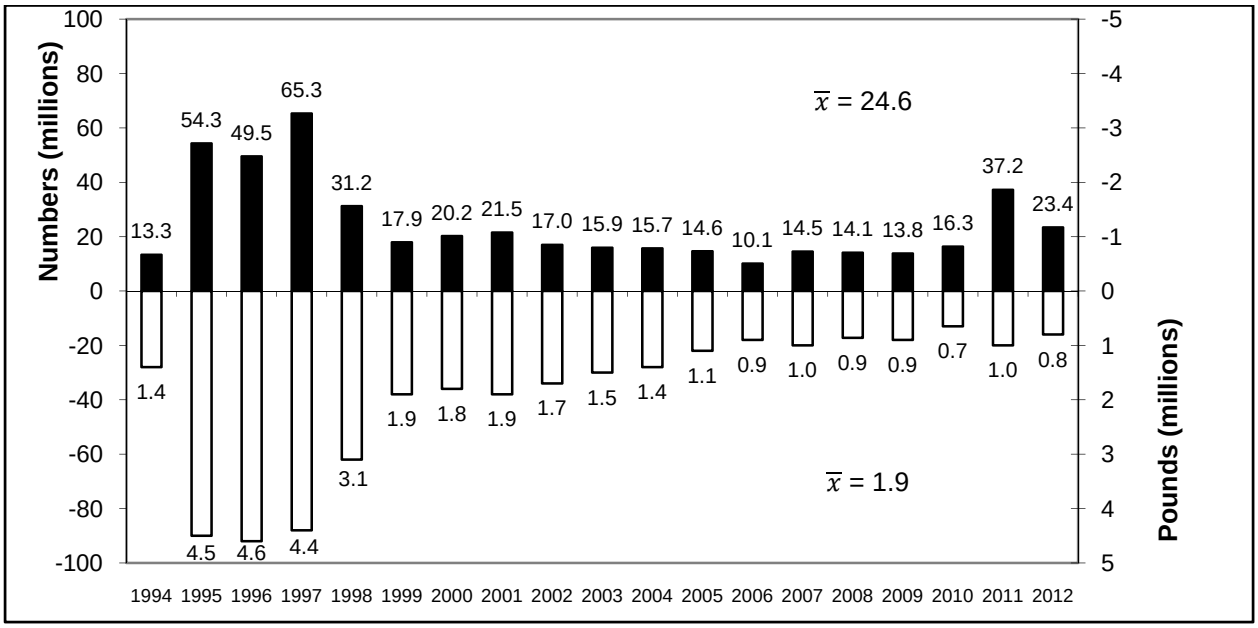

Figure 1. Estimated annual fish consumption in terms of numbers (top) and pounds (bottom) by the Little Galloo Island double-crested cormorant colony, 1993-2012.

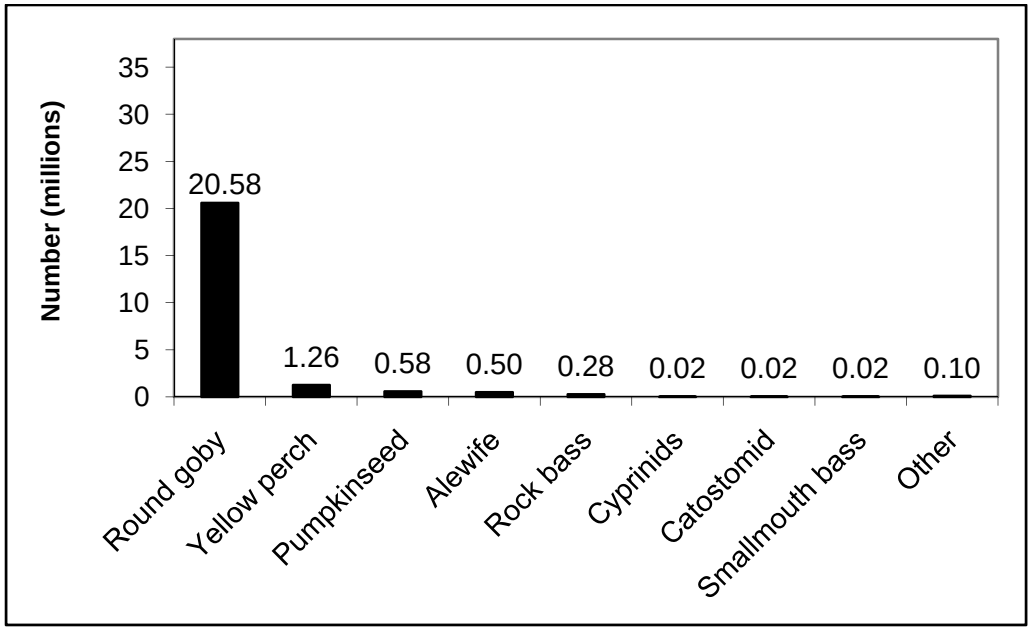

Figure 2. Estimated species-specific fish consumption by double-crested cormorants at the Little Galloo colony, 2012.

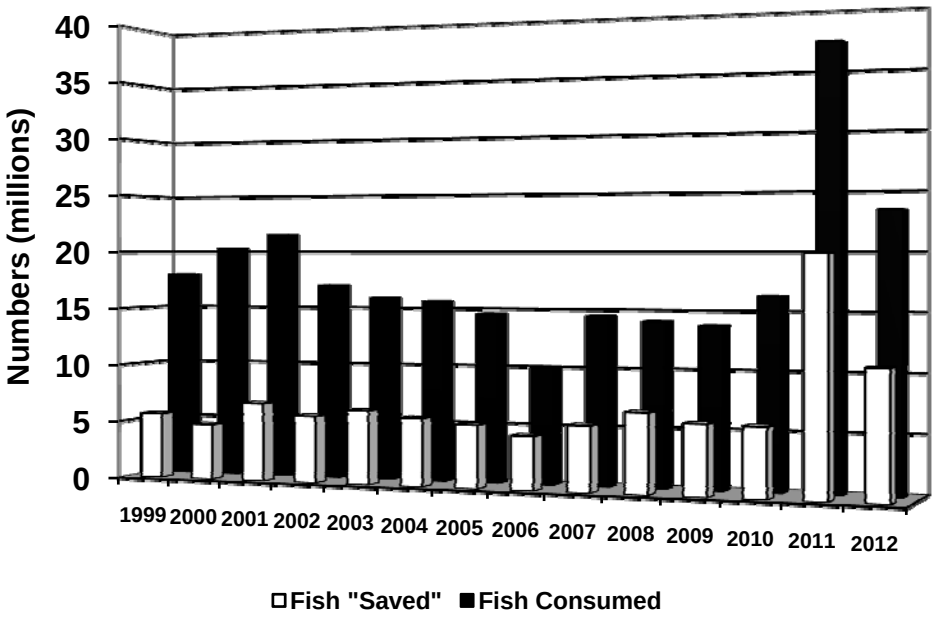

Figure 3. Estimated numbers of fish consumed by double-crested cormorant chicks and estimated number of fish "saved" by cormorant reproductive suppression since 1999 on Little Galloo Island.

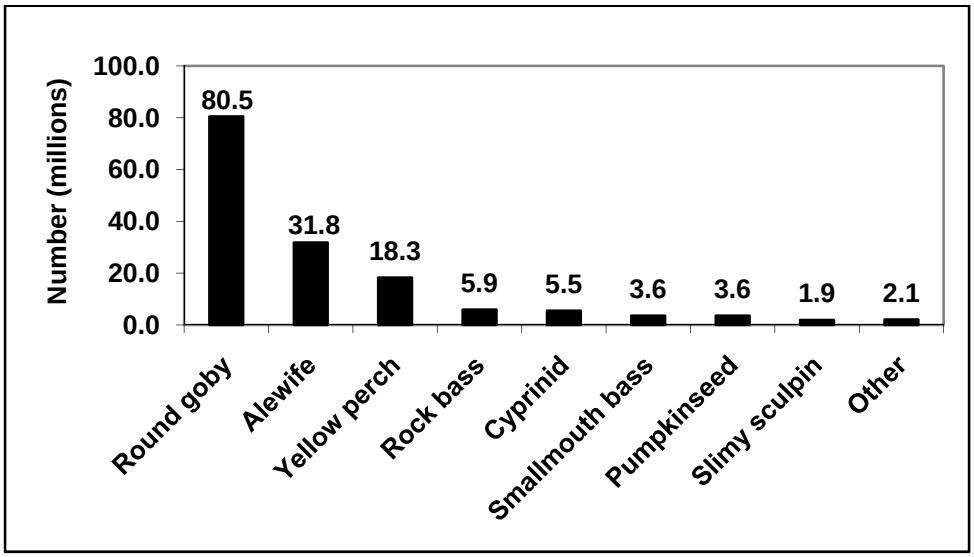

Figure 4. Total number (millions) of fish "saved" by egg oiling program at Little Galloo Island, 1999-2012.

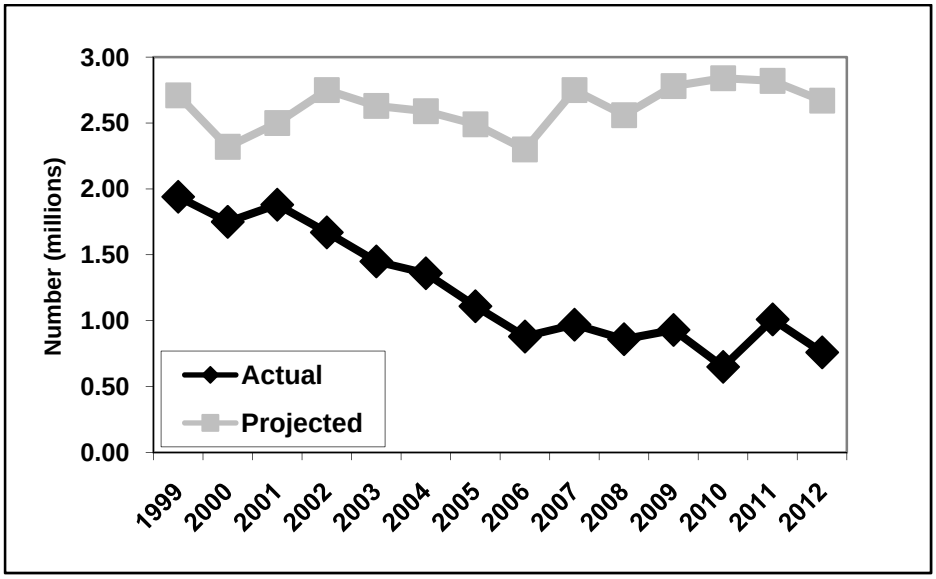

Figure 5. Actual (control-egg oiling) and projected (no control) double-crested cormorant feeding days at Little Galloo Island, Lake Ontario, 1999-2012.

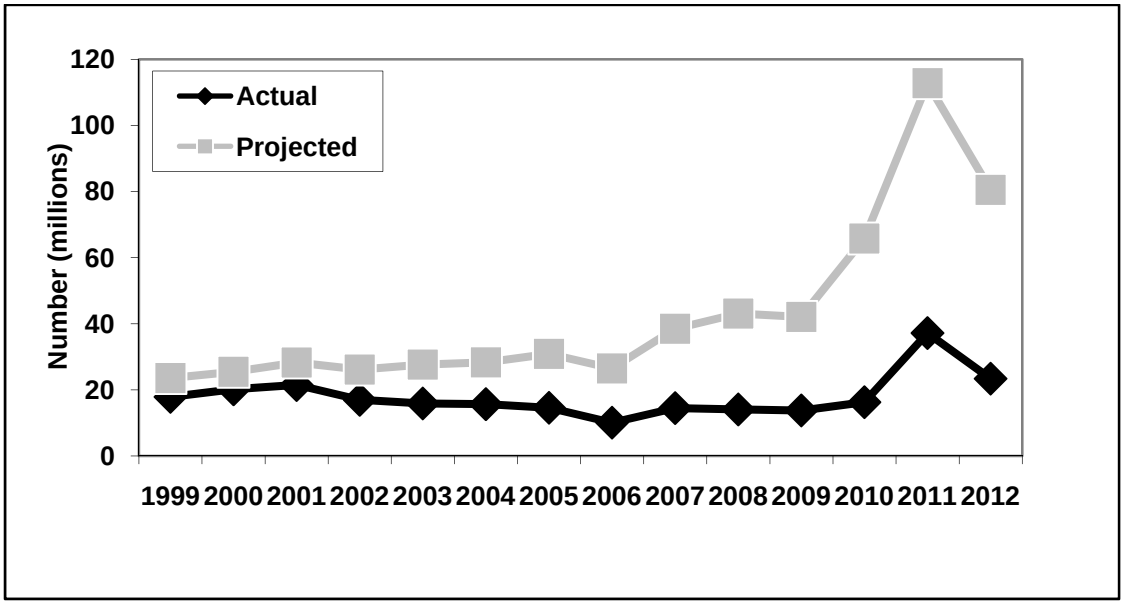

Figure 6. Actual (control-egg oiling) and projected (no control) estimates of double-crested cormorant fish consumption at Little Galloo Island, Lake Ontario, 1999-2012.

Diet Composition and Fish Consumption of Double-Crested Cormorants from Three St. Lawrence River Colonies in 2012

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Double-crested cormorants (*Phalacrocorax auritus*) were first observed nesting in the upper St. Lawrence River at Strachan Island in 1992. Cormorants now nest at a number of islands in the Thousand Islands section of the river. Griswold, McNair, and Strachan islands are among the largest colonies in the upper river. Until 2011, nest counts had remained relatively stable, ranging from 200 to 603 nests per colony. In 2011 and 2012 nest counts were 833 and 736 at McNair Island, respectively. Although the size of cormorant colonies in the upper St. Lawrence River is smaller than those in the eastern basin of Lake Ontario, the close proximity of islands in the upper river that have colonies may cause a cumulative fish consumption effect similar to a larger colony.

Because of increasing numbers of double-crested cormorants in the upper St. Lawrence River and the possible impacts on fish populations, studies were initiated in 1999 to quantify cormorant diet and fish consumption at the three largest colonies. From 1999 to 2011 these studies have shown that cormorants consumed about 115.3 million fish including 36.3 million yellow perch (*Perca flavescens*), 16.2 million rock bass (*Ambloplites rupestris*) and 0.9 million smallmouth bass(*Micropterus dolemieu)* (Johnson et al. 2012). During this same time period fish assessment studies near some of these islands have shown a major decrease in yellow perch populations (Klindt 2007). This occurrence is known as the halo effect and happens when piscivorous birds deplete local fish populations inareas immediately surrounding the colony (Ashmole 1963). This paper describes the diet and fish consumption of cormorants in the upper St. Lawrence River in 2012.

Methods

Diagnostic prey remains recovered in regurgitated pellets were used to describe the diet of double-crested cormorants at St. Lawrence River colonies in 2012. Pellets were collected beginning in mid-June and ending in early August. In the laboratory, diagnostic bones, all otoliths, and representative scales were removed from the pellets and identified under magnification. Eye lenses were also enumerated since, although they could not be used in species identification, their total number (i.e., number of lenses/2) generated fish counts that exceeded those based on bones or otoliths in some pellets. For prey species identified, diagnostic fish material recovered from cormorant pellets were compared with bones, scales, and otoliths from known specimens defleshed in a concentrated sodium hydroxide solution. Species were identified to the lowest practical taxonomic level.

To estimate the number of fish consumed by cormorants from each colony, we used a model similar to that of Weseloh and Casselman (1992) to estimate the number of fish eaten by

cormorants annually. This model incorporated cormorant age-class population size and seasonal residence time (time spent feeding in area) to estimate the number of cormorant feeding days, mean daily fish ingestion rates, and a fecal pathway correction factor for fish not detected in pellets (Johnson and Ross 1996). To estimate the number of cormorants feeding we used annual nest counts (all nests counted) provided by the Canadian Wildlife Service and the NYS Department of Environmental Conservation and assumed that (1) residence time for breeding adults, immatures, and young-of-year (YOY) was 158, 112, and 92 days, respectively (Weseloh and Casselman, unpublished report); (2) number of immatures was about 10% of adult population which was taken as twice the number of nests; and (3) the number of YOY cormorants is the product of the fledgling productivity estimate for the year and the number of active nests. We did not account for bird mortality during the time of residence or the migrant double-crested cormorant population (transient birds that stay an unknown amount of time). Incorporating bird mortality estimates into the model would reduce fish consumption estimates whereas including migrant birds would increase estimated consumption. Although YOY cormorants are generally present for about 113 days, consumption by chicks during the first 3 weeks post-hatch is considered minimal, and for the remainder of the season their daily food intake approximates that of adults (Weseloh and Casselman, unpublished report). Immature cormorants are essentially fully grown but non-reproductive birds.

Because of the apparent differences in feeding patterns of cormorants over the season, we identified three separate feeding phases, pre-chick (prior to chick hatch), chick (chicks present and being fed by adults), and post-chick (cessation of feeding chicks by adult) feeding. These phases are characterized by differences in diet consumption and daily fish consumption (i.e., the number of fish per pellet). Pre-chick feeding occurs from early April to early June, the chick feeding period from mid-June to late July, and the post-chick feeding period from early August to late September. To examine cormorant fish consumption by feeding period (i.e., pre-chick, chick, and post-chick) we further broke down the number of cormorant feeding days by age-class as follows:

	Days			
	Pre-chick	Chick	Post-chick	Total
Adults	64	42	52	158
Immatures	18	42	52	112
YOY	0	42	50	92

To estimate the number of fish consumed by cormorants during each feeding period we multiplied the number of double-crested cormorant feeding days by mean daily ingestion rates for that period. For estimates of mean daily ingestion rates, we used the mean number of fish per pellet multiplied by a fecal correction factor of 1.042 (Johnson and Ross 1996). Although variation in pellet production rates has been observed in cormorants (Carss et al. 1997) many researchers consider that a single pellet is typically produced by adult cormorants each day (Craven and Lev 1987, Orta 1992, Derby and Lovvorn 1997). Pellet production rates greater than one per day would increase our fish consumption estimates for each colony whereas rates less than one per day would reduce our estimates. Fish consumption estimates for each of the three feeding periods were summed to provide an annual fish consumption estimate. Specific fish consumption was estimated by multiplying the percent composition by number for a species in the diet for each feeding period by the total fish consumption estimate for that period. Consumption estimates were then summed for all three periods to provide annual consumption estimates for each species or taxon. When pellets were not collected during a single feeding period a mean value was calculated from the two feeding periods to estimate total fish consumption. The use of the Weseloh and Casselman model, which did not include variance estimates associated with the number of feeding days for each life stage, precluded us from generating standard error estimates for fish consumption estimates. To estimate the biomass of fish eaten, we assumed that cormorants consumed 1 lb fish per day (Schramm et al. 1984,

1987; Weseloh and Casselman 1992), representing about 25% of their body weight (Dunn 1975).

We estimated the size (total length) of key species including yellow perch, rock bass and pumpkinseed sunfish (*Lepomis gibbosus*) consumed during each cormorant feeding period by measuring otoliths from each species/period to the nearest 3.9 X 10^{-3} in (0.1 mm) with calipers (Burnett et al. 2001, Ross et al. 2005). Broken or chipped otoliths were not considered for measurement. To estimate the weight of these species consumed by cormorants we used length-weight regressions for eastern Lake Ontario populations (unpublished data).

Spatial and temporal variation in diet composition for the Griswold, McNair and Strachan Island colonies was determined by using the equation of Morisita (1959) as modified by Horn (1966). Overlap values can range from 0, when samples contain no food in common, to 1, when there is identical representation of food between samples. When using this formula, overlap values (Cλ) ≥ 0.60 are considered biologically significant (Zaret and Rand 1971).

Results

A total of 780 pellets were used to describe the feeding ecology of cormorants from Griswold (270 pellets), McNair (270 pellets), and Strachan (240 pellets) Islands in 2012 (Tables 1-3). Over the entire season the number of fish per pellet was highest at McNair Island (19.9) and was followed by Strachan Island (17.9) and Griswold Island (13.3) (Tables 1-3).

Diet Composition

Round gobies (*Neogobius melanostomus*)were the primary prey of cormorants at Griswold Island (63.0%) and rock bass (13.7%) and yellow perch (13.3%) were the second and third ranked prey (Table 1). Pumpkinseed (7.6%) was the only other species that contributed at least 2% of the diet of Griswold Island cormorants. For the entire season, panfish (i.e., yellow perch, rock bass, pumpkinseed, ictalurids) contributed 36.3% of the diet, forage fish (round goby, cyprinids, darters) composed 63.5%, and gamefish (mainly smallmouth bass and esocids) comprised 0.2% of the diet of Griswold Island cormorants.

Round goby (81.6%), rock bass (6.7%), pumpkinseed (5.7%) and yellow perch (5.0%) were the dominant prey in the diet of cormorants at McNair Island (Table 2). For the season,panfish made up 17.7% of the diet of McNair Island cormorants, forage fish 82.2%, and gamefish (smallmouth bass) 0.1% (Table 2).

Round goby (73.5%), yellow perch (14.2%), and rock bass (7.7%) were the main prey of Strachan Island cormorants (Table 3). Pumpkinseed (2.5%) was the only other prey species that contributed at least 1% of the diet. Panfish made up 25.1% of the seasonal diet, forage fish 74.8%, and gamefish 0.1% at Strachan Island in 2012 (Table 3).

Diet Overlap

Mean diet overlap for the entire season among all three upper St. Lawrence River colonies in 2012 was high, from 0.95 to 0.98 (Table 4). Diet was the most similar between cormorants from Strachan and McNair Islands (Cλ= 0.98). There was little temporal variation in diet composition between the two feeding periods at any of the three colonies (Table 5).

Fish Consumption

Based on nest counts of 558 on Griswold Island, 736 on McNair Island, and 234on Strachan Island, and fledgling productivities of 1.8 chicks per nest (pers. comm. James Farquhar, NYSDEC, Watertown), we estimated 0.21, 0.37 and 0.12 million cormorant feeding days for Griswold Island, McNair Island, and Strachan Island, respectively, in 2012. Fish consumption for the Griswold Island colony was estimated at 3.5 million fish and 0.28 million pounds, for the McNair Island colony at 7.4 million fish and 0.37 million pounds, and for the Strachan Island colony at 2.4 million fish and 0.12 million pounds (Table 6).

We estimate that during 2012 cormorants from Griswold Island consumed 1.26 million panfish (including 0.47 million yellow perch, 0.47 million rock bass and 0.26 million pumpkinseed),

2.3 million forage fish (including 2.2 million round goby) and 0.01 million gamefish (smallmouth bass) (Figure 1). We estimate that cormorants from McNair Island consumed 1.32 million panfish (mainly 0.50 million rock bass, 0.43 million pumpkinseed, and 0.37 million yellow perch), 6.06 million forage fish (including 6.03 million round goby and 0.02 million cyprinids), and 0.01 million gamefish (smallmouth bass). Cormorants from Strachan Island consumed 0.60 million panfish (including 0.34 million yellow perch, 0.18 million rock bass, 0.06 million pumpkinseed, and 0.02 million ictalurids), 1.75 million forage fish (mainly 1.73 million round goby and 0.01 million cyprinids), and 0.01 million gamefish (smallmouth bass) (Figure 1). The size of yellow perch and pumpkinseed consumed by cormorants at Griswold Island and rock bass at McNair Island, declined over the season (Table 7).

Discussion

Of the six double-crested cormorant colonies (3 eastern Lake Ontario, 3 St. Lawrence River) where diets have been examined, Griswold was the last colony to have round goby become the main fish prey (2009). Prior to 2009,yellow perch (55.5%) were the main prey of cormorants at Griswold Island (Johnson et al. 2012). Since 2009 round goby have contributed 62.2% and yellow perch 19.4% of the diet of cormorants at Griswold Island.

Round gobies first appeared in the diet of cormorants nesting in 2003 when they contributed about 2% of the diet of birds at McNair Island (Johnson et al. 2004). In 2004, cormorants at all three colonies consumed round gobies with the diet contribution at McNair increasing to 15% and the contribution at Griswold Island and Strachan Island being 1.2% and 1.7%, respectively. In 2005, gobies were almost non-existent (0.1%) in the diet of cormorants at Griswold Island but were the second most consumed prey and represented 24.3% and 19.6% of cormorant diets at McNair and Strachan Island, respectively. Since 2004, when round gobies first appeared in cormorant diets at all St. Lawrence River colonies, they have comprised 46.6% of the fish consumed at Strachan,49.2% at McNair and 33.8% at Griswold. The possible halo effect relative to yellow perch populations surrounding Strachan Island observed by Klindt (2007) has not been evident since round goby became abundant in the diet (Klindt and Gordon 2010).

From 1999 to 2004, panfish composed 78.6% and forage fish only 19.3% of cormorant diets at the three St. Lawrence River colonies. Since 2004, panfish have made up 44.4% and forage fish 54.7%, of cormorant diets in the upper St. Lawrence River. Over this same period game fish have made up 0.9% of cormorant diets at these three river colonies (Johnson et al. 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012). The contribution of gamefish in cormorant diets in 2012 (0.1%) was the lowest observed since diet studies began in 1999. As noted for panfish, reduced consumption of gamefish could be related to the dominance of round gobies in cormorant diets at these colonies.

Since 1999, we estimate that cormorants from these colonies have consumed 129.1 million fish (Figure 2). This includes 50.4 million round goby, 37.5 million yellow perch, 17.4 million rock bass, 10.6 million pumpkinseed, 1.5 million ictalurids, and 1.0 million smallmouth bass (Figure 2).

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Table 1. Seasonal and total percent diet composition by number of double-crested cormorants from Griswold Island, 2012. Pre-chick feeding period includes pellets collected on 6/14/12, chick feeding period includes pellets collected on 7/9/12 and post-chick feeding period collected on 8/2/12.

	Pre-chick	Chick	Post-chick	Total
No. of pellets	90	90	90	270
Fish/pellet (adjusted x 1.042)	12.2	10.9	13.7	13.3
Round Goby	55.1	61.9	68.5	63.0
Yellow Perch	21.9	12.0	9.4	13.3
Rock Bass	19.2	18.4	7.4	13.7
Pumpkinseed	2.8	4.0	12.6	7.6
Ictalurid	0.1	2.6	1.6	1.7
Smallmouth Bass	0.1	0.2	0.3	0.2
Banded killifish	0.4	0.3	----	0.2
Catostomid	0.1	0.1	0.1	0.1
Alewife	----	0.4	----	0.1
Cyprinid	0.2	0.1	----	0.1
Esocid	----	----	0.1	<0.1
Darter	0.1	----	----	< 0.1
Total	100.0	100.0	100.0	100.0

Table 2. Seasonal and total percent diet composition by number of double-crested cormorants from McNair Island, 2012. Pre-chick period includes pellets collected on 6/14/12 and chick feeding period includes pellets collected on 7/9/12 and post-chick feeding period collected on 8/2/12.

	Pre-chick	Chick	Post-chick	Total
No. of pellets	90	90	90	270
Fish/pellet (adjusted x 1.042)	21.3	16.3	22.0	19.9
Round Goby	75.0	76.1	89.8	81.6
Rock Bass	10.4	8.3	2.4	6.7
Pumpkinseed	4.0	10.3	4.1	5.7
Yellow Perch	10.0	3.9	2.6	5.0
Cyprinid	----	0.2	0.6	0.3
Ictalurid	0.1	0.9	0.1	0.3
Catostomid	0.2	0.1	0.1	0.1
Banded Killifish	0.1	0.1	----	0.1
Smallmouth Bass	0.1	----	0.2	0.1
Darter	----	0.1	0.1	0.1
Alewife	0.1	----	----	< 0.1
Total	100.0	100.0	100.0	100.0

Table 3. Seasonal and total percent diet composition by number of double-crested cormorants from Strachan Island, 2012. Pre-chick feeding periods includes pellets collected on 6/14/12 and chick feeding period includes pellets collected on 6/29/12, and post-chick feeding period includes pellets collected on 8/2/12.

	Pre-chick	Chick	Post-chick	Total
No. of pellets	60	90	90	240
Fish/pellet (adjusted x 1.042)	19.0	17.1	23.1	17.9
Round Goby	73.1	63.6	79.7	73.5
Yellow Perch	10.9	22.8	10.8	14.2
Rock Bass	11.6	7.8	5.6	7.7
Pumpkinseed	2.0	4.1	1.7	2.5
Ictalurid	0.6	0.5	0.8	0.7
Catostomid	0.6	0.5	0.9	0.7
Cyprinid	1.0	0.3	0.4	0.5
Smallmouth Bass	0.1	0.1	0.1	0.1
Banded Killifish	0.1	0.1	----	<0.1
Darter	----	0.1	----	<0.1
Walleye	----	0.1	----	< 0.1
Total	100.0	100.0	100.0	100

Table 4. Spatial diet overlap among three St. Lawrence River cormorant colonies, 2012.

	Colonies		
Feeding period	Griswold I.-McNair I.	Griswold I.-Strachan I.	McNair I.-Strachan I.
Pre-chick	0.94	0.95	0.99
Chick	0.96	0.97	0.95
Post-chick	0.95	0.98	0.99
Average	0.95	0.97	0.98

Table 5. Temporal diet overlap at each of the three St. Lawrence River cormorant colonies, 2012.

Feeding period	Griswold I.	McNair I.	Strachan I.
Pre-chick feeding-Chick feeding	0.98	0.99	0.98
Pre-chick feeding-Post-chick feeding	0.94	0.98	0.99
Chick feeding-Post-chick feeding	0.97	0.98	0.96
Average	0.96	0.98	0.98

Table 6. Fish consumption estimates in millions for cormorants at each of the three St. Lawrence River colonies, 2012.

	Griswold Island		McNair Island		Strachan Island	
Period	Number	Pounds	Number	Pounds	Number	Pounds
Pre-chick feeding	0.9	0.07	2.1	0.10	0.6	0.03
Chick feeding	1.0	0.09	2.0	0.12	0.7	0.04
Post-chick feeding	1.6	0.12	3.3	0.15	1.1	0.05
Total	3.5	0.28	7.4	0.37	2.4	0.12

Table 7. Estimated mean total length (TL, inches), weight (Wt., pounds), and number of otoliths examined (No.) for yellow perch, rock bass, and pumpkinseed consumed by double-crested cormorants during the pre-chick and chick feeding periods on Griswold, McNair, and Strachan Islands in 2012. (SD = standard deviation).

	Griswold			McNair			Strachan		
				Pre-chick					
	TL (SD)	Wt.	No.	TL (SD)	Wt.	No.	TL (SD)	Wt.	No.
Yellow perch	4.0 (1.0)	0.03	100	3.8 (1.4)	0.02	100	3.5 (1.3)	0.02	94
Rock bass	5.1 (1.3)	0.09	100	4.4 (1.2)	0.06	100	4.1 (1.1)	0.05	100
Pumpkinseed	4.6 (1.8)	0.08	28	3.4 (1.4)	0.03	72	3.6 (1.0)	0.03	22
				Chick					
Yellow perch	3.5 (1.1)	0.02	100	3.2 (1.3)	0.01	48	3.4 (1.1)	0.01	100
Rock bass	4.3 (1.1)	0.05	100	3.9 (1.3)	0.04	100	4.3 (1.1)	0.06	94
Pumpkinseed	4.5 (1.3)	0.07	71	3.0 (2.0)	0.02	100	2.4 (0.7)	0.01	58
				Post-chick					
Yellow perch	3.2 (1.1)	0.01	100	3.6 (1.3)	0.02	45	3.5 (1.4)	0.02	100
Rock bass	4.3 (1.0)	0.05	86	3.8 (1.0)	0.04	46	4.1 (0.9)	0.05	79
Pumpkinseed	3.2 (1.4)	0.02	100	4.5 (1.5)	0.07	76	2.7 (1.1)	0.01	25

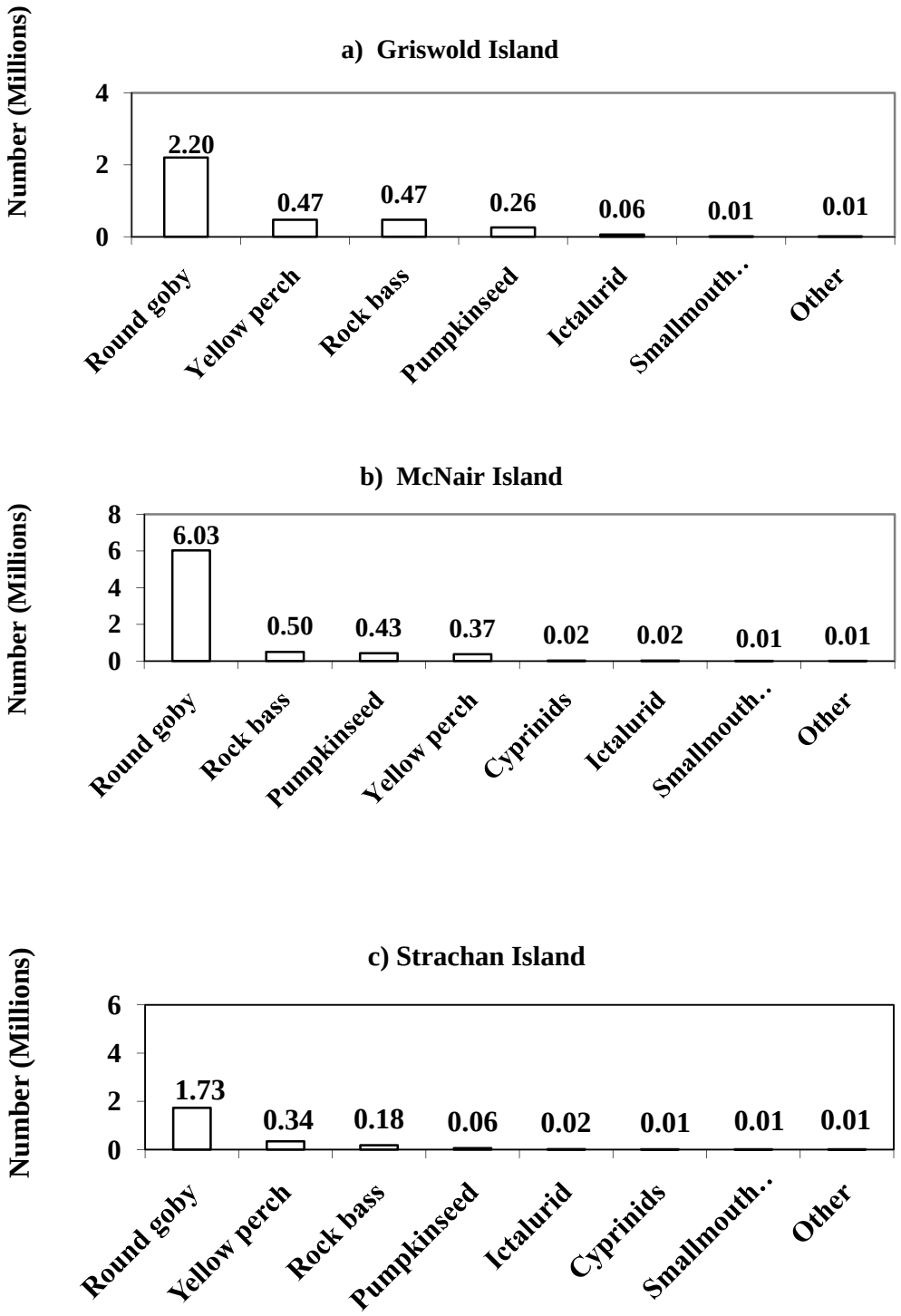

Figure 1. Estimated number of fish, in millions, consumed by cormorants from colonies at (a) Griswold, (b) McNair and (c) Strachan Islands in the St. Lawrence River in 2012.

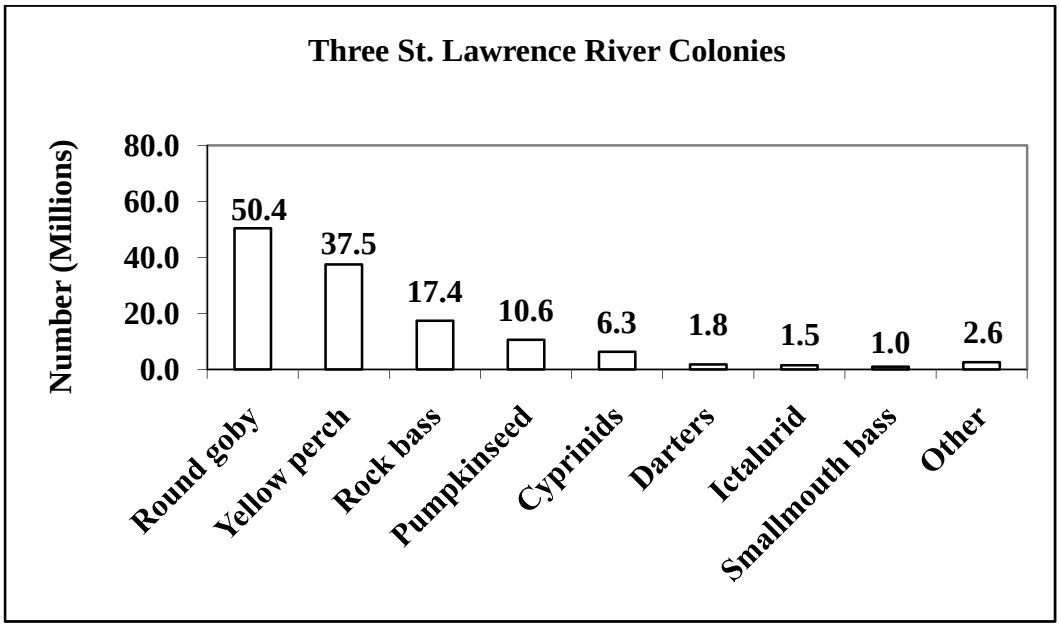

Figure 2. Estimated number of fish, in millions, consumed by cormorants at the three St. Lawrence River colonies 1999 to 2012.

2012 Status of the Lake Ontario Lower Trophic Levels

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Significant Findings for Year 2012:

1) Phosphorus showed only small variations across sites for both the nearshore (10m depth) and the offshore (20 m and deeper) stations. Average total phosphorus (TP) ranged between 4.6 to 8.3 μg/L and average soluble reactive phosphorus (SRP) ranged between 0.9 and 2.7 μg/L in the epilimnion. TP and SRP were higher in the nearshore than in the offshore, but differences were small.
2) Spring TP has declined in the longer data series (since 1981), but not since the inception of the Biomonitoring Program in 1995. It averaged 6.9 μg/L in the nearshore and 4.9 μg/L in the offshore in 2012--substantially lower than 10 μg/L (the goal of the Great Lakes Water Quality Agreement of 1978) and about 30% lower than in 2011.
3) Offshore summer chlorophyll *a* declined significantly in both the short and long-term time series at a rate of about 3% per year. Nearshore chlorophyll *a* increased after 2003 but then declined again after 2009. Epilimnetic chlorophyll *a* averaged between 0.7 and 1.5 μg/L at the different sites in 2012 with no difference between nearshore and offshore habitats. Average Secchi disk depth ranged from 4.4 m to 10.3 m and was higher in the offshore (average 8.4m) than the nearshore stations (6.6m). These values are indicative of oligotrophic conditions in both habitats.
4) Summer nearshore zooplankton density and biomass have declined significantly since 1995 at rates of 11-12% per year.
5) Summer offshore zooplankton density and biomass in the epilimnion of Lake Ontario has have also declined significantly since 1995, also at rates of 11-12% per year; density also declined significantly in the long-term (since 1981) but has remained at a lower stable level since 2005.
6) Bosminid and cyclopoid copepod biomass have declined significantly in offshore and nearshore waters. Daphnid biomass has also declined significantly in the nearshore. Changes in the zooplankton community structure are consistent with a decline in fish predation and an increase in invertebrate predation.
7) The predatory cladoceran *Cercopagis* continued to be abundant in the summer and also became abundant again in the fall at the same time *Bythotrephes* peaked (Oct); at that time the biomass of *Cercopagis* was approximately twice that of *Bythotrephes*.
8) Zooplankton biomass was concentrated in the metalimnion and hypolimnion in 2012. With the exception of one date in April, between 65 and 99% of zooplankton biomass was found below the thermocline throughout the year.

Introduction

This report presents data on the status of lower trophic level components of the Lake Ontario ecosystem (zooplankton, phytoplankton, nutrients) in 2012 and compares the 2012 data with available time series. Lower trophic levels are indicators of ecosystem health (as identified by the Lake Ontario Pelagic Community Health Indicator Committee [EPA 1993] and presented in the biennial State of the Lake Ecosystem Conference [SOLEC] reports) and determine the lake's ability to support the prey fish upon which both wild and stocked salmonids depend. Understanding the production potential of lower trophic levels is integral to ecosystem-based management. There is a concern about the ability of the lake to support current alewife production in the offshore due to declining production at lower trophic levels at the same time as there is a concern about excessive attached algal production (e.g., *Cladophora*) in some beach areas. The collapse of the alewife population and decline in Chinook salmon fishery in Lake Huron in 2003 may have been due to declines in lower trophic levels (Barbiero et al. 2011, Bunnell et al. 2012). Alewives have not returned to Lake Huron by 2012 and concerns of a similar crash in Lake Michigan has led to a decision to decrease Chinook stocking rates by about 50% in that lake.

From 1995-2012 we conducted a research program (hereafter referred to as the biomonitoring program, BMP) in Lake Ontario with the primary objective of evaluating temporal and spatial patterns in a number of ecological indicators: total phosphorus (TP), chlorophyll *a* (chl *a*), Secchi depth, and crustacean zooplankton (density, biomass, species composition, and size structure). Samples were collected from April through October. These indicators are assessed from spring through fall because each indicator has particular importance at a specific time of the year. Springtime (Apr-May) represents a time of peak nutrient levels in many systems, nutrients that will be available for biological activity during the year. This makes spring TP a logical indicator choice. The summer stratified period characterizes the peak production period for phytoplankton and many zooplankton species; therefore, summer chl *a* and zooplankton biomass were chosen as indicators. The September-October time period is useful to track species such as *Bythotrephes* whose biomass typically peaks later in the year. The BMP is a collaborative project that, in 2012, included the New York State Department of Environmental Conservation (NYSDEC) Lake Ontario Unit and regional staff at Watertown, Cortland, and Avon; the U.S. Fish & Wildlife Service Lower Great Lakes Fishery Resources Office (USFWS); the U.S. Geological Survey–Lake Ontario Biological Station (USGS); and Cornell University.

Report Objectives

Using data from 1995 to 2012, we address the following questions:

(1) What is the status of Lake Ontario's lower trophic levels in 2012, and are there differences between nearshore and offshore sites this year?
(2) What are the time trends in key indicators, and are there changes over time in these trends (regression and change-point analysis). How does the year 2012 compare to these time trends (using BMP data and other long-term data sets)?
(3) What is the status of the two non-native predatory cladocerans, *Bythotrephes* and *Cercopagis*?
(4) Are there changes in zooplankton community structure (biomass, size, species composition) that are indicative of changes in alewife predation, changes in predatory invertebrates (*Cercopagis*, *Bythotrephes*, *Mysis*, *Hemimysis*) or decreased overall productivity of the lake?
(5) Are the changes observed in the epilimnion indicative of changes in zooplankton in the whole water column?

Methods

Sampling

We measured total phosphorus (TP), soluble reactive phosphorus (SRP), chlorophyll *a* (chl *a*), water temperature, Secchi depth, and zooplankton density, size, and biomass by species at offshore and nearshore sites in Lake

Ontario (Figure 1). Samples were collected from seven nearshore sites biweekly from May through October 2012 (12 potential sampling weeks). Inclement weather precluded sampling in at least one week at all sites except NWL; however all sites were sampled on at least 9 occasions. Offshore samples were collected during April-May, June, July, and September by the R/V Seth Green, and approximately monthly (April–October) by the R/V Kaho. In addition, four stations were sampled at night in July during the hydroacoustic survey conducted by the R/V Seth Green. Nearshore sites had depths ranging from 9.0 m to 14.5 m (30 to 48 ft), and offshore sites ranged from 20 m to 206 m (66 to 676 ft). Offshore sampling totaled 32 daytime samples taken from seven sites and four nighttime samples from four sites.

Water Chemistry

Water samples were collected for analysis of chl *a*, TP, and SRP. Each sample was obtained by using an integrated water sampler (1.9 cm inside diameter Nalgene tubing) lowered to a depth of 10 m or bottom minus 1 m where site depth was 10 m or less. The tube was then closed off at the surface end and the column of water transferred to 2 L Nalgene containers. From each sample, a 100 mL unfiltered aliquot was frozen for later analysis of TP (Menzel and Corwin 1965). We also filtered 1-2 L of water through a Whatman 934-AH glass fiber filter that was frozen for later analysis of chl *a* using the standard acetone extraction method (Strickland and Parsons 1972). A 100 mL aliquot of filtered water was frozen for later analysis of SRP (Strickland and Parsons 1972).

Quality Control and Variability

To measure analytical precision we, processed replicate samples for TP and SRP. In July, five aliquots of water were taken from the same sample at each nearshore site. TP and SRP samples were processed at Upstate Freshwater Institute (UFI).

In 2012, we collected replicate samples to determine within site variability of TP, SRP, and chl *a*. Triplicate samples were collected at each nearshore (except SPL, no August sampling) location once in August. From each of the three samples, one aliquot was taken for TP, one for SRP, and one for chl *a* analysis. TP and SRP samples were analyzed at UFI. Chl *a* was analyzed at CBFS.

Duplicate samples for TP, SRP, and chl *a* were collected at each offshore site throughout the year. Mean values from those duplicates were used in the analyses.

Zooplankton

Zooplankton samples were collected with a standard 0.5 m diameter, 153 µm-mesh nylon net equipped with a calibrated flowmeter (except SPL—no flowmeter available). At nearshore sites, we strained a water column between 8.5 and 10 m. At offshore sites, we sampled a 5 to 40 m water column (to the thermocline when stratification was present, epilimnetic sample). A total water column sample was also collected from two sites during the day and from four sites at night. At the deeper Smoky Point, Oak Orchard, and Mid Lake sites one 50 m and one 100 m tow were obtained in addition to the standard epilimnetic sample. Zooplankton were anesthetized using antacid tablets, then preserved in the field with 95% ethyl alcohol. At nearshore sites, single samples were collected on a biweekly basis from May to October with the exception of July and August during which duplicate samples were collected on each sampling date. Mean values from these duplicates were used in all analyses.

At CBFS, each sample was strained through a 1.02 mm mesh cup to separate *Cercopagis* and other larger organisms (>1 mm in length) from smaller zooplankton (<1 mm). This was done because *Cercopagis* and *Bythotrephes* form clumps in the sample, making the usual random sub-sampling of 1 mL samples inappropriate. For each sample that contained clumps of *Cercopagis* or *Bythotrephes* two analyses were performed, one on the smaller zooplankton and one on the larger zooplankton (including *Cercopagis* and *Bythotrephes*) that were caught in the 1 mm mesh strainer. At least 100 larger zooplankton (or the whole sample) were measured and enumerated by sub-sampling organisms from a gridded, numbered Petri dish in which the sample had been homogeneously separated. In some cases different subsamples were used for *Bythotrephes* and *Cercopagis*. To

calculate the total number of large crustaceans and *Cercopagis* in the clumped part of the sample, we used a ratio of wet weights of the sub-sample to wet weights of the total sample. Wet weights were determined using a Sartorius balance.

For smaller sized zooplankton, we counted and measured at least 100 organisms from one or more 1 mL random sub-samples. The sub-sample was examined through a compound microscope at 10-40X magnification. Images from the sample were projected onto a digitizing tablet that was interfaced with a computer. Zooplankton were measured on the digitizing tablet and identified to species (with the exception of nauplii and copepodites) (Pennak 1978, Balcer et al. 1984). In earlier years of this project an electronic touch screen (1995-1997) and a 20X microprojector (1998-2000) were used for measuring the zooplankton (Hambright and Fridman 1994). We then used length:dry-weight regression equations (CBFS standard set, Watkins et al. 2011) to estimate zooplankton biomass. Densities from all counts of the same sample (large and small animals) are summed to yield an overall density of all organisms in each sample.

Data Analyses

We compared April/May to October mean TP, SRP, chl *a*, water temperature, Secchi depth, zooplankton density, size, and biomass, and zooplankton group biomass between the two habitats by first averaging across sites for each month (nearshore, n=7; offshore, n=7) and then comparing the two habitats using a paired t-tests (paired by month, n=5). Logarithmic transformations were needed for TP, SRP and zooplankton to reduce heteroscedasticity. We divided zooplankton into the following eight groups: daphnids (*Daphnia mendotae*, *D. pulicaria*, *D. retrocurva*); bosminids (*Bosmina longirostris*, *Eubosmina coregoni*); calanoid copepods (*Diaptomus minutus*, *D. oregonensis*, *D. sicilis*, *D. ashlandi*, *Epischura lacustris*, *Eurytemora affinis*, *Limnocalanus macrurus*); cyclopoid copepods (*Acanthocyclops vernalis*, *Diacyclops thomasi*, *Mesocyclops edax*, *Tropocyclops prasinus*); other cladocera (*Ceriodaphnia quadrangula*, *Chydorus sphaericus*, *Leptodora kindtii*, *Diaphanosoma sp.*, *Alona sp.*, *Holopedium gibberum*, *Polyphemus pediculus*, *Camptocercus sp.*); *Bythotrephes longimanus*; *Cercopagis pengoi*; and nauplii. Differences were considered significant at $p<0.05$.

Change point analyses (Taylor Enterprises, Inc. 2003) were performed on long-term trends in two time stanzas (1995–2012 and 1981–2012) to look for breaks in the data. These were performed on spring TP, summer chl *a*, summer epilimnetic zooplankton density and biomass, and on zooplankton group biomass. Change point analysis uses cumulative deviations from the mean to assess if there are significant changes in time trends and when those changes occurred. This is done by resampling the data series 10,000 times to construct confidence intervals based on the inherent variability in the data series, and testing if and when the observed data series differ significantly from these confidence intervals.

Regression analyses (JMP Pro v9.0.2, SAS Institute Inc. 2010) were performed on the same two time stanzas (1995–2012 and 1981–2012) using spring TP, summer chl *a*, summer epilimnetic zooplankton density and biomass, and on zooplankton group biomass.

Results

Quality Control and Variability

To estimate analytical precision (i.e. within sample variability), we analyzed 35 TP samples and 35 SRP samples (7 sites x 5 samples per site). Coefficients of variation (CV=SD/mean) ranged from 4 to 16% (mean of 9%) for TP and from 5 to 31% (mean of 16%) for SRP. Values from replicated sampling occasions were averaged for all analyses.

The analysis of August nearshore TP, SRP, and chl *a* triplicate samples showed that the CV for TP ranged from 1 to 37% (mean of 14%), the CV for SRP ranged from 0 to 28% (mean of 17%), and the CV for chl *a* ranged from 15 to 60% (mean of 29%). Within site variability for TP was higher than the analytical precision. Within site variability in SRP was similar to analytical precision. Ranges represent typical

variation observed in previous years. Values were averaged for later analyses.

2012 Water Quality

The nearshore sites east and west of the Niagara River had lower water clarity compared with other nearshore sites but not higher chl *a* levels; average May through October Secchi depth was less than 5 m at those locations. Average Secchi depths at other nearshore and offshore sites were between 5 m and 11 m (Table 1, Figure 2a). May - Oct chl *a* concentrations were low; all sites averaged below 2 µg/L, and several averaged below 1 µg/L (Table 1, Figure 3a). Average spring TP concentrations at nearshore (6.9 µg/L) and offshore (4.9 µg/L) sites were below the 10 µg/L target established by the Great Lakes Water Quality Agreement (IJC 1988) for offshore waters (Table 1, Figure 4a). Nearshore sites east and west of the Niagara River had the highest TP levels while deep, offshore (Smoky Point-O, Oak Orchard-O, and Midlake) sites had the lowest (Table 1). Nearshore sites had highest TP concentrations in September while offshore concentrations peaked in July (Figure 4a). This is a deviation from a typical TP pattern; values are usually highest in the spring. Nearshore and offshore SRP concentrations were low ($\leq$2 µg/L) with the exception of the Chaumont Lake and Galloo Island Lake sites, which had slightly higher concentrations (Table 1, Figure 5). Theses inter-site differences were similar to 2011. May - Oct water temperatures (top 10 m) ranged from 18-20C at nearshore sites and from 12-17 at offshore sites (Tables 1 and 2). Nearshore sites were warmer than offshore sites throughout the season (Figure 6).

Total phosphorus, chl *a*, and Secchi depths are typically correlated, as all are indicators of phytoplankton abundance. This was also the case in 2012, with the exception of the Niagara River sites which had low Secchi depth and low chl *a*. Low Secchi depths at the Niagara River sites may result from sediment load or turbulence associated with the river inflow. TP and water temperature were significantly higher in the nearshore, while Secchi depth was significantly higher in offshore areas (Table 2).

Water Quality Trends Since 1995

Comparisons with data collected since 1995 show that 2012 had low concentrations of TP and SRP but not unusually so. Levels of chl *a* in both nearshore and offshore waters were the lowest on record, however, these values were similar to the values measured in 2011 (Figure 3b). Secchi depths were not different from mean values (Figure 2b). Although 2012 shows a return to more oligotrophic conditions after an increase in TP in 2010 and 2011, the values are within the normal range observed since 1995 (Figure 4b).

2012 Zooplankton

In 2012, mean (May-Oct) density and biomass did not differ significantly between nearshore and offshore sites (Table 2, Figure 7). Offshore density and biomass were highest during spring, while nearshore density and biomass peaked in fall. Zooplankton mean size was significantly higher in the offshore (Table 2, Figure 7).

Although Apr/May - October epilimnetic zooplankton biomass did not differ significantly between the nearshore and offshore, there were differences in the biomass of certain community groups (Table 2; Figure 8). Bosminid biomass was significantly higher in the nearshore, and *Bythotrephes* biomass was significantly higher in the offshore. Calanoid copepods represented the greatest proportion of biomass in the offshore (39%) while cyclopoid copepods dominated in the nearshore (32%).

In 2012, *Cercopagis* and *Bythotrephes* were detected in samples from both habitats (Figures 8 and 9, Table 2). *Cercopagis* was first detected in late-June at several nearshore sites and in mid-July in the offshore. *Cercopagis* peaked initially during mid-July in the offshore and in mid-August in the nearshore. It then had a secondary peak in October in both offshore and nearshore locations (Figure 8). *Bythotrephes* was first detected in mid- July in offshore and nearshore locations. Peak *Bythotrephes* biomass occurred in early September in the offshore and in October in nearshore areas (Figure 8). Combined biomass of *Cercopagis* and *Bythotrephes* represented 4% of the zooplankton community at nearshore sites and offshore sites.

Zooplankton Trends Since 1995

Total summer epilimnetic zooplankton biomass at nearshore and offshore sites declined significantly from 1995 to 2012 (Figure 10, Table 3). This was primarily due to a significant decline in bosminids and cyclopoid copepods in both nearshore and offshore sites (Table 3). At the same time, the predatory cladocerans *Bythotrephes* and *Cercopagis* (offshore only) showed significant increases in biomass. A change point analysis using data from 1995–2012 showed that a break occurred in offshore density and biomass in 2005 (Figures 10 and 11, Table 3), in nearshore density in 1998 and 2005 and in nearshore biomass in 1998. The offshore break in 2005 was also evident in cyclopoid copepods and coincided with a positive break point for *Bythotrephes* in 2006. In the nearshore, the break point in 1998 was related to declines in calanoids, bosminids and cyclopoids and coincided with an increase in *Cercopagis* (see also Warner et al. 2006). The 2005 break point in the nearshore density was related to a decrease in nearshore cyclopoid biomass. *Bythotrephes* abundance also increased in the nearshore in 2006 (Table 3).

Changes in lower trophic indicators were similar between the two habitats (regression analysis), but the timing of changes varied (change point analysis). In both habitats, spring TP was stable from 1995 – 2011 while zooplankton density and biomass declined. The decline in total zooplankton biomass was due to declines in bosminid and cyclopoid biomass in both habitats. Summer chl *a* declined significantly in the offshore, but remained stable in the nearshore. In nearshore waters, there was a positive break in chl *a* concentration after 2003 and a negative break after 2009, while there was no such breaks in the offshore. Breaks in bosminid and cyclopoid biomass occurred at the same time in nearshore and offshore waters. Despite the lack of significant trends, a negative break occurred in nearshore calanoid copepod biomass in 1997 and a positive break occurred in other cladoceran biomass in 2004 in offshore waters. A positive break in other cladocerans was detected in 2000 in the nearshore and in 2004 in the offshore, but the time trends were not significant (Table 3).

Longer term trends (1981-2011) were significant for several offshore lower trophic level indicators. These trends were evaluated by adding BMP data to available data series from the Department of Fisheries and Oceans Canada, and point data from the LOTT and LOLA studies (Table 3). Significant long-term trends were a decrease in spring TP, a decrease in summer chl *a*, a decrease in summer zooplankton density, and an increase in Secchi depth (Figures 2b, 3b, 4b, and 11; see also Mills et al. 2003, Holeck et al. 2008).

Stratified Zooplankton Hauls

Comparison of epi-, meta-, and hypolimnetic zooplankton tows showed that zooplankton were more evenly distributed throughout the water column in mid-April and early June (Figure 12a), however, epilimnetic biomass remained low throughout the year (Figure 12b). Much of the total zooplankton biomass was concentrated in the meta- and hypolimnion, particularly under stratified summer conditions (Figure 12b). From July – October, 84% of the zooplankton biomass of Lake Ontario resided below the thermocline. Calanoid copepods and daphnids accounted for most of the meta- and hypolimnetic zooplankton biomass from July – October (Table 4).

With the exception of the Sodus site, nighttime tows taken in mid-July show a more even distribution of zooplankton above and below the thermocline (Figure 13). Nearby samples taken during the day show a greater concentration of zooplankton below the epilimnion.

Results of the hypo-, meta-, and epilimnetic tows from summer and fall deep sites (>100m) showed most groups had the greatest biomass in the metalimnion than in either the epilimnion or hypolimnion (Table 4). The groups 'other cladocderans' and *Bythotrephes* had the greatest biomass in the epilimnion. Nauplii and *Cercopagis* biomass was similar in the epi- and metalimnion. All other groups had the greatest biomass in the metalimnion.

Discussion

Secchi depth, chl *a* and total phosphorus are often used as trophic level indicators (Carlson

1977). Average values by site ranged from 0.7 to 1.5 µg/L for chl *a*, 4.6 to 8.3 µg/L for TP, 0.9 to 2.7 µg/L for SRP, and 4.4 to 10.3 m for Secchi depth for both the nearshore and offshore sites. These values are within the range for oligotrophic (low productivity) systems (0.3-3 µg/L chl *a*, 1-10 µg/L TP; Wetzel 2001). We note that average spring TP in the nearshore returned to a concentration below the long-term mean (8.4 µg/L) after a near record high in 2011. TP and SRP values were significantly higher in the nearshore in 2012, while Secchi depth was significantly higher in the offshore. Despite differences between nearshore and offshore sites, Lake Ontario should be classified as oligotrophic in both habitats.

Other studies have shown that the TP levels can be substantially higher in the shoreside habitat (<5 m depth). Makarewicz et al. (2012) reported high nutrient levels (often over 50 µg/L TP) in this habitat at several stations along the US southern shore and these levels can result in nuisance bloom of attached algae (Malkin et al. 2010). These observations are not in contrast to ours as Makarewicz et al. (2012) showed that nutrient levels decrease with distance from shore and reach values presented in this report at 1-4 km from shore depending on season and station. This is consistent with our data from 10 m depth being similar to the offshore stations.

Spring TP is a good indicator of summer phytoplankton production (Dillon and Rigler 1975), and the low chl *a* levels observed in both the offshore and nearshore are consistent with the low spring TP values. Spring TP has declined from values between 20 and 25 µg/L in the 1970s to values between 4 and 7 ug/L in the 2000s in the offshore and 5-11 µg/L in the nearshore (Figure 4b). These values are consistent with data from the Canadian Surveillance Program and EPA's lower trophic level assessments in 2003 and 2008. Spring TP has been below the goal of 10 µg/L set by the Great Lakes Water Quality Agreement of 1978 in the offshore sites since 1995 (not all years available) and around that goal in the nearshore sites (Figure 4b). Interestingly, spring TP has not declined further since 1995, but offshore summer chl *a* has declined during the same time period. This paradox may be associated with phosphorus being retained in the deep chlorophyll layer (see below) or retained in the bottom waters by quagga mussels. In any case, the lack of change in epilimnetic TP since 1995 is indicative of stable nutrient loading into Lake Ontario over the last 18 years.

Epilimnetic crustacean zooplankton density and biomass were low at nearshore and offshore sites in 2012 compared to the long-term mean (Figures 9 and 10). Epilimnetic zooplankton biomass has been particularly low since 2005 in both nearshore and offshore, and there is a significant change point in 2005 in the offshore data set with little change since that year. The nearshore data is more variable, and density but not biomass shows a significant change point in 2005. Density and biomass also show change points in 1998, the year *Cercopagis* was first abundant. Average size shows no trend in time (not shown) although nearshore sites have smaller average sizes than the offshore. Average size in the nearshore was smallest in June, coinciding with alewife concentrating in the nearshore to spawn (O'Gorman et al. 1991, Klumb et al. 2003).

The decline in epilimnetic zooplankton biomass is primarily the result of significant declines in bosminids and cyclopoids (mainly *Diacyclops thomasi*) in the nearshore and offshore. Daphnids and calanoid copepods showed no significant change in the offshore, however, daphnids showed a significant decline in the nearshore. These two groups are also more abundant in whole water column samples. The two groups with significant increases over time in the epilimnion are the invasive predatory cladocerans *Cercopagis* and *Bythotrephes*. We do not think this is a coincidence. The decline in smaller zooplankton is consistent with observed effects of these predatory zooplankton in Lake Ontario and elsewhere (Lehman and Caceres 1993, Yan et al. 2001, Pangle et al. 2007, Bunnell et al. 2011, Benoit et al. 2002, Laxson et al. 2003, Warner et al. 2006). In addition, we note that the majority of the biomass of these invertebrate predators is in the epilimnion, whereas the majority of the zooplankton biomass is in the metalimnion and hypolimnion (see below). These metalimnetic zooplankton are likely to migrate into the epilimnion at night,

as observed in Lake Michigan (Vanderploeg, NOAA Great Lakes Laboratory, Ann Arbor, pers. comm.). *Bythotrephes* is known to induce migration in Daphnia in the laboratory (Pangle and Peacor 2006).

It is harder to understand the reasons for the increase of the predatory cladocerans, in particular *Bythotrephes.* This species has been in Lake Ontario since the mid-1980s (Mills et al. 1993). Both large alewife and rainbow smelt select for *Bythotrephes* (Mills et al. 1992, Parker et al. 2001) and both fish species have declined over time. However, it is hard to detect a major change in these fish population associated with the 2005 resurgence of *Bythotrephes* in the lake. Alewife appear to be stable throughout the 2000s (Walsh et al. this volume). There may be time lags involved in building a sufficiently large *Bythotrephes* population that can withstand the predation rates from the current alewife population. There may also be a lack of spatial overlap if alewife tend to move into the deep chlorophyll layer to feed on abundance metalimnetic zooplankton rather than staying in the epilimnion. This would represent a change in alewife behavior from the 1980s, but is consistent with higher dietary importance of mysids for this fish species (Stewart et al. 2009, Boscarino et al. 2010).

This year, we also sampled the meta- and hypolimnetic layers for zooplankton by using depth stratified tows (different tow depths). We then calculated densities in deeper water through subtraction. Although this procedure introduces additional errors compared to an opening and closing net, it is simpler logistically in the field. The results are interesting. Areal biomass (mg/m^3) was higher in deeper water for 15 of 16 sampling occasions with depth-stratified net hauls. Epilimnetic areal biomass was higher on only one occasion in the spring un-stratified period. With the exception of one date in April, we found 65 - 99% of the zooplankton biomass to be below the thermocline during the day. Species composition in these deeper waters was dominated by larger zooplankton (i.e. *Daphnia mendotae*, *Limnocalanus macrurus*, and *Leptodiaptomus sicilis*). However, the smaller cyclopoid, *Diacyclops thomasi*, was found in deeper waters, particularly in the fall. Metalimnetic concentrations of zooplankton were also observed in 2008 (Rudstam et al. 2012) and in 2010-2011 (Holeck et al. 2012). It is clear that future sampling in offshore water must include deep tows.

Total abundance and biomass of zooplankton in Lake Ontario may not have declined to the extent suggested by the epilimnetic tows as the proportion of biomass in deep water may have increased over time. These deep zooplankton may migrate into the epilimnion during the night or feed on the deep chlorophyll layer. Deep chlorophyll maxima are common in the upper Great Lakes (Barbiero et al. 2012; Barbiero and Tuchman 2004). Such maxima develop when nutrients are limiting and water clarity is sufficient to allow for positive algal growth at depth with elevated nutrient concentrations. Understanding the identity and productivity of this layer and the extent it is utilized by zooplankton is a major thrust of the research during the Lake Ontario Field Year of 2013. Deep zooplankton, in addition to higher mysid and *Bythotrephes* consumption, are possible explanations for the increase in alewife condition observed in the lake in recent years (O'Gorman et al. 2008, Walsh et al. 2011). However, age-0 alewife may not have access to the deep zooplankton and have difficulty handling the spine of the predatory cladocerans (Bushnoe et al. 2003). Therefore, the observed changes in zooplankton biomass, community composition and spatial distribution could decrease growth rates of young-of-year alewife and increase over-winter mortality (O'Gorman et al. 2004, Höök et al. 2007).

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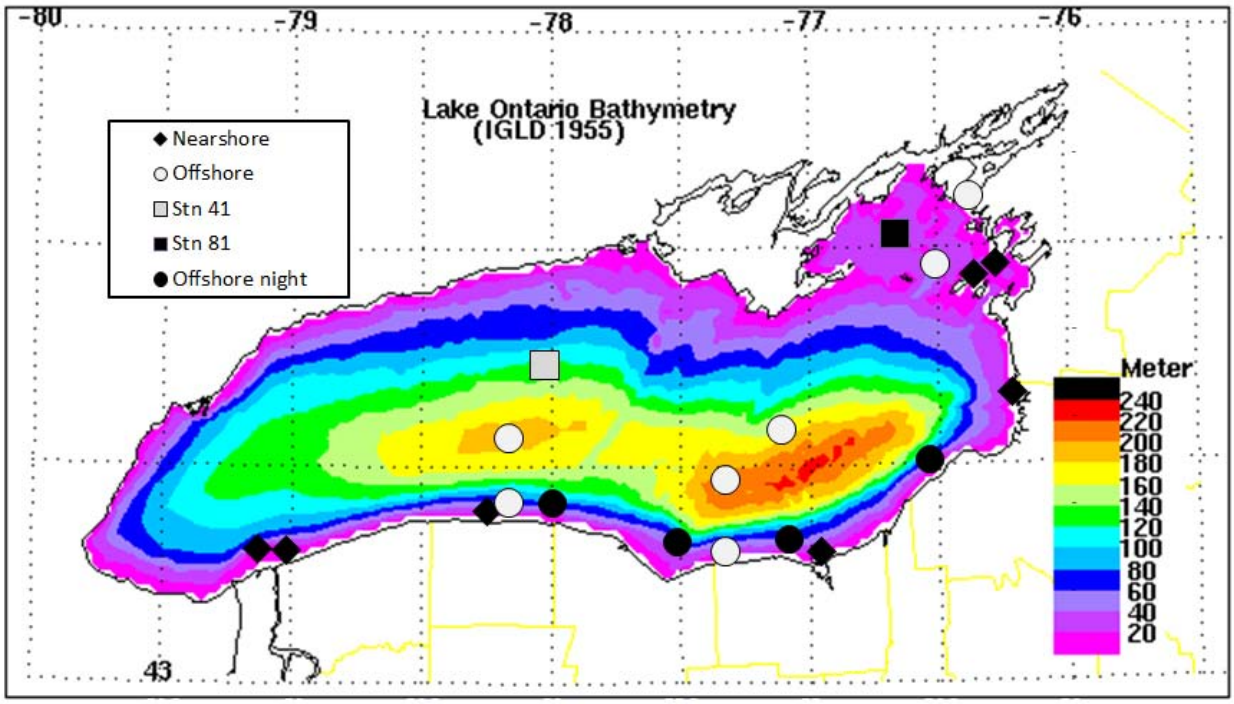

Figure 1. Map of Biomonitoring Program sites, 2012. Station 41 and station 81 are locations sampled by the Department of Fisheries and Oceans Canada's Biomonitoring Program (1981 – 1995) and are included here as reference for long-term data included in subsequent figures.

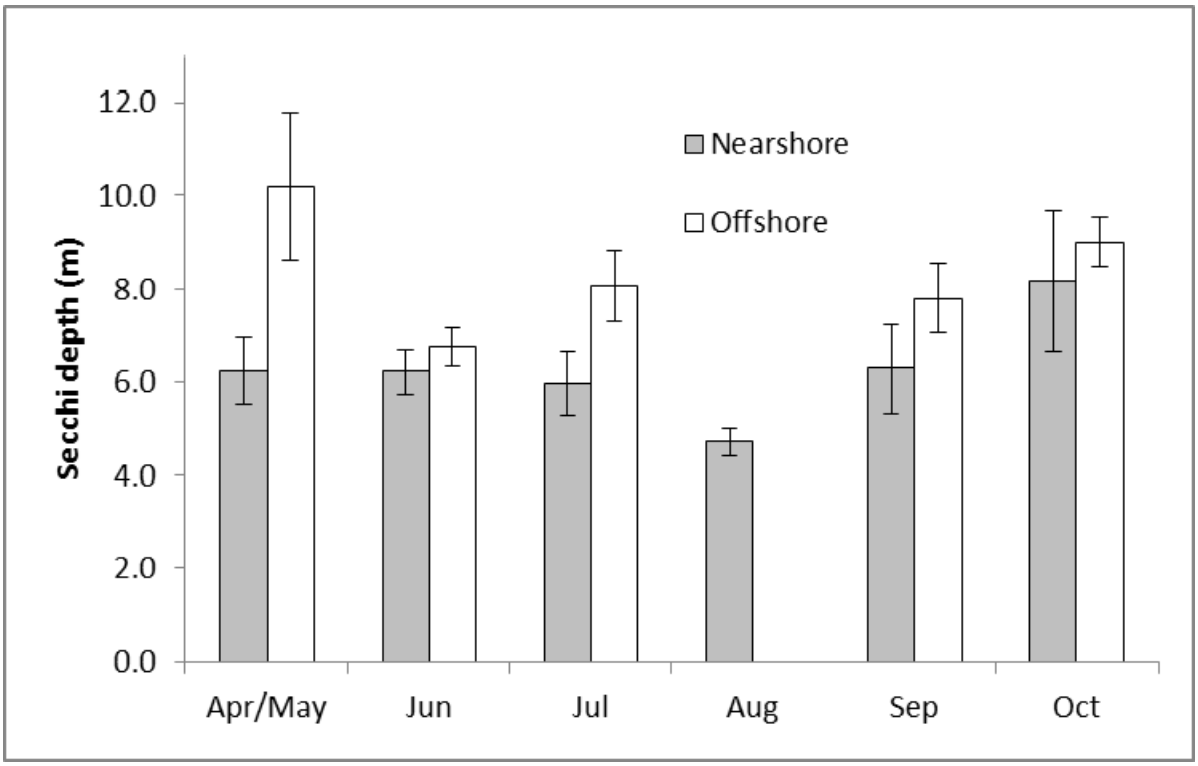

Figure 2a. Mean monthly Secchi depth (meters) for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2012. Error bars are ± 1SE.

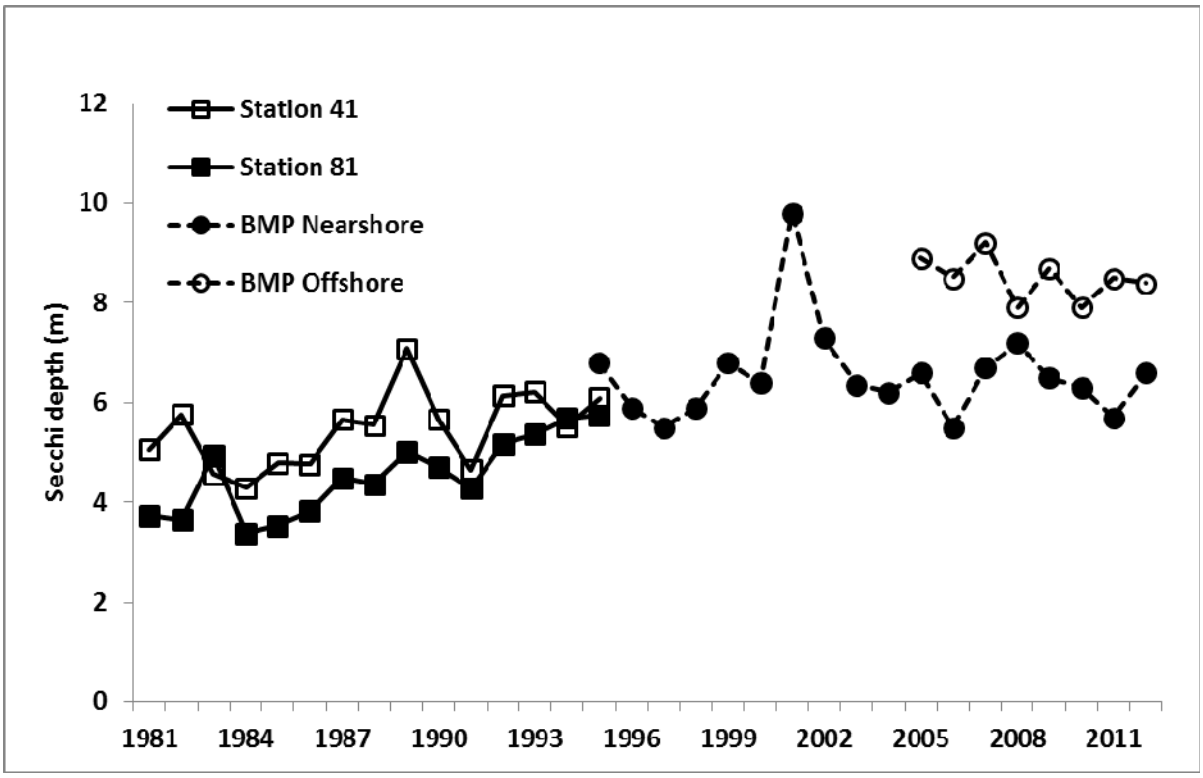

Figure 2b. Long-term mean Apr/May – Oct Secchi depth (meters) in Lake Ontario, 1981 – 2012. Station 41 and Station 81 are from the Department of Fisheries and Oceans Canada's Bioindex Program. Data from 1995 – 2012 are from the US Biomonitoring Program (BMP).

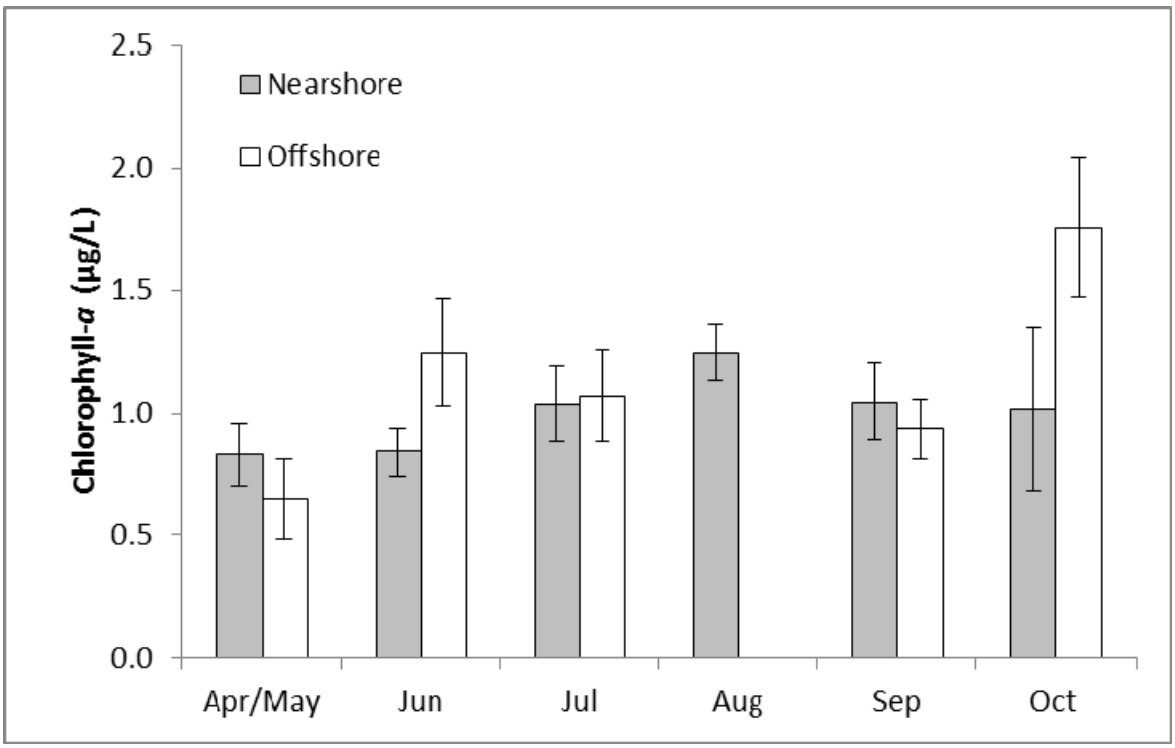

Figure 3a. Mean monthly epilimnetic chlorophyll a concentrations for nearshore and offshore habitats in Lake Ontario, Apr/ May - October, 2012. Error bars are ± 1SE.

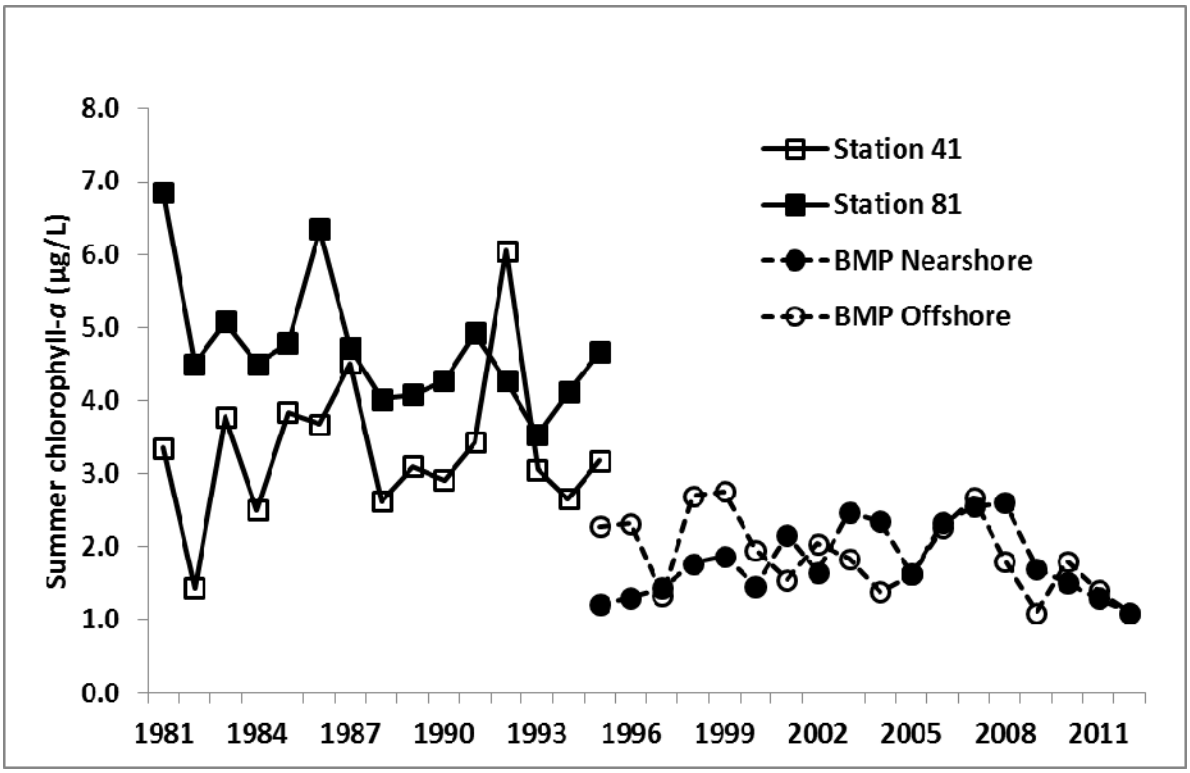

Figure 3b. Long-term summer (Jul – Aug) epilimnetic chlorophyll a concentrations in Lake Ontario, 1981 - 2012. Station 41 and Station 81 are from the Department of Fisheries and Oceans Canada's Bioindex Program. Data from 1995 – 2012 are from the US Biomonitoring Program.

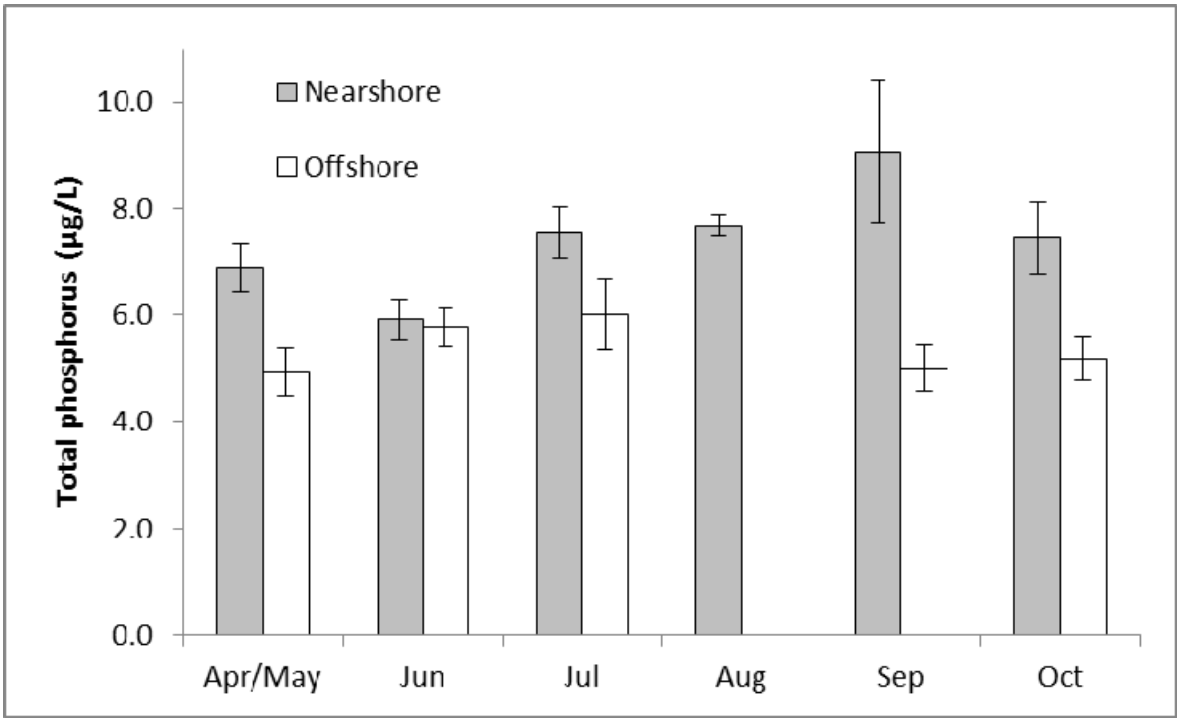

Figure 4a. Mean monthly total phosphorus concentrations for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2012. Error bars are ± 1SE.

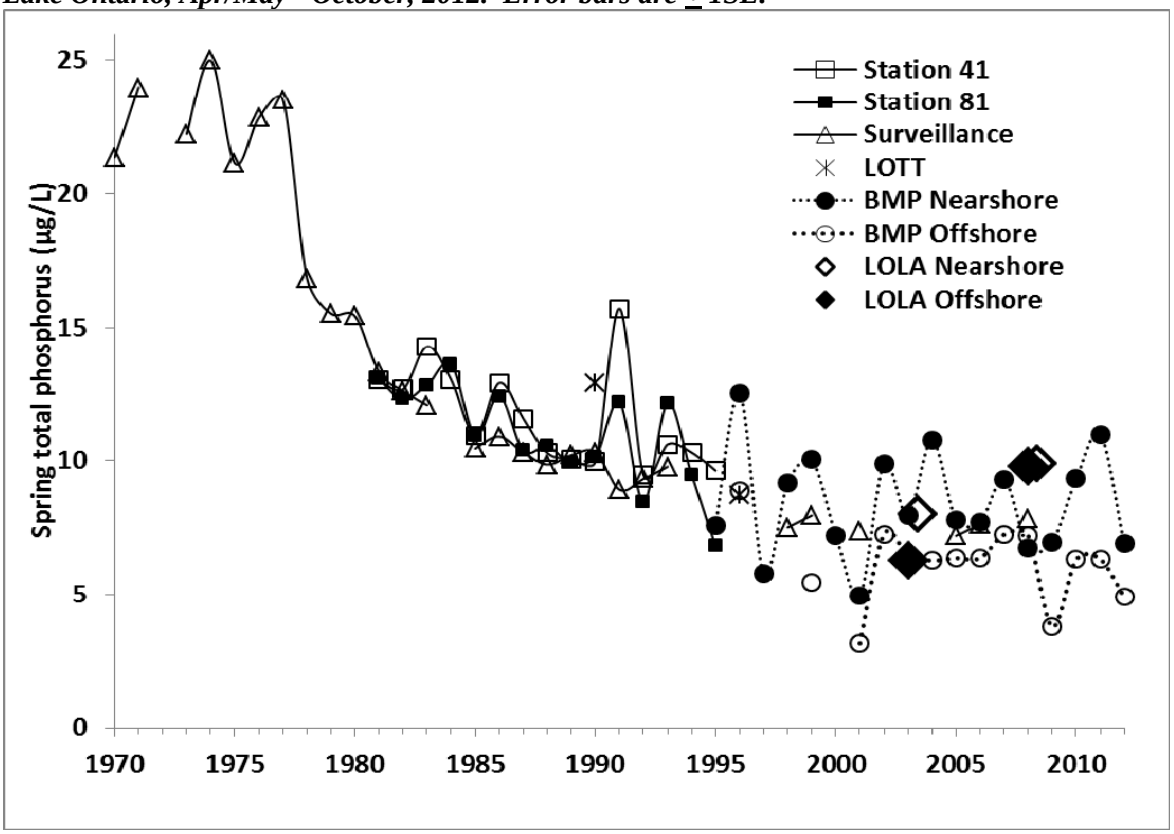

Figure 4b. Long-term spring (Apr – May) epilimnetic total phosphorus concentrations in Lake Ontario, 1970 - 2012. Data from 1970 – 2001 are from Environment Canada's Surveillance Program. Station 41 and 81 are from the Department of Fisheries and Oceans Canada's Bioindex Program. LOTT data is from the Lake Ontario Trophic Transfer Project. LOLA data is from the Lake Ontario Lower Food Web Assessment. Data from 1995 – 2012 are from the US Biomonitoring Program.

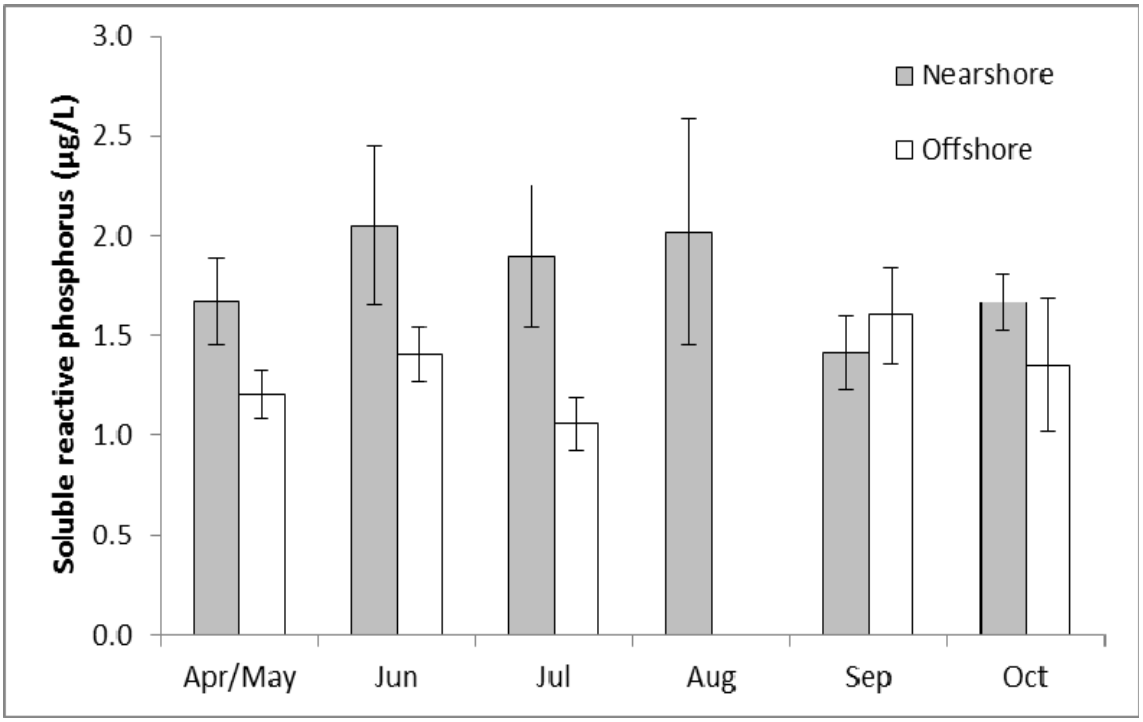

Figure 5. Mean monthly soluble reactive phosphorus concentrations for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2012. Error bars are ± 1SE.

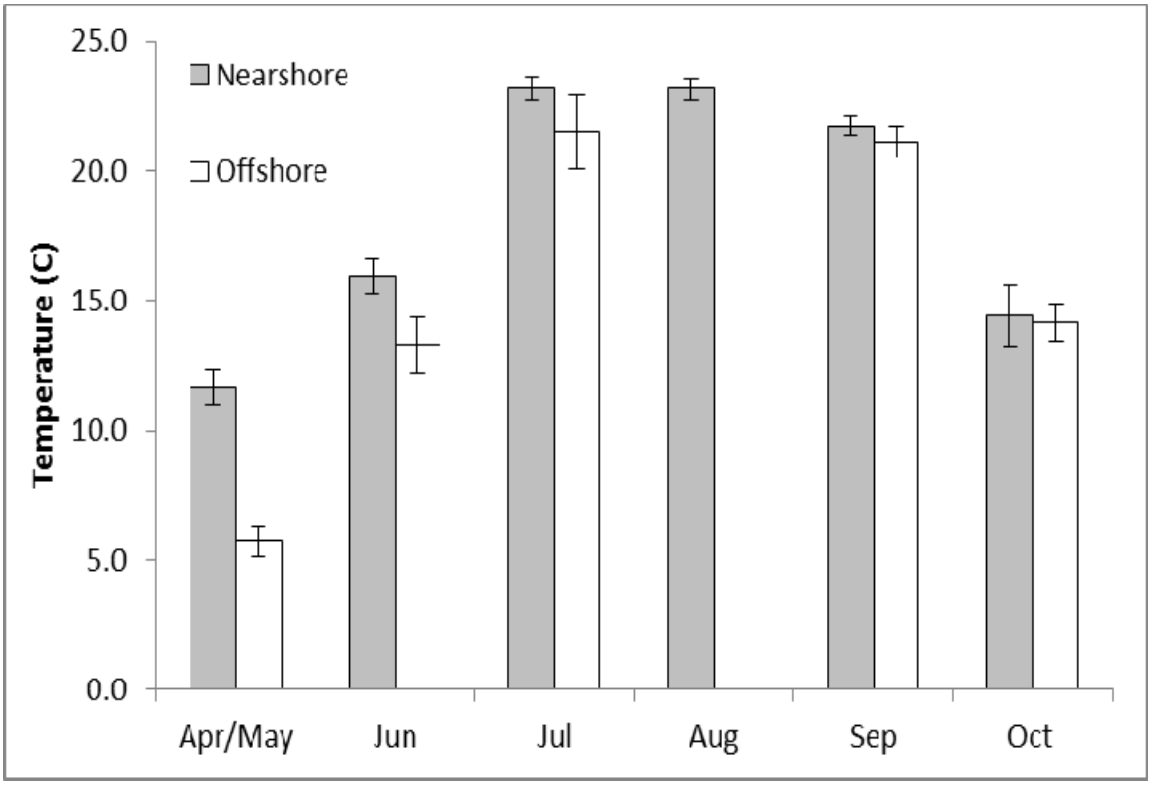

Figure 6. Mean monthly water temperatures in nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2012. Error bars are ± 1SE. Nearshore site depths ranged from 9-12m. At offshore sites, temperatures are averages of readings taken every meter from the surface to 10m.

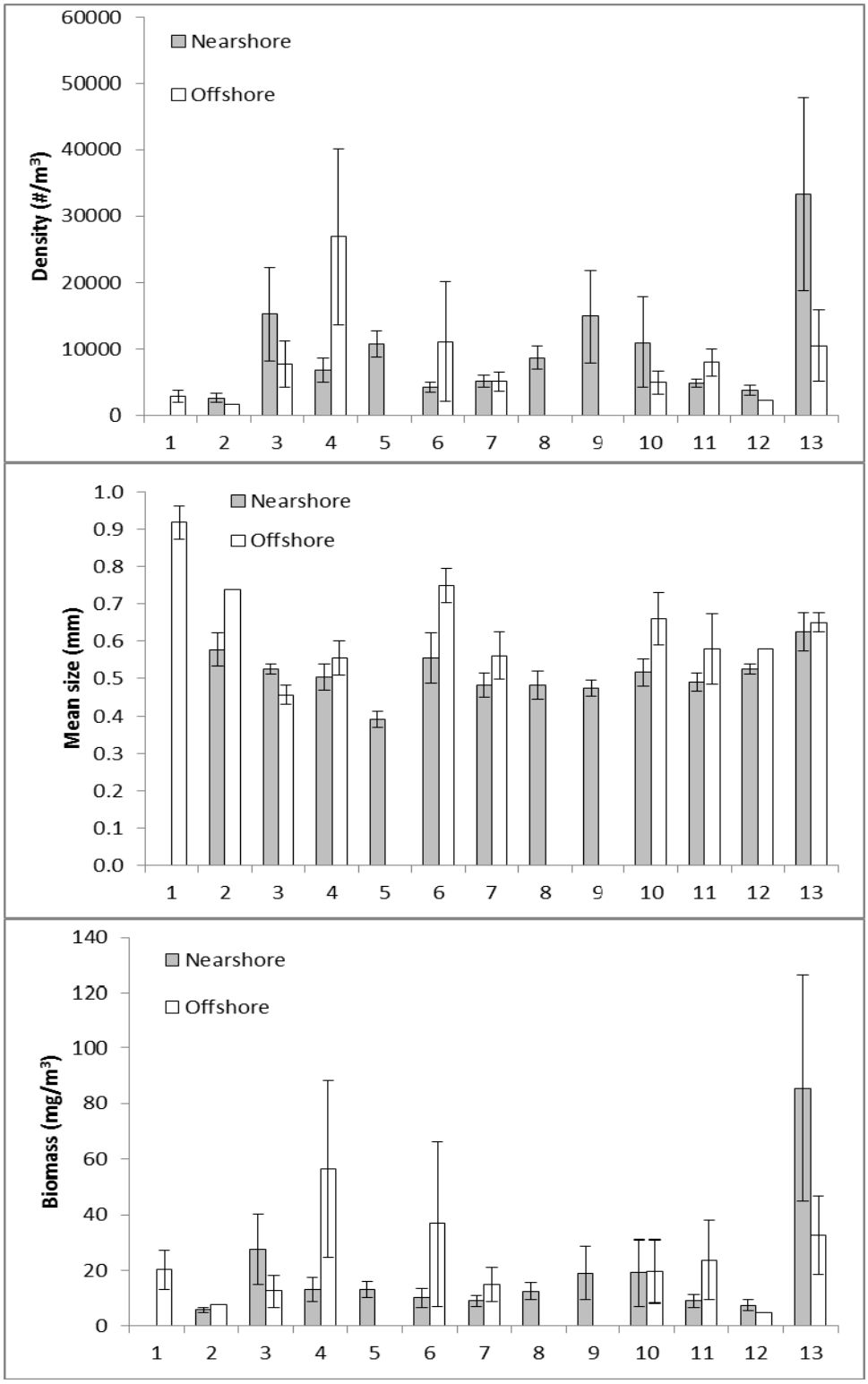

Figure 7. Biweekly means (± 1 SE) of epilimnetic zooplankton density, size, and dry biomass for April through October 2012, nearshore and offshore sites on Lake Ontario. On the x-axis, biweeks are designated by the numbers 1-13.

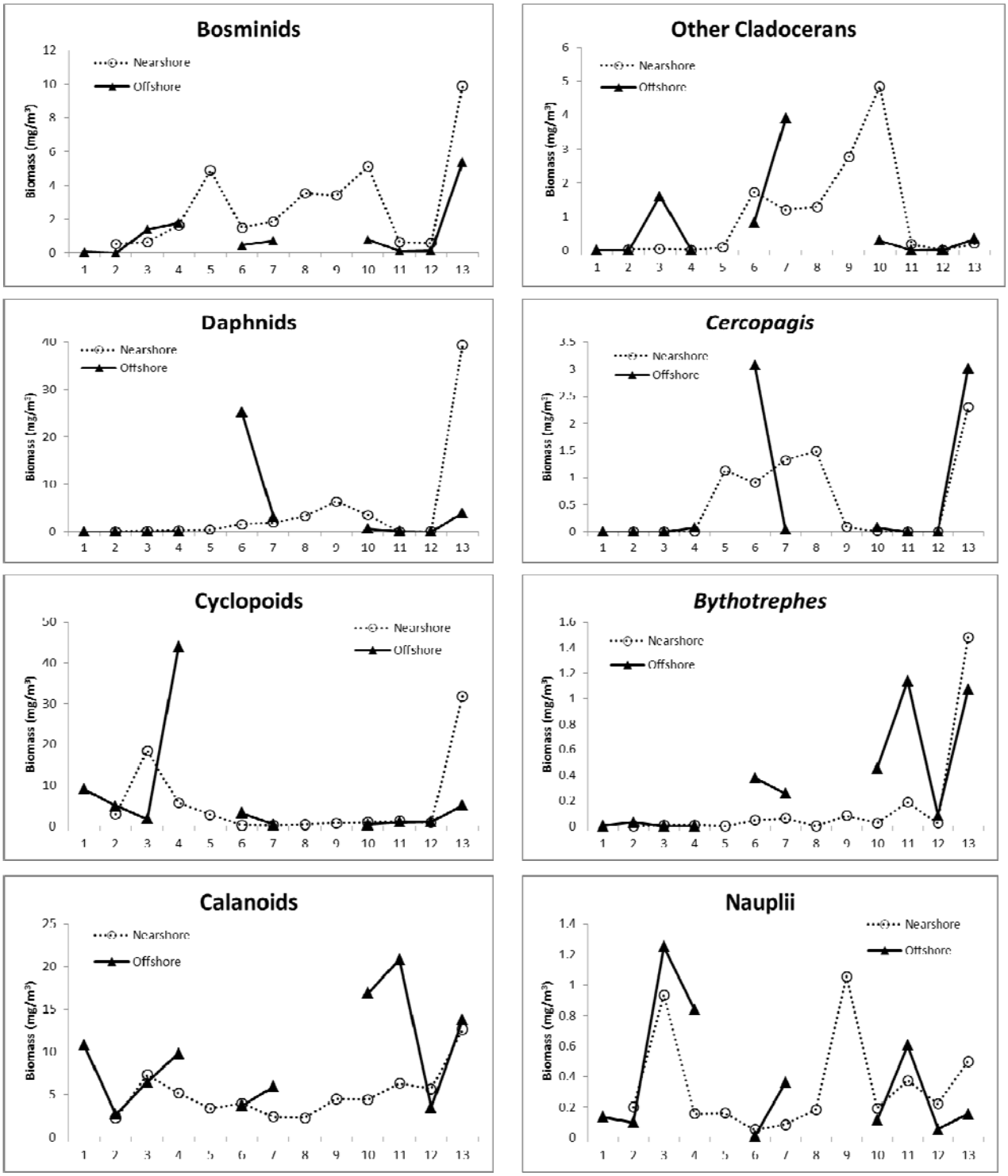

Figure 8. Epilimnetic dry biomass of zooplankton community groups for nearshore and offshore areas of Lake Ontario, Apr - October 2012 (biweeks 1-13 on x-axis). Note different y-axis scales.

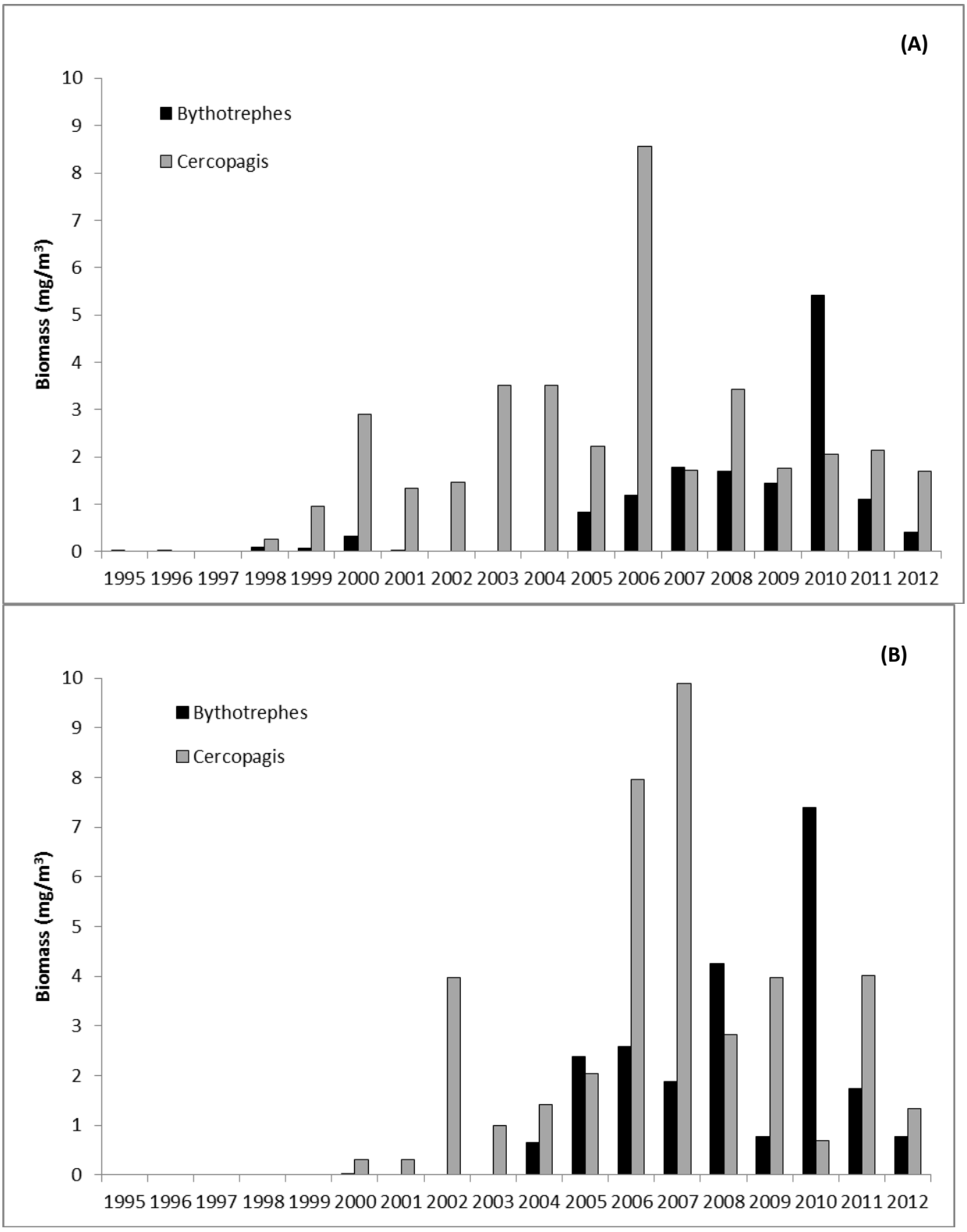

Figure 9. Daytime nearshore (A) and offshore (B) fall (September and October) Bythotrephes and summer (July) Cercopagis biomass in Lake Ontario, 1995 – 2012.

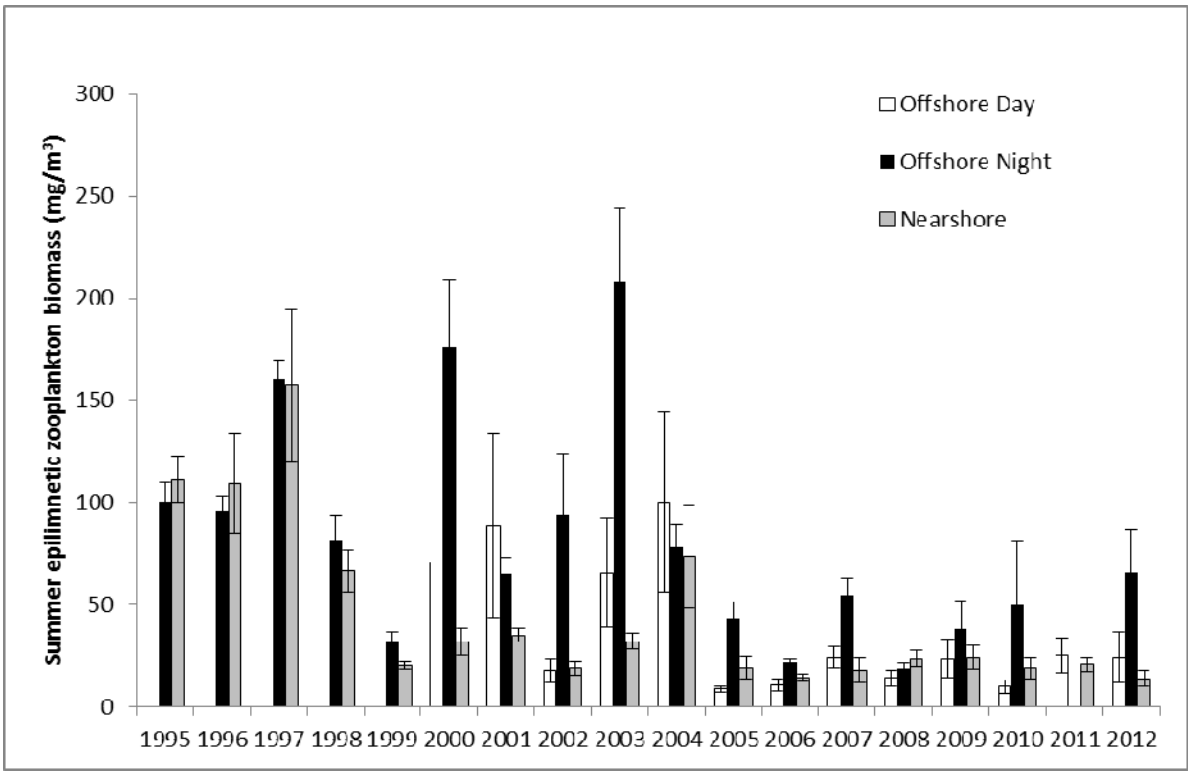

Figure 10. Mean summer (Jul – Aug) epilimnetic zooplankton biomass in nearshore and offshore habitats in Lake Ontario, 1995 - 2012.

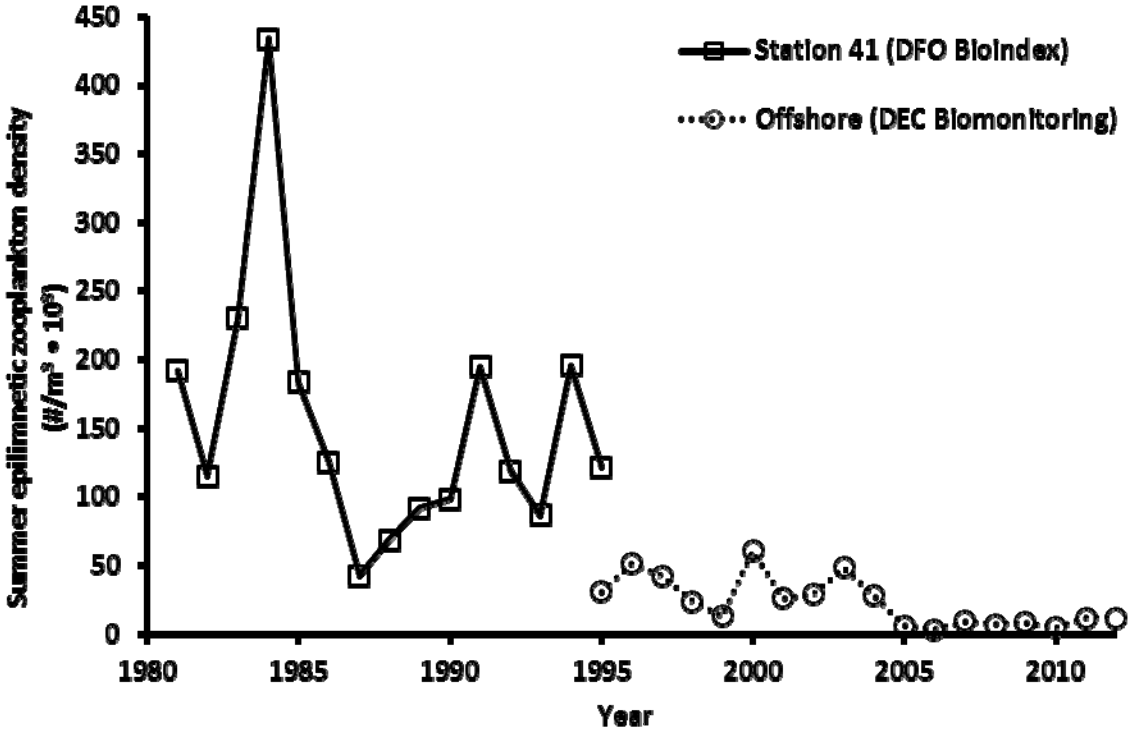

Figure 11. Mean summer epilimnetic zooplankton density in Lake Ontario's offshore, 1981 – 2012.

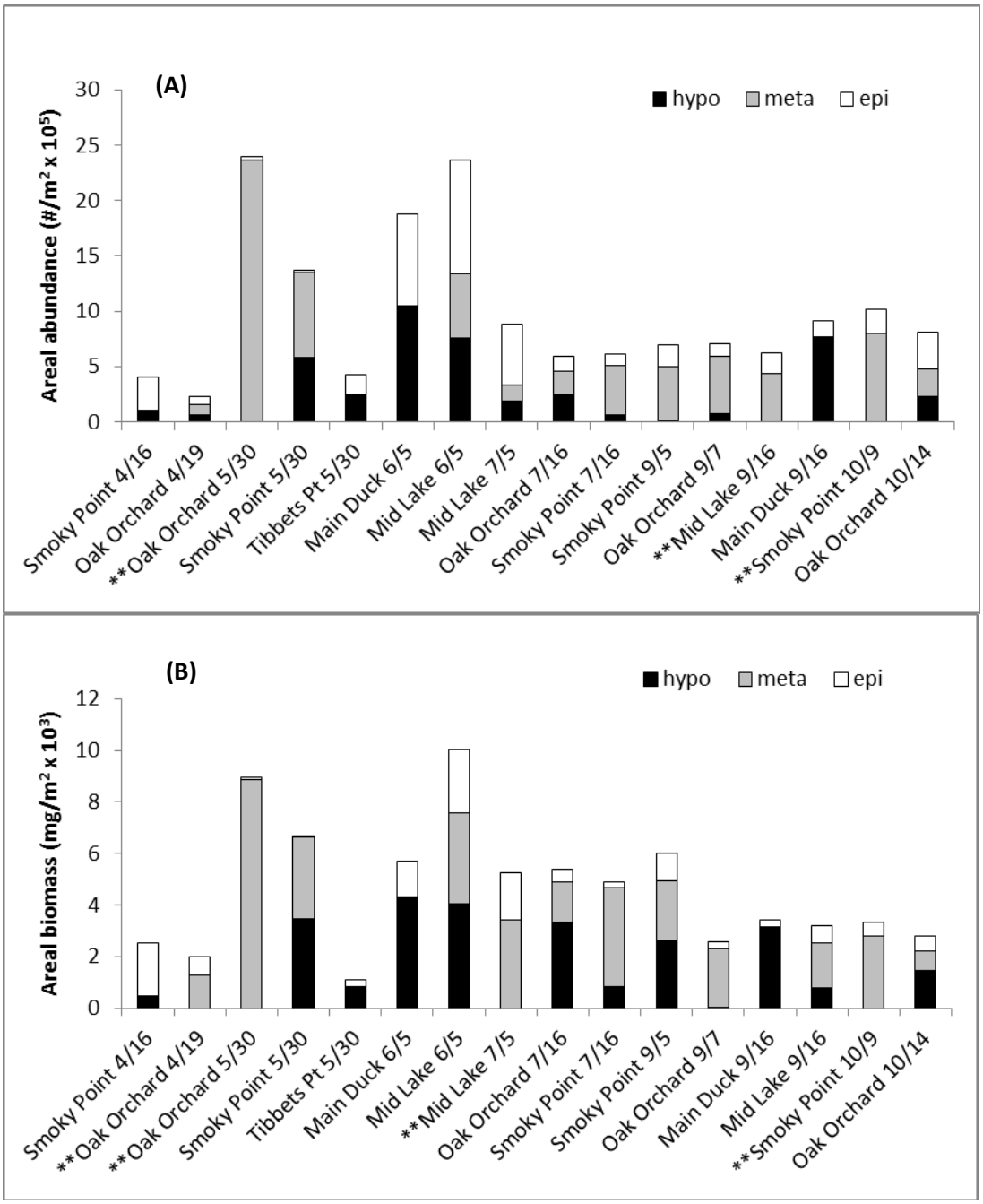

Figure 12. Epilimnetic, metalimnetic, and hypolimnetic zooplankton density (A) and dry biomass (B) in Lake Ontario's offshore, 2012. Epilimnetic values determined directly from the epilimnetic tow. Metalimnetic values determined by subtracting epilimnetic tow values from the metalimnetic (50 m) tow. Hypolimnetic values determined by subtracting metalimnetic tow values from the hypolimnetic tow. Stations without metalimnetic values are based on samples from only two depth strata (epilimnetic and 50m tows). **indicates a site where hypolimnetic values were negative (not shown) due to variation in catch of zooplankton between metalimnetic and hypolimnetic tows.

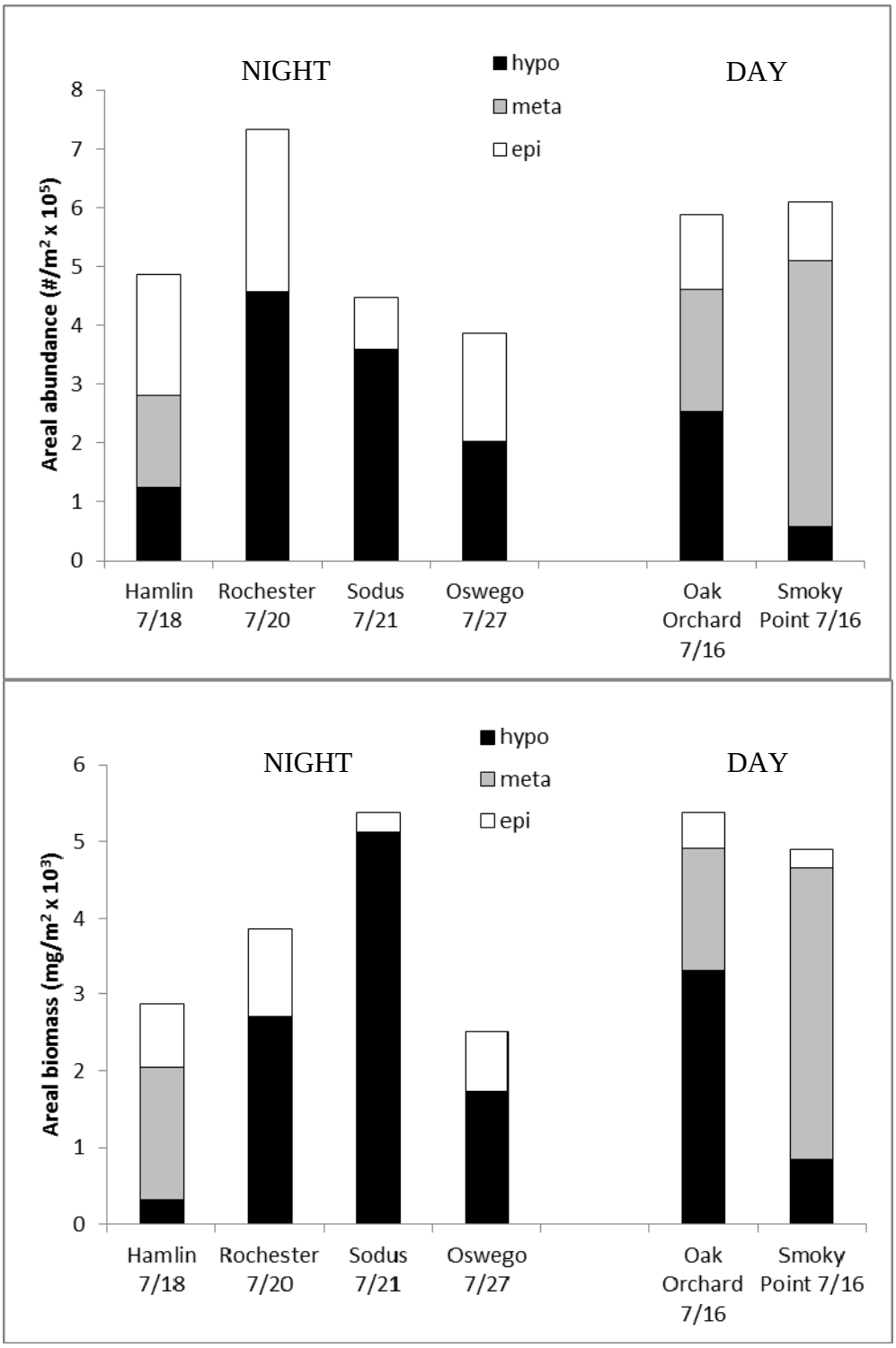

Figure 13. Nighttime epilimnetic, metalimnetic, and hypolimnetic zooplankton density (A) and dry biomass (B) in Lake Ontario, July 2012. Two data points farthest to the right in each figure are from July daytime data presented in Figure 12. Epilimnetic values determined directly from the epilimnetic tow. Metalimnetic values determined by subtracting epilimnetic tow values from the metalimnetic (50 m) tow. Hypolimnetic values determined by subtracting metalimnetic tow values from the hypolimnetic tow. Stations without metalimnetic values are based on samples from only two depth strata (epilimnetic and 50m tows).

Table 1. Mean chl a, TP, SRP and water temperature (±SE) for nearshore and offshore sites, Apr – Oct 2012.

	Mean ± 1 SE				
Sites	Chlorophyll *a* (µg/L)	Total phosphorus (µg/L)	Soluble reactive phosphorus (µg/L)	Secchi depth (m)	Water temperature (^{o}C)
Nearshore					
Chaumont Lake (CBL)	1.0± 0.2 (n=11)	7.0± 0.5 (n=11)	2.7± 0.4 (n=11)	6.5± 0.6 (n=11)	19.4± 1.4 (n=10)
Galloo Island (GIL)	0.8± 0.1 (n=11)	7.3± 0.7 (n=11)	2.2± 0.2 (n=9)	7.3± 0.5 (n=11)	18.4± 1.9 (n=10)
Oak Orchard (OOL)	1.3± 0.2 (n=10)	7.4± 0.7 (n=11)	1.3± 0.1 (n=11)	5.5± 0.5 (n=10)	20.0± 1.5 (n=10)
Sodus Lake (SOL)	0.7± 0.1 (n=11)	6.8± 0.4 (n=11)	1.4± 0.2 (n=10)	7.4± 0.9 (n=10)	18.6± 1.8 (n=10)
Sandy Pond Lake (SPL)	1.1± 0.1 (n=9)	6.3± 0.2 (n=9)	1.2± 0.1 (n=9)	5.9± 0.4 (n=9)	17.9± 2.1 (n=9)
Niagara East Lake (NEL)	1.1± 0.1 (n=11)	7.9± 0.9 (n=11)	1.4± 0.3 (n=11)	4.4± 0.4 (n=9)	19.8± 1.5 (n=11)
Niagara West Lake (NWL)	1.0± 0.1 (n=12)	8.3± 0.8 (n=12)	2.0± 0.4 (n=12)	4.4± 0.5 (n=10)	19.2± 1.6 (n=11)
Offshore					
Kaho					
Oak Orchard-N	0.9± 0.2 (n=5)	5.9± 0.6 (n=5)	1.8± 0.1 (n=5)	7.1± 1.1 (n=5)	11.9± 2.6 (n=5)
Oak Orchard-O	1.0± 0.1 (n=5)	4.8± 0.3 (n=5)	1.4± 0.3 (n=5)	9.2± 1.8 (n=5)	15.7± 3.7 (n=5)
Smoky Point-N	1.5± 0.4 (n=5)	6.2± 0.9 (n=5)	1.5± 0.3 (n=5)	7.4± 0.8 (n=5)	16.1± 3.1 (n=5)
Smoky Point-O	1.1± 0.3 (n=5)	4.6± 0.5 (n=5)	0.9± 0.2 (n=5)	7.9± 0.9 (n=5)	15.9± 3.5 (n=5)
Seth Green					
Main Duck	0.9± 0.3 (n=4)	5.5± 0.6 (n=4)	1.3± 0.1 (n=4)	10.3± 1.7 (n=4)	15.4± 3.6 (n=4)
Mid Lake	1.1± 0.3 (n=4)	4.9± 0.3 (n=4)	1.1± 0.04 (n=4)	9.4± 0.8 (n=4)	15.3± 3.9 (n=4)
Tibbetts Point	0.9± 0.2 (n=4)	6.0± 0.4 (n=4)	1.2± 0.1 (n=4)	7.3± 0.7 (n=4)	16.9± 2.9 (n=4)

Table 2. Comparison of nearshore and offshore sites Apr/May-October, 2012 using paired t-tests on log-transformed (TP, SRP, zooplankton density, and zooplankton biomass) or untransformed (Chl-a, Secchi depth, temperature, and zooplankton size) seasonal mean values. The Wilcoxon test was used on zooplankton group biomass components because data could not be normalized by transformation. Values shown are arithmetic means across months 4/5, 6, 7, 9, and 10. Month 8 was removed from the analysis because the offshore was not sampled during that time. All offshore data are for the epilimnion (zooplankton) or the top 10 m (water chemistry).

Parameter	Mean		
	Nearshore	Offshore	p-value
Total phosphorus (µg/L)	7.3	5.4	**0.0003**
Soluble reactive phosphorus (µg/L)	1.8	1.3	0.1
Chlorophyll *a* (µg/L)	1.0	1.1	0.4
Secchi depth (m)	6.6	8.4	**0.0239**
Temperature (C)	17.4	15.2	**0.0036**
Total zooplankton:			
Density (#/m^3)	10221	9339	0.5
Size (mm)	0.52	0.66	**<0.0001**
Biomass (mg dw/m^3)	20.9	26.4	0.2
Group biomass (mg dw/m^3):			z-value
Bosminids	2.4	1.2	**0.07**
Other Cladocera	0.4	0.8	0.3
Daphnids	7.1	3.4	0.4
Calanoid copepods	6.8	10.6	0.1
Cyclopoid copepods	8.2	8.3	0.7
Cercopagis pengoi	0.7	0.9	1.0
Bythotrephes longimanus	0.3	0.4	**0.0387**
Nauplii	0.3	0.4	0.8

Table 3. Results of regression and change point analyses performed on data from two time stanzas in Lake Ontario, 1995 - 2012 and 1981 – 2012. All data were log-transformed prior to analysis. Trends are indicated by (+) or (-). Significant p-values and change points are indicated in bold. % change is average annual change.

	Regression				Change Point Analysis	
Offshore	1995 - 2012	% change	1981 - 2012	% change	1995 - 2012	1981 - 2012
Spring TP (ug/L)	ns		**(-) p<0.0001**	**3**	no breaks	**(-) 1999**
Summer chlorophyll *a* (ug/L)	**(-) p=0.033**	**3**	**(-) p<0.0001**	**3**	no breaks	**(-) 1995**
Summer epilimnetic zooplankton density (#/L)	**(-) p=0.0012**	**12**	**(-) p<0.0001**	**12**	**(-) 2005**	**(-) 1986, (-)2005**
Summer epilimnetic zooplankton biomass (ug/L)	**(-) p=0.0004**	**11**	not tested		**(-) 2005**	not tested
Secchi depth (m)	**(+) p=0.0004**	**2**	**(+) p<0.0001**	**2**	not tested	not tested
Summer epilimnetic zooplankton group biomass						
Bosminids	**(-) p=0.0154**	**14**	not tested		**(-) 1998**	not tested
Bythotrephes longimanus	**(+) p<0.0001**	**3**	not tested		**(+) 2006**	not tested
Calanoid copepods	ns		not tested		no breaks	not tested
Cercopagis pengoi	**(+) p=0.0231**	**6**	not tested		no breaks	not tested
Cyclopoid copepods	**(-) p<0.0001**	**27**	not tested		**(-) 2005**	not tested
Daphnids	ns		not tested		no breaks	not tested
Other Cladocera	ns		not tested		**(+) 2004**	not tested

	Regression		Change Point Analysis
Nearshore	1995 - 2011	% change	1995 - 2011
Spring TP (ug/L)	ns		no breaks
Summer chlorophyll *a* (ug/L)	ns		**(+) 2003, (-) 2009**
Summer epilimnetic zooplankton density (#/L)	**(-) p<0.0001**	**12**	**(-) 1998, (-) 2005**
Summer epilimnetic zooplankton biomass (ug/L)	**(-) p=0.0003**	**11**	**(-) 1998**
Summer epilimnetic zooplankton group biomass			
Bosminids	**(-) p<0.0001**	**15**	**(-) 1998**
Bythotrephes longimanus	**(+) p=0.0251**	**1**	**(+) 2006**
Calanoid copepods	ns		**(-) 1997**
Cercopagis pengoi	ns		**(+) 1999**
Cyclopoid copepods	**(-) p=<0.0001**	**30**	**(-) 1998, (-) 2005**
Daphnids	**(-) p=0.0334**	**8**	no breaks
Other Cladocera	ns		**(+) 2000***

*analysis performed on ranks of values due to outliers

Table 4. Comparison of mean zooplankton biomass (dry) in epilimnetic, metalimnetic, and hypolimnetic samples taken from deep (>100m) sites in Lake Ontario's offshore, July - October, 2012. The epilimnetic strata includes zooplankton from the thermocline (15 – 37 m) up to the surface, the metalimnetic strata includes zooplankton from 50 m up to the thermocline, and the hypolimnetic strata contains zooplankton from 100 m up to the bottom metalimnion (50 m).

	Areal Biomass (mg/m^2)							
Strata	**Bosminids**	**Daphnids**	**Cyclopoids**	**Calanoids**	**Other Cladocerans**	**Nauplii**	***Cercopagis***	***Bythotrephes***
Epilimnetic	25.5	225.3	64.3	316.8	41.0	6.2	4.3	25.7
Metalimnetic	102.1	590.3	307.3	1317.3	23.8	6.3	4.8	0
Hypolimnetic	4.7	283.4	178.7	526.9	29.7	0	1.4	0

Progress report for the Sportfishing Restoration & Spending Plan for the Lake Ontario System

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Background

In June of 2006, New York State (NYS) announced that the Department of Environmental Conservation and the Office of the Attorney General had reached a settlement with Occidental Chemical Corporation (OCC) on the State's Natural Resources Damages (NRD) claim for the Lake Ontario system. The claim was originally filed in 1983 against Hooker Chemical, the predecessor of Occidental Chemical Corporation, for compensation for the release of harmful chemical contaminants into the Lake Ontario system, which includes the Lower Niagara River, Lake Ontario, the St. Lawrence River, and tributaries to these waters upstream to the first barrier impassable to fish (hereafter referred to as the Lake Ontario system).

There are several federal statutes, as well as NYS law, that authorize federal and NYS officials to act on behalf of the public to restore natural resources affected by releases of contaminants. This claim arose under the federal *Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)* of 1980, and NYS common law, holding parties accountable for contaminating the environment and causing injury to natural resources. NRD funds provide compensation for the injury to, loss of, loss of the use of, or destruction of New York's natural resources, including land, biota, air, surface and ground waters.

Natural Resources Damages Assessment

The NRD assessment process seeks to ensure that the public is compensated for losses experienced as a result of injuries to their natural resources resulting from environmental contamination. This process determines the nature and extent of injury to the natural resources, and then aims to restore the use and enjoyment of either the injured or lost natural resources, or the services provided by these resources.

Funds recovered as a result of a NRD claim are to be used to restore/enhance either the injured natural resources themselves, or the services provided by the lost or injured natural resources. The general hierarchy for the use of NRD funds, in order of greatest to least preference, is to restore or replace the injured resources. If neither of these approaches is possible or practical, then equivalent resources could be acquired.

In this case, restoring the injured resource by reducing contaminant levels in fish to pre-contamination levels would be impracticable and cost prohibitive. A restoration effort of this magnitude would require extensive sediment dredging/disposal that would far exceed the resources available through the Lake Ontario NRD (LONRD) program, as these contaminants now reside in sediments and biota throughout the entire system. In addition, toxic "hot spots" within the Lake Ontario system have already been identified, and efforts to remediate contamination in these areas are being coordinated through individual Remedial Action Plans (RAPs).

The settlement was based on an assessment of lost recreational fishing benefits resulting from the imposition of fish consumption advisories due to the presence of contaminants in the fish. The damages were calculated by measuring the difference between the value to anglers for fishing for contaminated fish in the Lake Ontario system, and what the value would have been if the fish had not been contaminated. This $12 million

settlement is one of the largest NRD claim settlements in the nation based on lost recreational fishing use.

Restoration Planning and Public Outreach

The Sportfishing Restoration & Spending Plan for the Lake Ontario System (the *Plan*) was prepared by the New York State Department of Environmental Conservation (NYSDEC) in its capacity as Trustee for New York's natural resources. Its purpose is to describe the use of funds from the Lake Ontario NRD claim settlement. More specifically, it describes projects selected to restore injuries to sportfishing in the New York waters of the Lake Ontario system. This *Plan* also describes the public role in its development and provides reasons why some proposed projects are unlikely to be implemented.

Department staff developed four basic project proposal categories to restore/enhance recreational sportfisheries: fisheries management enhancement, fishing access improvements, aquatic habitat restoration, and education/outreach projects.

A 60-day notice period was offered following the release of the *Plan* to afford the public an opportunity to review the *Plan* prior to public meetings and to submit their thoughts subsequent to the meetings. The public meetings, one each in NYSDEC Regions 7, 8, and 9, and two in Region 6, were scheduled approximately half-way through the review period. Copies of the draft *Plan* were provided to the New York State Library Document Distribution Center, as well as NYSDEC Headquarters in Regions 6 (Watertown), 7 (Syracuse), 8 (Avon), and 9 (Allegany).

Notices of opportunities for review of the *Plan* were provided both formally and informally. A formal notice was posted in the New York State *Environmental Notice Bulletin (ENB* were published weekly from 1-17-2007 to 3-20-2007). Additionally, notices were provided on the Department's website, through press releases, and by direct mailings (see Appendix B, *Public Participation Plan for the Development of the Sportfishing Restoration and Spending Plan for the Lake Ontario System*). A constituent letter and fact sheet summarizing the *Plan* and announcing public meetings and comment periods was posted on the Department website, and these documents were also mailed to interested constituents including non-governmental organizations, individuals, local government officials, elected state and federal officials, federally recognized native American tribal authorities, and NYS and federal natural resource agencies (U.S. Fish and Wildlife Service, U.S. Army Corp of Engineers, U.S. Geological Survey, Bureau of Indian Affairs, U.S. Environmental Protection Agency, National Oceanic and Atmospheric Administration).

Project Lists

Of approximately 150 project proposals received from stakeholders, 80 were scored by the review committee. The remainder included comments rather than project proposals (not scored), or were rejected based on lack of merit. The Project Evaluation Team produced the following lists; *Selected Projects, Other Scored Projects,* and the *Rejected list.* To see the complete lists, please visit: http://www.dec.ny.gov/outdoor/40068.html

The projects listed on the Selected Projects list are in order of rank with the best scoring proposal listed first. The estimated costs for each of the proposals are preliminary and used for planning purposes only, are in no way a guarantee of funding, and are subject to change. More detail on the actual costs will be determined as implementation proceeds.

The $12 million settlement has been apportioned to include $10.8 million for projects and $1.2 million for fund administration. The cost estimates were developed to approximate how many projects the $10.8 million can accommodate. As project implementation begins, detailed spending plans for each project will be developed as needed. Matching funds and contributions to this program from other agencies, non-governmental organizations and programs

such as RAPs, the Open Space Plan and the Fisheries Enhancement, Mitigation and Research Fund (FEMRF, as detailed in the following project descriptions) will be actively sought out to increase the longevity of this fund. This effort will also reduce redundancy of restoration efforts.

Project Implementation

As discussed in the *Plan*, the project implementation schedule should give priority to the assigned project ranking, however, the implementation schedule has been influenced by issues including, permitting, availability of other funding sources, land acquisition, contract bidding, planning and development, and other practical concerns. While project implementation has not followed exact rank order, emphasis has generally been placed on the highest-ranked projects.

Projects at Impasse

Two projects have met impasse for implementation. The Port Bay (west) access road project (Project #38), which proposed measures to improve access road conditions during winter, will not be implemented. After reviewing the project description and site conditions, NYSDEC engineers have determined that the scope and costs of this project far exceed its' $500,000 allocation. Additionally, there are significant regulatory hurdles that would make this project extremely difficult, if not impossible, to undertake.

The other project at impasse is the Waterport Dam tailrace reconfiguration (Project #41), that proposed reconfiguration of the dam tailrace and bypassed reach to alleviate fish stranding. During periods of high water flow, water crests the dam and increases flow in the bypassed reach, which attracts migrating fish into that reach. Once flows attenuate to normal operational levels, fish in the bypassed reach can become stranded. The fish are then subjected to unsportsmanlike fishing practices, or perish due to lack of water flow. While this project was deemed worthy in the project review process, legal counsel has determined that it would be inappropriate to use New York State funds to fix a problem that arises at a facility owned and operated by one of the Department's regulated entities. The funds allocated to these projects will now be used to implement other projects on the Selected Projects list.

2012-2013 Program update

The following describes what has been done in the 2012-2013 fiscal year to implement the list of selected projects in the Final Sportfishing Restoration & Spending Plan for the Lake Ontario System. The previous year's updates can be viewed at:
http://www.dec.ny.gov/outdoor/27068.html

Projects Completed in 2012-13

Lindsey and Stony Creek Angler Parking Areas (#3). The 5 car, Stony Creek angler parking area on Jefferson County Rt. 152 was completed in September 2011. The 6 car, Lindsey Creek angler parking area on Jefferson County Rt. 87 was completed in October 2012. Total project cost was approximately $12,000.

Golden's Marina Renovation Project (#7). This fishing access site is located on County Rt. 57 in the Town of Lyme, Jefferson County. This site is more than 98% complete and has been re-named Lake Ontario Access at the Isthmus. It will be open to the public no later than May 2013. Total project cost was approximately $725,000.

Maxwell Creek Fishing Access Site Improvements (#14). The re-surfacing of this 40 car parking area, located in Wayne County, was completed in July of 2012 at a cost of $53,115.

Slater Creek Fishing Access Site (#21). Improvements to this Monroe County site, approximately 1.5 miles west of the mouth of the Genesee River, included repairs to the accessible fishing area and re-paving of the 40 car parking lot. This project used $33,620 of its $75,000 allocation.

Village of Morristown Boat Launch Improvement Project (#27). The Village has contributed an additional $63,900 to fund this project. Reconstruction of this municipal boat ramp is now complete. NRD funding for the project totaled $50,000.

Project Progress in 2012-13

Improve the NYSDEC Salmon River Fish Hatchery (Project #1).

- Main Gravity Pipeline - A tethered video inspection probe will be used to determine the cause of reduced flow in the main pipeline from the Salmon River Reservoir. The inspection is tentatively scheduled for the end of May 2013.
- Infiltration well development – Soil borings were used to determine the depth needed to make the best use of a water holding strata in the hatchery's well field. The new infiltration well will be installed in 2013.
- Well field survey and maintenance - The Bureau of Design and Construction is developing contracting documents for a comprehensive survey of the hatchery's existing ground water wells and identification of well maintenance needs. The survey has been scheduled for October 2013.

Fisheries Promotion Assistance Project (#12). An updated NYSDEC Great Lakes Fishing brochure is completed, and will be printed and ready for distribution in summer 2013 at a total cost of $49,000.

Irondequoit Creek Stream Bank Stabilization Project (#25). In partnership with the US Fish and Wildlife Service and the NYSDEC, the County of Monroe Parks Department will improve over 2,000 lineal feet of stream bank and stream habitat. Contract documents are currently in development, and work is tentatively set to commence in summer/fall 2013. NRD funding for the project is estimated at $250,500.

Salmon River Hatchery Aquaria and Interpretive Displays (#30). The Bureau of Design and Construction (BDC) has drafted documents for the purchase and installation of new aquaria and associated equipment, as well as the installation of a closed circuit video system allowing visitors to view salmon in the hatchery's fish ladder. This project has been delayed due to work on the hatchery's water supply. The anticipated cost of this project is $100,000.

Sea Lamprey Control Barrier on Orwell Brook (#39). The Great Lakes Fishery Commission completed construction of a sea lamprey barrier on Orwell Brook (Oswego Co.) in fall 2012. The barrier was operational in spring 2013, and will greatly reduce the need for chemical control of sea lampreys in the Orwell Brook system. Contract documents are in development to contribute $60,000 of NRD funds to the project.

Deepwater Cisco Reintroduction in Lake Ontario (#26). Until the mid 1950's, Lake Ontario was home to four species of deepwater ciscoes which represented the main prey fish in Lake Ontario. The NYSDEC in partnership with the Great Lakes Fishery Commission (GLFC), Ontario Ministry of Natural Resources, the U.S. Geological Survey and the U.S Fish and Wildlife Service are continuing efforts to re-establish self-sustaining deepwater cisco populations in Lake Ontario. In support of ongoing deepwater cisco egg collections in Lake Michigan, a contract is in development to contribute $50,000 in NRD funds to the GLFC.

Projects for 2013-14

Planning efforts continued in 2012 for the projects listed below.

- **Cape Vincent aquaria and interpretive display improvements.**
- **Cranberry Creek Marsh water control structure.** Renovate or rebuild the structure to restore its functionality and resume its use.
- **Sandy/North Pond boat launch acquisition.**
- **Four fishing access related projects on New York State Parks in the Niagara Region.**

- **Upgrade Hatchery Pond Complex at Lisbon, NY.**

Other On-Going Projects

Pen Rearing Program Assistance (Project #29) has been available to cooperators who have requested funding for new nets for the pens, supplies, and materials, etc. Assistance will continue as agreed to by NYSDEC and pen program cooperators.

AutoFish Marking Trailer (Project #2). Chinook marking and tagging to evaluate the effectiveness of net pen rearing was suspended in 2012, but resumed in April 2013.The AutoFish system was used to mark all lake trout stocked into the NY waters of Lakes Erie and Ontario.

Lake Sturgeon Tagging Study 2012

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Lake sturgeon (*Acipenser fulvescens*) were historically an abundant and widely distributed species in New York State (NYS). Overharvest, habitat degradation, and migratory impediments (dams) resulted in drastic decline of the species by the early 1900s. Due to severely depleted stocks, the lake sturgeon fishery was closed in NYS in1976. Lake sturgeon are currently listed as a threatened species in NYS, with lost, sparse or declining populations in 6 of the 9 watersheds where they historically occurred.

Currently, little is known about lake sturgeon in the upper St. Lawrence River and the Eastern Basin of Lake Ontario. The ability to identify individual fish for more than a few years has generally been lacking. As restoration efforts increase, including stocking and habitat enhancement, having a long term tagging methodology has become important when considering brood stock genetics, understanding spawning site fidelity and gaining general biological knowledge.

This was the third year of a five year project funded in part by the U.S. Fish and Wildlife Service's Fish Enhancement, Mitigation and Research Fund (FEMRF) to tag lake sturgeon with permanent individual markers. Lake sturgeon will be collected annually (2010-2014), at various sites in the St. Lawrence River and Eastern Basin of Lake Ontario. Fish are evaluated for basic biological information and then scanned for Passive Integrated Transponder (PIT) tags to determine if they have been previously tagged. A PIT tag is applied to untagged fish for permanent individual identification. The goal is to create a long term database of individual fish that will be used to support ongoing species rehabilitation.

Methods

Geographic Area

Project boundaries encompass the U.S. portions of the St. Lawrence River and the Eastern Basin of Lake Ontario. The U.S. portion of the St. Lawrence includes approximately 84 mi^2 of water, of which a very small portion is both suitable for netting activity and overlaps with suitable sturgeon habitat.

Near shore areas of eastern Lake Ontario encompass waters from the southern boundary of Jefferson County near Montario Point, north to the beginning of the St. Lawrence River at Cape Vincent, approximately 800 mi^2. Water less than 100 feet in depth was considered for sampling.

Collection

Lake Sturgeon were collected from April-June in 2012. Collection and tagging of sturgeon was a combination of netting targeting sturgeon exclusively, miscellaneous surveys, and existing annual fish stock assessment projects where sturgeon are encountered regularly.

Sampling for sturgeon in spawning condition occurred in the Black River below the first barrier and in the St. Lawrence River immediately downstream of the Moses Power Dam at Massena, NY. Post spawning period netting targeted juvenile sturgeon in the South Channel in mid June. Existing fisheries assessment programs include two long term St. Lawrence River index gill net series in the Thousand Islands and Lake St. Lawrence. Netting sites are shown in Figures 1 and 2.

All fish were collected with monofilament gill nets fished from 2.5 – 25.5 hours in waters from 12-60 feet in depth. Several gill net configurations used are described in Table 1.

Lake sturgeon collected were measured to the nearest millimeter total length, weighed, and scanned for existing PIT or Floy® tags. Sex was also evaluated at the time of capture predominantly by external palpation. Some fish captured for potential egg take were examined internally with a hypodermic extractor (Candrl et al. 2010) for confirmation that they were late stage gravid females.

PIT tags were applied to fish captured for the first time. The tag was placed under the fourth dorsal scute, which is the standard location for the New York State Department of Environmental Conservation (NYSDEC), Ontario Ministry of Natural Resources (OMNR), and U.S. Geological Survey (USGS). Floy® tags were applied when available to serve as both a quick visual marker and to evaluate tag retention. All fish, with the exception of those held for egg take, were released immediately after tagging within 0.1 miles of their capture location. PIT tag data were shared with the Great Lakes Lake Sturgeon Database (USFWS) which will allow researchers to acquire information related to individual sturgeon they may encounter.

Results and Discussion

The NYSDEC has sampled St. Lawrence River lake sturgeon since the early 1990's below the Moses Power Dam. Collections initially focused on documenting presence of sturgeon and acquiring basic biological information. Beginning in 1996, sturgeon were collected for use as broodstock in restoration efforts. As restoration efforts intensified and genetic investigations have revealed distinct spawning stocks of sturgeon (Welsh et al. 2008), the need for a reliable and permanent identification of individual fish became clear.

Use of PIT tags began in 2008-2009 when a limited number of tags were made available to NYSDEC Region 6. In 2010 a FEMRF grant provided 1,000 tags and related equipment for large scale tagging of sturgeon in the St. Lawrence River and eastern Lake Ontario.

NYSDEC personnel captured a total of 228 Lake Sturgeon throughout the sampling area in 2012. PIT tags were applied to 199 sturgeon, ranging in length from 28.3-63.0 inches and weighing from 4.2-69.4 pounds. Length-weight relationships were constructed using combined data from all sturgeon collected in 2010-2012 (Figure 3) and separated by sex (Figure 4). A total of 21 recaptures were recorded in 2012, three from historic collections (SUNY College of Environmental Science and Forestry (SUNY ESF), 1995-1998) and 18 from collections dating from 2006-2011. Fourteen recaptures were below the Moses Power Dam and seven from the Black River.

Males (N=141) accounted for 65.3% of the catch while females (N=7) constituted 3.2%. The remainder of the catch were either immature or of undetermined sex (31.5%). Sex could only be reliably verified in fish captured during the spawning period through extrusion of gametes. Six mortalities occurred during the June juvenile assessment. Sex was determined on mortalities by direct observation of internal organs.

Black River

Lake sturgeon spawning in the Black River was first documented in 2005 (Klindt and Adams 2006). Annual sampling since 2005 has targeted spawning fish to acquire biological information and apply Floy® or PIT tags.

Discharge in the Black River ranged from 2,780-7,000 cfs (USGS gage 04260500, Watertown) during the planned sampling period from April 2-23, 2012. The effective netting limit of 6,000 cfs was exceeded early in the third week which ended the sampling effort.

A total of 18 lake sturgeon were captured in the Black River during the sampling event. Early sampling from April 2-5 collected no sturgeon with 93.25 net/hours of effort. Water temperature was low (42-43° F) and upstream migration may not have initiated at that time. No sampling took place from April 9-12.

All 18 sturgeon collected were taken from April 16-19 with water temperatures ranging from 52-53° F. A total of 83.0 net hrs (4 net nights) of effort were expended yielding a Catch per Unit Effort (CUE) = 0.23 fish/hr (Table 2). Sturgeon ranged in length from 46.1-54.4 in and in weight from 25.8-48.0 lbs. All fish for which sex and stage could be determined were ripe males (N=13). Sex could not be assigned for five fish, although three were evaluated as potential females with the hypodermic egg extractor. Limited sampling occurred the week of April 23rd, but was ended after only 19.66 net hrs (1 net night) due to rising water levels.

There were seven recaptures from this effort with fish returning from netting events from 2009-2011. Two of the returning fish had been originally tagged off of Pillar Pt. in 2011, one of which was a male that was in spawning condition in both 2011 and 2012. By-catch was made up of adult channel catfish (*Ictalurus punctatus*, N=4), common carp (*Cyprinus carpio*, N=4), northern pike (*Esox lucius*, N=1), walleye (*Sander vitreus*, N=1), and smallmouth bass (*Micropterus dolomieu*, N=1).

St. Lawrence River: Moses Power Dam

The South Channel, where it meets the main stem St. Lawrence River has been used as a lake sturgeon brood stock source for the NYSDEC since 1996 (LaPan et al. 1999). This area is considered a staging area for sturgeon spawning at the base of the power dam. Net sites used for this collection typically capture large numbers of fish, both potential migrating spawners and resident fish.

A total of 159 sturgeon were collected from May 21-29, 2012 at four net sites with an effort of 17 net nights (Table 2). The CUE for 2012 was similar to seven previous collections for which there are data, at 9.35 fish/net night (range 5.3-13.1 fish/net night, $\bar{x}$ = 8.9). The majority of fish collected were males (N=128), 51.6% ripe and 28.9% non-ripe. Females, most of which were ripe, comprised 4.4% of the sample (N=7). One female produced immature eggs (stage 2) upon internal examination and was released immediately after tagging. Sturgeon used for the 2012 egg take (females N=3, males N=12) were taken from this group. Sex for the remainder of fish (N=24) was unknown. Sturgeon collected in 2012 ranged in length from 30.3-63.0 inches and in weight from 6.6-69.4 lbs.

There were 14 recaptures at this location in 2012 which were classified as historic (N=3) and recent (N=11). Historic recaptures were fish originally Floy® tagged from 1995-1998 by researchers from the SUNY ESF. Recent recaptures included fish tagged (Floy® or PIT) by NYSDEC from 2006-2010.

PIT tagging fish at the power dam serves several purposes. Broodstock for lake sturgeon restoration are currently collected at this location, therefore tracking fish used for gamete collection are imperative to effective management of genetic diversity. Sturgeon biology, including spawning periodicity, growth rates, and population mixing can be studied more effectively where large numbers of fish can be handled on a regular basis.

Juvenile sturgeon, ages 1 to 4, were targeted in the South Channel on June 11 & 14 in an attempt to assess recruitment. Gill nets 150 x 8' with mesh ranging from 4-6 inch stretch were deployed both as overnight sets (4 nets, 97.9 net hrs) and as mid day sets (4 nets, 11.6 net-hrs). Net locations and relative catch per net site for all South Channel efforts are represented in Figure 2.

Overnight sets collected a total of 41 sturgeon (CUE= 0.42 fish/hr) while the mid day sets caught 10 sturgeon (CUE= 0.86 fish/hr). Unlike the largest mesh nets used for adults, the mesh sizes used for this project proved fatal to 6 fish in the overnight sets. All fish that expired were sexed as males through direct examination of gonads. The catch rate was roughly double for the short sets indicating that fish are very active during the day. Further efforts for targeting juveniles will be done as short-term sets only.

Pectoral fin rays were removed from 21 sturgeon ranging from 28.3-43.3 inches in total length for aging. In general, fin rays were only taken from

fish less than 39.4 inches as the project goal was to find recent cohorts (ages 0-4). Ages were determined for 17 fish and ranged from 6-11 years (Table 4). Due to the small sample size statistical comparisons were not made against other populations, however, the age-length relationship from the South Channel fish was similar to that of fish collected and processed from the Grass River in 2007 (Normandeau 2009). It is unlikely that fish in the 0-4 year range are susceptible to capture by the current net configurations used, therefore smaller mesh will be needed to collect younger fish.

Lake Ontario

There were no targeted efforts to collect lake sturgeon in Lake Ontario in 2012. The annual gill net survey conducted by the Lake Ontario Unit (Cape Vincent, NY) in the eastern basin also failed to collect sturgeon with an effort of 27 net nights (501.8 net hrs).

St. Lawrence River- Upstream

In contrast to the downstream portion of the St. Lawrence (Moses Power Dam), the river upstream of the power dam has been largely unexplored with regard to sturgeon. Occasional catches have been made in existing index gill net projects in the Thousand Islands (N=6) and Lake St. Lawrence (N=13) (NYSDEC regional Warm Water Assessment database).

There were no targeted efforts at collecting sturgeon in 2012. A fish contaminant survey collection in June utilized the same gear employed to collect sturgeon in the vicinity of Cape Vincent and Ogdensburg with a total effort of 234.9 net hrs (11 net nights). Existing index netting projects consisted of 1204.7 net hrs (62 net nights) in U.S. waters of the Thousand Islands and the international waters of Lake St. Lawrence. Although sturgeon have been consistently caught in several areas of the upper river since 2003, none were collected in 2012 (Table 2).

Of interest in the upstream section was the recapture of a sturgeon on September 1 in Canadian waters (Dr. John Casselman, pers comm.). The fish was tagged in 2011 in the vicinity of Morristown, NY and was recaptured approximately 8.5 miles upstream.

Conclusions

Collection and tagging of lake sturgeon in 2012 was very successful, however, most of the effort targeted known populations of sturgeon in either the Black River or below the Moses Power Dam. A total of 228 sturgeon were captured over a wide geographic range and 199 fish (92% in the St. Lawrence; 8% in Lake Ontario) received new PIT tags.

Recaptures of tagged sturgeon are slowly increasing, primarily in the Black River. In this case it may suggest a relatively small spawning population using the Black River. Capture of tagged sturgeon by other researchers is encouraging in that information may be recovered by agencies and researchers other than the NYS DEC.

Recommendations

1. Continue focused effort on known spawning concentrations: Black River, St. Lawrence River below the Moses Power Dam.

2. Continue efforts to collect juvenile sturgeon in Black River Bay and the Coles Creek area utilizing gill nets and trawls.

3. Continue to focus effort on areas of the St. Lawrence River with demonstrated concentrations of lake sturgeon such as Oak Point, Morristown, and Coles Creek.

4. Continue to explore areas of Lake Ontario around Point Peninsula, Grenadier Island, and Henderson Bay.

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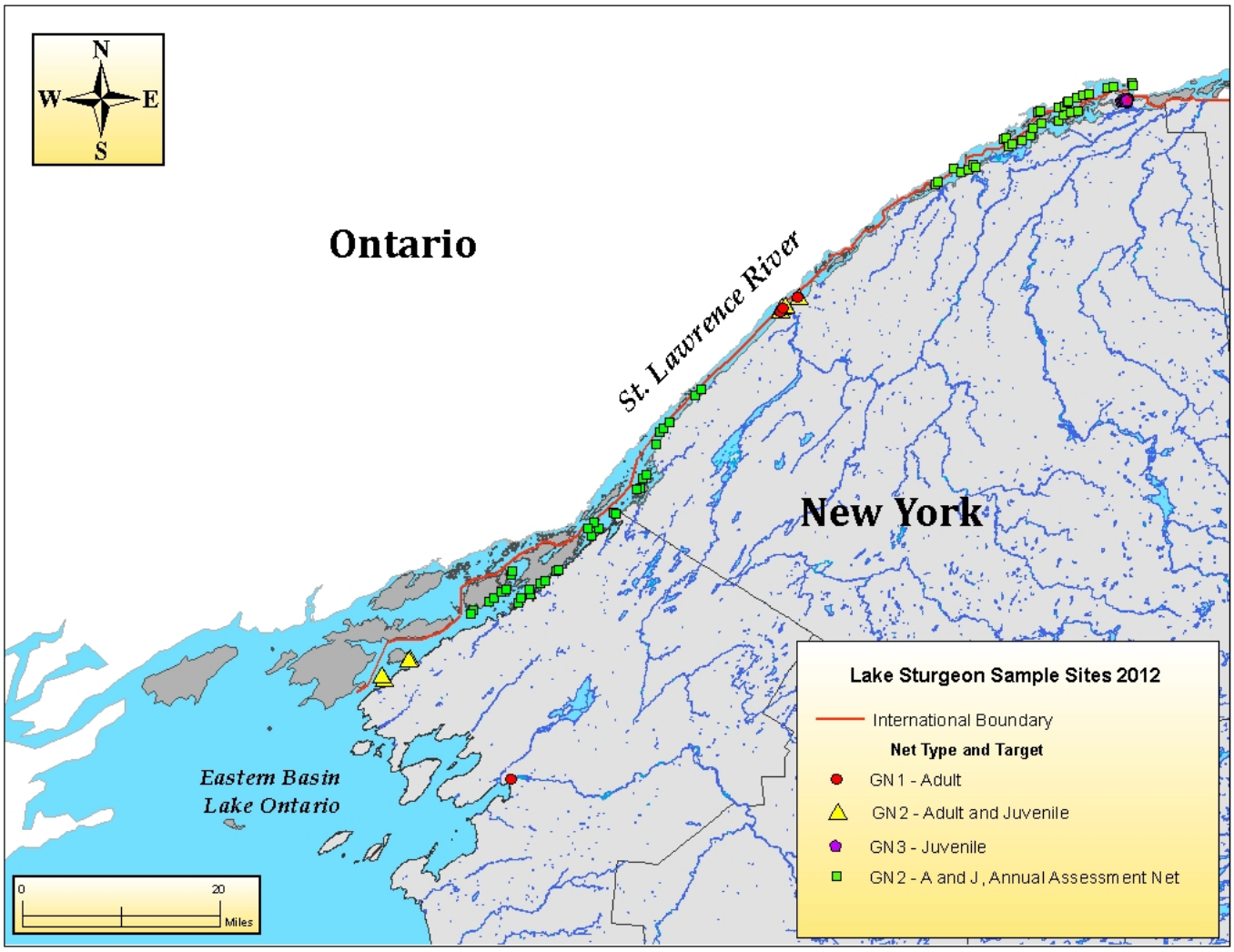

Figure 1. Lake Sturgeon collection locations and targets for 2012. Adults were targeted with gill nets only (GN1). Existing index projects in the Thousand Islands and Lake St. Lawrence potentially targeted "Both", juveniles and adults, utilizing experimental gill nets (GN2). Small mesh gill nets (GN3) targeted juvenile Lake Sturgeon.

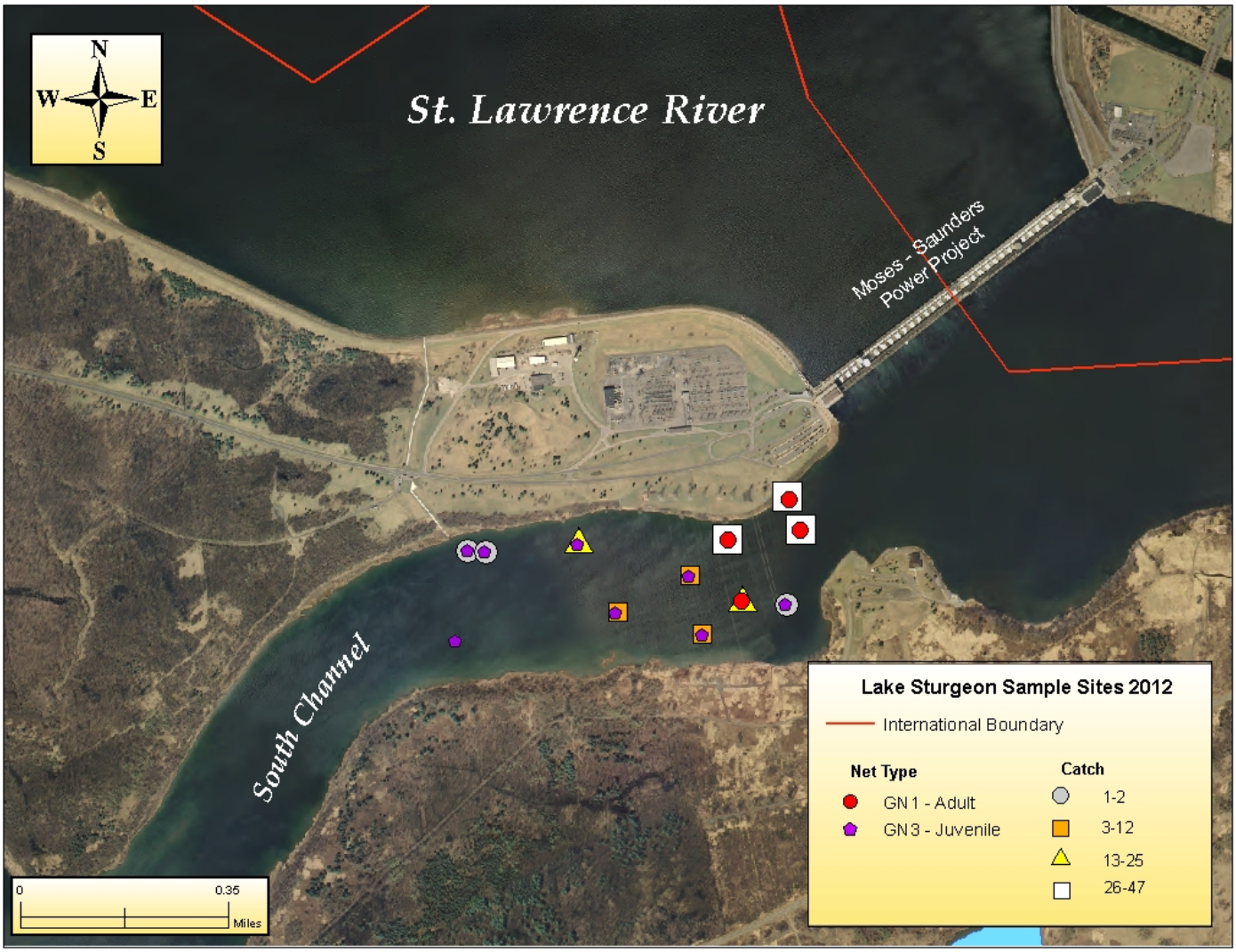

Figure 2. Lake sturgeon collection below the Moses Power Dam at the South Channel in 2012. Large mesh gill nets targeting adults (GN1) were deployed in May, while smaller mesh gill nets (GN3) were deployed in June for juveniles.

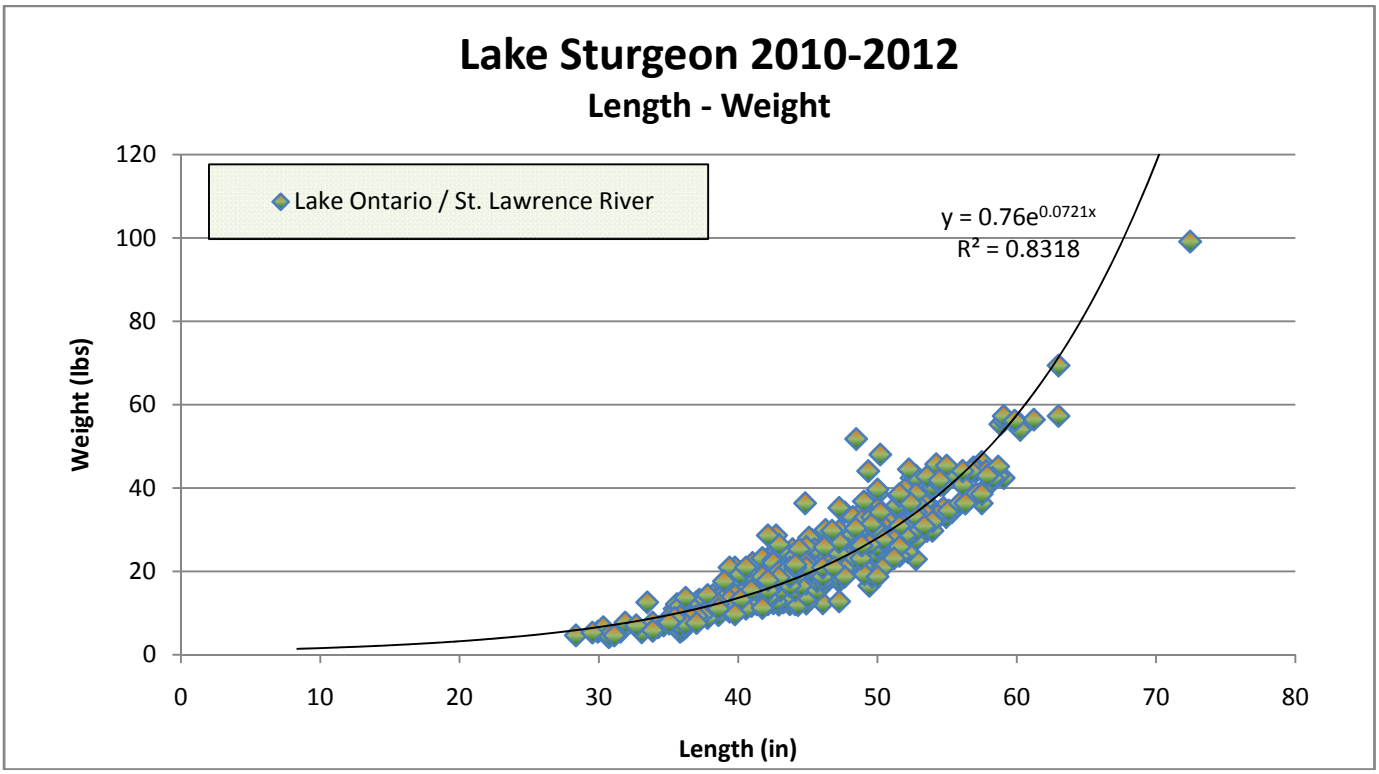

Figure 3. Length-weight relationship for lake sturgeon collected by NYSDEC from 2010-2012. Fish from the St. Lawrence River, Lake Ontario, and the Black River were combined with no differentiation to gender.

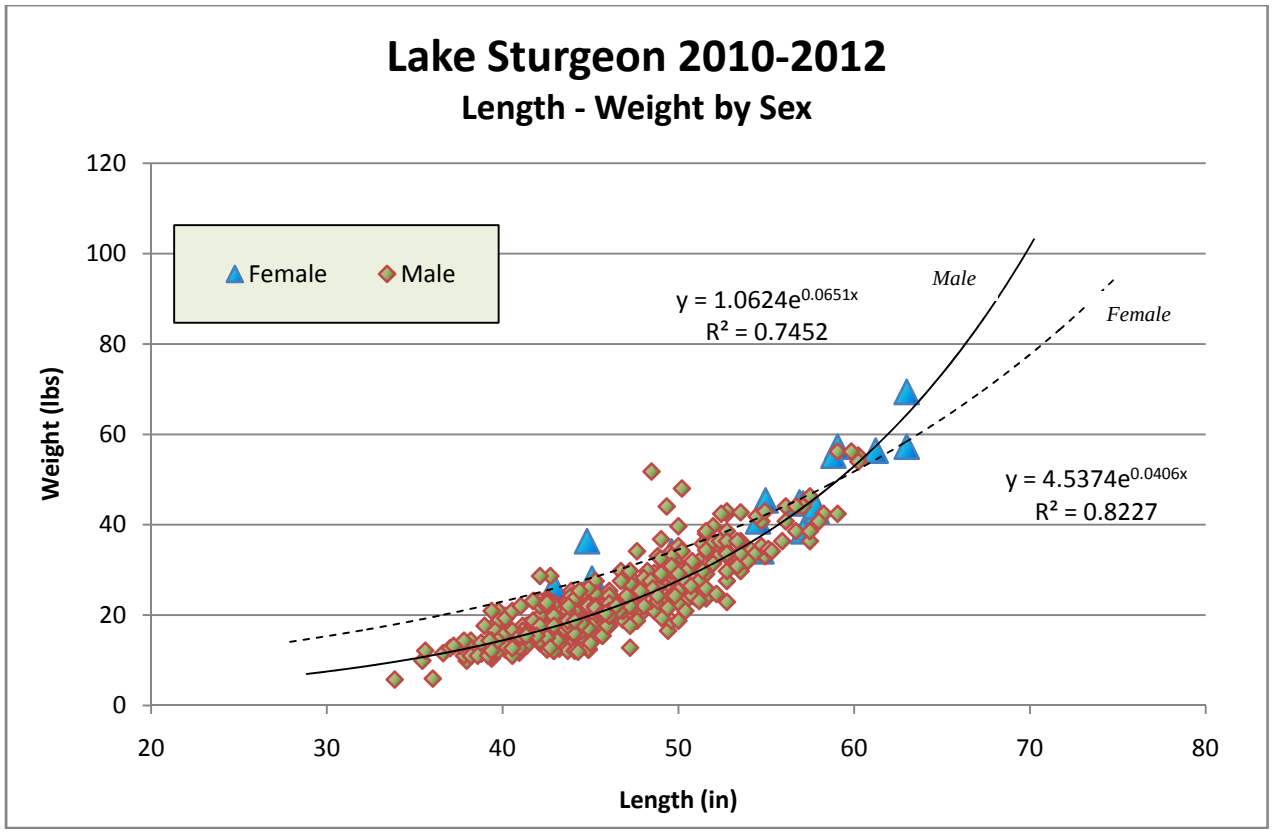

Figure 4. Length-weight relationship for lake sturgeon collected by NYSDEC from 2010-2012 separated by sex. Fish from the St. Lawrence River, Lake Ontario, and the Black River were combined.

Table 1. Net specifications used for collecting lake sturgeon in 2012. Net target refers to the general size of sturgeon anticipated to be collected: A=adult, B=both adult and juvenile, J=juvenile

Name	Net Target	Net Code	Length(ft)	Depth (ft)	Stretch Mesh (in)	Material
R6 Sturgeon	A	GN1	300	8	10	monofilament
SLR	B	GN2	200	8	1.5-6 (8 panel)	monofilament
Inland	J	GN3	150	8	4-6 (3 panel)	monofilament

Table 2. Relative effort and success rate of lake sturgeon collection attempts on the St. Lawrence River and Black River in 2012. Targeted surveys specifically attempted to collect sturgeon. Existing and ancillary project surveys targeted the major fish assemblage with sturgeon as a possible component. The St. Lawrence is referenced as SLR- down or SLR-up, referring to the position either downstream or upstream of the Moses Power Dam, Massena NY.

Location	Dates	# Sites	Target	Net Code	Effort (hrs)	Catch	CUE (fish/hr)
Targeted							
Black River	4/2-23/2012	1	A	GN1	195.9	18	0.09
SLR- Down	5/21-29/2012	4	A	GN1	401.4	159	0.40
SLR- Juvenile	6/11&14/2012	8	J	GN3	109.5	51	0.47
Ancillary project							
SLR- Up	6/25/2012	11	B	GN1 & GN2	234.9	0	0.00
Existing project							
SLR- TI	7/25-28/2011	32	B	GN2	620.4	0	0.00
SLR- LSL	9/19-22/2011	32	B	GN2	501.8	0	0.00

Table 3. Number, lengths and ages of juvenile sturgeon collected in the South Channel on June 11 & 14, 2012. Ages determined by fin ray sectioning.

Age (yrs)	Number	Length Range (in)
6	2	29.5-35.0
7	1	32.7
8	5	28.3-35.0
9	1	39.8
10	2	35.0-42.1
11	4	35.8-43.3

Monitoring and Management of Upper St. Lawrence River Muskellunge

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The upper St. Lawrence River is well known for its world-class Great Lakes strain muskellunge (*Esox masquinongy*, Mitchell) fishery. This population has been proactively managed through the efforts of an international St. Lawrence River Esocid Working Group and guidance by muskellunge management plans (Panek 1980, LaPan and Penney 1991, Farrell et al. 2003). The goal for management is: "To perpetuate the muskellunge as a viable, self-sustaining component of the fish community in the St. Lawrence River and to provide a quality trophy fishery" (with a catch rate of 0.1 fish per hour). The Esocid Working Group, composed of resource managers from the US and Canada, meets periodically to discuss recently completed studies, research needs, and potential management actions. Attention to muskellunge management and research needs has served as a long-term management model (Farrell et al. 2007) that is now focused on trends related to significant population reductions subsequent to an invasive viral hemorrhagic septicemia (VHSv) outbreak in the mid-2000s.

As recommended by management plans, monitoring of adult and young-of-year (YOY) muskellunge has been ongoing since 1990 and recent population changes have been detected using this data series. The first was an apparent positive response to the improved management strategies of the late 1990s and early 2000s with increased numbers of YOY on nursery grounds and higher adult catch rates. Beginning in 2005, however, widespread mortality of adult muskellunge was observed and attributed to VHSv recently introduced to the Great Lakes (Elsayed et al. 2006). Since these adult muskellunge mortality events, substantial declines have been observed in adult catch rates in the spring spawning survey and YOY abundance on the nursery grounds later in the summer.

Monitoring is important to understanding the population's response to perturbations such as disease-induced mortality as well as changes to habitat such as vegetation or fish community structure. For example, invasions by nonnative species such as round goby, (*Neogobius melanostomus*) are now known to include littoral nursery habitats of muskellunge. Maintenance of productive critical habitats is imperative to ensure sustained natural muskellunge reproduction (Dombeck et al. 1986). In order to address these needs, monitoring in nursery areas and research targeting factors influencing reproductive success continues to be of high importance. Significant progress has been made in these areas in previous work (summarized in Farrell et al. 2007), including studies of spawning ecology (LaPan et al. 1995, Farrell 1991, Farrell et al. 1996), nursery habitat requirements (Werner et al. 1990, Clapsadl 1993, Jonckheere 1994, Farrell and Werner 1999, Murry and Farrell 2007, Woodside 2008), dietary characteristics of YOY (Kapuscinski et al. 2012), and their response to invasions by non-native prey fish (Kapuscinski and Farrell, in press). The information obtained in these studies will be used to develop a more comprehensive understanding of muskellunge habitat and population dynamics, and guide enhancement strategies.

Our objective here is to report current research and monitoring efforts with annual updates pertinent to muskellunge management.

Methods

Spring trapnetting survey

Standardized trapnet surveys to monitor adult muskellunge at a set of spawning bays were conducted in 1997-2000, 2003, and since 2006 for a minimum of four weeks during the spawning period. In 2012, sixteen nets, including 3' hoop nets and 6'

Oneida trap nets were fished near shore in eleven known muskellunge spawning bays from 14 May to 13 June (Table 1).

Data collected include total length (TL), sex, spawning condition, and weight when possible. All adult muskellunge are tagged with Floy™ dart tags. A fin tissue sample is retained for future genetic analysis. Catch data are used to monitor trends in abundance, size and age distribution, and sex ratios of spawning muskellunge. Data on muskellunge recaptured in this survey and by angler collaborators are used to examine growth and fish movements, particularly as it may pertain to spawning site fidelity. In addition to collecting muskellunge-specific data, all other fishes are identified and enumerated to provide an indication of the fish assemblages present at muskellunge spawning sites.

Summer seining surveys

In 1990, a standardized seining procedure was initiated at six sites to monitor YOY muskellunge in the upper St. Lawrence River. Since 1997, monitoring the relative abundance of YOY muskellunge during the nursery period has continued with two surveys per year at each of eleven sites between Cape Vincent and Alexandria Bay, NY. Procedures for these are further detailed in Farrell and Werner (1999). Data collected include geographic coordinates detailing the location of each haul and habitat features (depth, temperature, vegetation type, and coverage). Juvenile esocid data comprises abundance, distribution, and total length (mm). Seining survey data are used to monitor trends in abundance, growth between periods, and monitor fish assemblage/habitat relationships at muskellunge nursery locations.

In addition to the standardized survey at index sites, continued identification of critical habitats is conducted at *exploratory* sites. These are areas where muskellunge were not previously detected (habitats in Eastern Lake Ontario downstream through Lake St. Lawrence) or have not been sampled in recent years using the standardized procedures for seining and data collection.

Angler diary program

Thousand Islands Biological Station (TIBS) staff continue to maintain an angler diary program with participants ranging in angling frequency from casual though dedicated muskellunge anglers to a professional guide with multiple record catches to his credit. Cooperators are selected based on quality of information volunteered in previous diary projects. They are asked to record information on daily effort (rod hours), catch and harvest rates, total lengths, and approximate location of angled muskellunge. We have investigated the feasibility of training cooperators to tag released muskellunge with Floy™ dart tags to learn more about population status and angling mortality. Willing anglers who have demonstrated competence with this procedure are currently tagging fish.

Muskellunge Catch and Release Program

A partnership with a local environmental advocacy group, Save the River, continued through 2012 sponsoring the Muskellunge Catch and Release Program. This program aims to both educate and involve the angling community in the conservation of the local adult muskellunge population by rewarding anglers who release a legal-size muskellunge with a limited edition, signed muskellunge print by St. Lawrence River artist Michael Ringer. Data are collected on each participant's total muskellunge catch and effort expended in hours, as well as information for the specific released fish submitted for the reward. Those details include location caught, water depth , weather conditions, date, time of day, weight of line used, bait or lure type, and total length of the muskellunge.

Muskellunge mortality

Throughout the field season, TIBS staff, collaborators, and other members of the Thousand Islands community who are familiar with the TIBS's mission, contribute to muskellunge mortality monitoring by reporting and/or collecting dead fish. When possible, dead and moribund fish are processed to record details on size, weight, potential cause of death, and stomach contents. During this necropsy, the cleithrum bone is excised and preserved for later age determination by Drs. John Farrell, or John Casselman of Queen's University as part of the Ontario Ministry of Natural Resources (OMNR) Cleithrum Project.

Results and Discussion

Spring trapnetting survey

A total of only 5 muskellunge were captured (catch rate = 0.012 fish/net night) in 2012, continuing a trend of decline since the 2005 outbreak of VHSv (Figure 1). The mean number of muskellunge caught in the spring trapnetting survey before the

VHSv outbreak was 28.0 (SD=10.5), but a mean of 10.7 (SD=6.6) muskellunge have been captured in subsequent years. The 2012 catch rate of 0.012 muskellunge per trap net night (Table 1) matched that of 2011, and was the second lowest observed since the VHSv outbreak.

A male muskellunge tagged in Garlock Bay in June 1998 (36.5 in. TL) was recaptured at the same location in 2012 (43.9 in. TL), and grew only 7.4 inches TL in 14 years.

On May 29, 2012, a large female muskellunge (57 inches TL; 53.2 lbs.) was found dead in a net at Densmore Bay. The fish displayed no significant signs of damage or other obvious signs of infection or disease, and was immediately submitted to Cornell University's Aquatic Animal Health Lab for further testing. Gross external and internal examination, as well as histological examination, virology (via cell culture and qT-PCR), and bacteriology were all negative and did not provide further clues as to the cause of death. Serosanguinous ascites were found in the coelemic cavity and hydropericardium, and are common in organisms suffering from liver malfunction. However, this could be a secondary consequence of a prexisting injury or illness that was the actual cause of death, and is not a conclusive finding.

Summer seining surveys

The sixteenth consecutive annual standardized YOY muskellunge seining index was completed in 2012 (Table 2). A total of 11 bays were sampled twice during July with a fine-mesh seine (pre-index period=71 hauls; index period=88 hauls) and during August with a large-mesh seine (88 hauls). A total of 2 (CPUE = 0.03 fish/haul) and 1 YOY muskellunge (CPUE = 0.01 fish/haul) were captured in the pre-index and index fine-mesh seine surveys, respectively. The large-mesh seining series in August resulted in a catch of 4 YOY muskellunge in 88 seine hauls (CPUE = 0.046).

For the exploratory seining series, a total of 112 hauls were completed in the Thousand Islands during July, resulting in a catch of 11 YOY muskellunge from five different sites (CPUE = 0.098) (Table 2). Northern pike and grass pickerel were captured in slightly greater abundance. Three esocid species were captured in Plum Tree Marsh on the east end of Grindstone Island. The capture of YOY muskellunge represents a new identification of nursery use for this site. No seining surveys were conducted in the Middle Corridor or Lake St. Lawrence areas in 2012.

YOY muskellunge abundance within nursery areas remains suppressed, with catch rates for both the small and large mesh series being among the lowest on record for two consecutive years. This eight-year decline in YOY abundance appears to signal a series of weak year-classes and potentially poor recruitment to the adult population.

Angler diary program

In 2012, angler diary program anglers spent 695 hours of effort for 9 muskellunge captured (0.013 fish/hour). The catch rate is an improvement over 2011 where 8 muskellunge where captured in 1,029 hours effort (0.008 fish/hour) but continues a downward trend in the quality of the muskellunge fishery.

The number of diary participants continues to decline in recent years and the program is in need of dedicated and committed cooperators. Catch rates remain well below the management goal of 0.1 fish per hour.

Muskellunge Catch and Release Program

In 2012, ten anglers participated in the Muskellunge Catch and Release program with TIBS and Save the River. Catches ranged in size from 49 to 54 inches. By the point in the season at which the anglers participated in this program, their angling effort ranged from 4 to 580 hours, with an average of 105.5 angler hours.

Muskellunge mortality

There was no evidence of disease-related mortality with muskellunge during the 2012 season. The VHS virus, to which significant muskellunge mortality was attributed beginning in 2005, appears to be in a latent stage based on samples analyzed in 2012 for smallmouth bass and other centrachids. VHSv was isolated from round goby in early spring (Dr. Emily Cromwell, personal communication). This suggests that the fish can no longer be considered naïve to the virus appear to have developed what is currently a sufficient immune response. However, whether today's muskellunge population is still infected or not, the virus is still in the system and other species, likely round goby, are serving as a reservoir for the pathogen. If VHSv returns to a lytic stage via mutation or prompted by deterioration of habitat or

other sources of environmental stress, significant muskellunge mortality could resume.

Acknowledgements

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Location	Site	Survey Start	Survey End	Nets fished	Nights fished	Net - Nights	M catch	M CPUE	M Catch date(s)
DOWN river <--------> UP river	Peos Bay	5/14/2012	6/11/2012	1	28	28		0.000	
	Millens Bay *	5/14/2012	6/6/2012	1	23	23		0.000	
	Rose Bay	5/14/2012	6/11/2012	2	28	56		0.000	
	Lindley Bay	5/14/2012	6/11/2012	1	28	28		0.000	
	Flynn Bay *	5/14/2012	6/7/2012	2	24	48		0.000	
	Frinks Bay	5/14/2012	6/13/2012	1	30	30		0.000	
	Blind Bay *	5/14/2012	6/13/2012	2	16,30	46		0.000	
	Cobb Shoal	5/14/2012	6/8/2012	2	25	50		0.000	
	Swan Bay *	5/14/2012	6/13/2012	1	30	30		0.000	
	Garlock Bay	5/14/2012	6/11/2012	1	28	28	4	0.143	5/15,5/16,5/18,5/18
	Densmore Bay	5/14/2012	6/11/2012	2	28	56	1	0.018	5/29/2012
TOTAL	**11**			**16**	**272**	**423**	**5**	**0.012**	

Table 1. Locations, sampling period, trapnet effort expended, and resulting muskellunge records with dates of catch in St. Lawrence River bays, 2012. Locations with an asterisk were used for both northern pike and muskellunge monitoring and tagging. Remaining bays were those surveyed as part of muskellunge index monitoring project only.

* Sites with one asterisk are part of M & NP surveys.

Bay	Hauls	Muskie	NP	CPUE Muskie	CPUE NP
30' Index Series					
Affluence Bay	6	0	0	0.00	0.00
Boscobel	6	0	0	0.00	0.00
Cobb Shoal	10	0	0	0.00	0.00
Deer Island	6	0	2	0.00	0.33
Frinks	10	0	0	0.00	0.00
Garlock	10	0	0	0.00	0.00
Lindley	6	0	0	0.00	0.00
Millens	10	0	0	0.00	0.00
Peos	8	1	0	0.13	0.00
Rose	10	0	0	0.00	0.00
Salisbury	6	0	0	0.00	0.00
Total	**88**	**1**	**2**	**0.011**	**0.023**
30’ Exploratory Series					
Grindstone Is. (A2)	6	3	0	0.50	0.00
Grindstone Is. (A3)	4	2	1	0.50	0.25
Blind Bay (Jefferson Co.)	7	0	1	0.00	0.14
Blind Bay (St. Lawrence Co.)	5	0	0	0.00	0.00
Buck Bay	2	0	0	0.00	0.00
Delaney Bay	12	0	2	0.00	0.17
Flynn Bay	16	1	2	0.06	0.13
French Bay	11	0	1	0.00	0.09
Goose Bay	10	0	1	0.00	0.10
Plum Tree Marsh	6	2	2	0.33	0.33
Point Vivian Bay	10	0	1	0.00	0.10
Swan Bay	11	0	2	0.00	0.18
Thurso Bay	6	2	0	0.33	0.00
Affluence Bay	6	1	0	0.17	0.00
Total	**112**	**11**	**13**	**0.098**	**0.116**
60’ Index Series					
Boscobel	6	0	0	0.00	0.00
Cobb Shoal	12	0	3	0.00	0.25
Deer Island	6	1	0	0.17	0.00
Frinks	10	0	0	0.00	0.00
Flynn	6	0	1	0.00	0.17
Garlock	8	1	2	0.13	0.25
Lindley	6	0	0	0.00	0.00
Millens	10	0	1	0.00	0.10
Peos	8	1	0	0.13	0.00
Rose	10	1	0	0.10	0.00
Salisbury	6	0	0	0.00	0.00
Total	**88**	**4**	**7**	**0.046**	**0.080**

Table 2. Seining catch summary for 2012 sampling using a 1/16” fine-mesh 30’ bag seine in index sites (top), exploratory sites (middle), and a ¼” large-mesh bag seine targeting esocids.

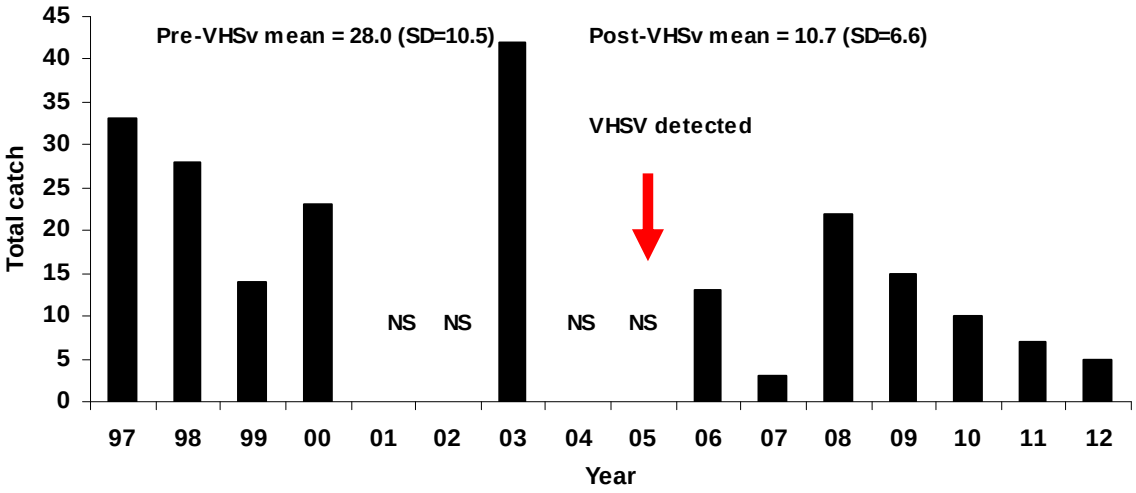

Figure 1. Total catch of muskellunge during spring trapnet sampling during 1997- 2012. Sites and effort are approximately equal over the series. Samples were not collected in 2001-02 and 2004-05 (NS) because of a decision of the Esocid Working Group to monitor muskellunge every third year. Following VHSv outbreak it was decided to resume annual monitoring.

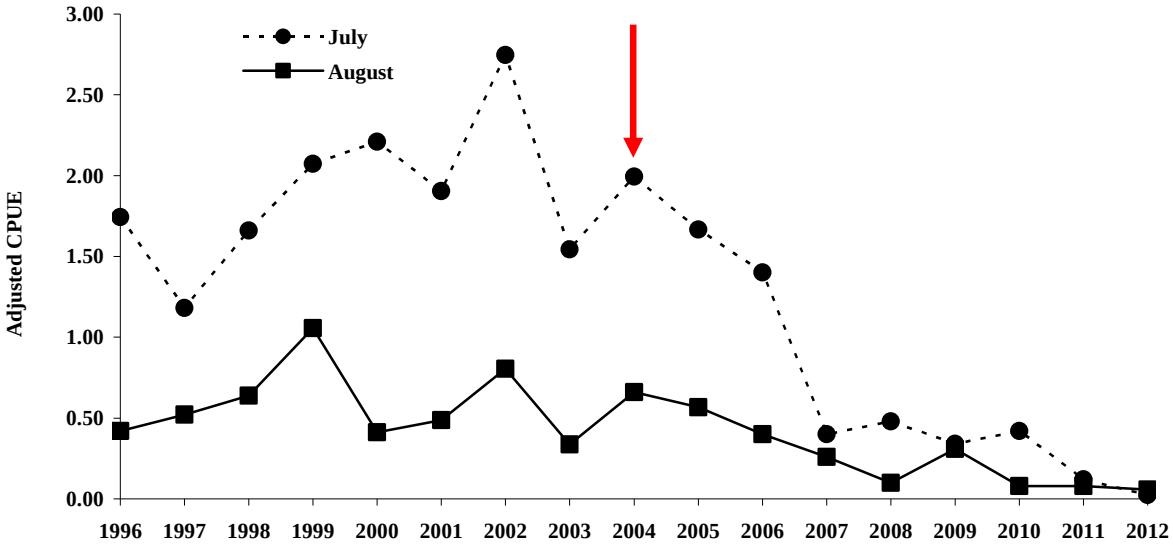

Figure 2. Catch per unit effort of YOY muskellunge captured in standardized seine hauls in eleven upper St. Lawrence River nursery sites from 1996 to 2012. A 9.14 m fine-mesh seine was used from July 15-31 and an 18.3 m large-mesh seine was used from August 15-31. The fine-mesh seine CPUE was doubled to standardize the area swept among the two gears. The arrow indicates the year prior to detection of VHSv (2004) and widespread mortality of muskellunge in the upper River.

Lake Ontario Commercial Fishery Summary, 2000-2012

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Commercial fishing activity in the New York waters of Lake Ontario is limited to the embayments and nearshore open waters of the eastern basin. Commercial fishing gear includes gill nets, trap nets, and fyke nets, however, only gill nets were actively fished in 2012. Commercial harvest generally targets yellow perch (*Perca flavescens*) and brown bullhead (*Ameurus nebulosus*), however, harvest of lake herring (*Coregonus artedii*), white perch (*Morone americana)* and whitefish (*Coregonus clupeaformis*) was also reported in 2012. Herring harvest in recent years went unreported, and fishers were reminded of reporting requirements (all fish caught, whether sold or not) in 2009. Of five licensed commercial fishermen, only four actively fished on three licenses (Table 2) in 2012. Data from previous years are reported by LaPan (2005).

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Table 1. Approximate reported value ($US) of the 2012 commercial catch from the New York waters of Eastern Lake Ontario (*estimated mean value, as price fluctuates throughout the year).

SPECIES	TOTAL POUNDS	PRICE/POUND*	TOTAL VALUE
Yellow Perch	59,989	$1.54	$ 92,149
White Perch	1,130	$ .68	$ 763
		Estimated Total Value	**$ 92,912**

Table 2. Reported* commercial fish catch in pounds from the New York waters of Eastern Lake Ontario, 2000-2012.

	# Lic.	YP	BBH	WP	RB	SF	CRP	WTF	CAT	DRM	CSCO
2000	7	59,928	5,709	383	280	3,571	308	-	-	-	-
2001	6	40,323	5,875	442	15	16	-	-	-	-	-
2002	6	37,223	4,435	-	-	-	-	-	-	-	-
2003	6	6,153	5,815	-	-	-	-	-	-	-	-
2004	3	37,066	1,200	-	-	-	-	-	-	-	-
2005	3	6,354	1,040	-	-	-	-	-	-	-	-
2006	3	4,274	500	-	-	-	-	-	-	-	-
2007	3	34,343	535	-	-	-	-	-	-	-	-
2008	3	14,428	735	-	-	-	-	-	-	-	-
2009	3	41,338	31	-	20	-	-	-	-	-	347**
2010	2	44,008	75	546	-	-	-	16	-	-	465
2011	3	77,238	105	3,736	-	-	-	-	-	-	613
2012	3	59,989	105	1,130	-	-	-	18	-	-	44

*does not include documented illegal and/or unreported harvest
**known harvest in previous years was not reported

# Lic. = number of active licenses
YP = Yellow Perch
BBH = Brown Bullhead
WP = White Perch
RB = Rock Bass
SF = sunfish (Pumpkinseed, Bluegill)
CRP = Black Crappie
WTF = Whitefish
CAT = Channel Catfish
DRM = Freshwater Drum
CSCO= Lake Herring

Yellow Perch Population in the New York Waters of the St. Lawrence River Thousand Islands

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The St. Lawrence River supports one of the major fisheries in New York State, ranking from second through fourth in angling effort during recent years, based on statewide angling surveys (Connelly et al. 1997, Connelly and Brown 2009). Most of this effort occurs in the 48 mile long stretch of river known as the Thousand Islands (McCullough 1983). Klindt (2011) reported that yellow perch (*Perca flavescens*) dominated catch in the St. Lawrence River fishery, with up to 1.34 million fish caught. Based on Jolliff and LeTendre (1967), McCullough (1983) and Cholomondeley (1989), yellow perch have been a major part of the St. Lawrence River fishery for decades.

Over the time period covered by this study (1977 through 2012) the St. Lawrence River ecosystem has experienced a number of significant disturbances, including reduced nutrient input from Lake Ontario, the introduction and expansion of dreissenid mussels, the expansion of a major piscivore (double-crested cormorant [*Phalacocrorax auritus*]), the introduction and expansion of a prolific invasive fish (round goby [*Neogobius melanostomus*]) and the appearance of a serious fish disease (viral hemorrhagic septicemia [VHS]). This study examines the characteristics of the St. Lawrence River Thousand Islands yellow perch population during this period of change.

Methods

Sampling

This analysis of yellow perch population characteristics was based on fish collections conducted as part of the New York State Department of Environmental Conservation's warmwater fish community assessment program for the upper St. Lawrence River (McCullough and Gordon 2012). This takes place in New York waters of the Thousand Islands area (Figure 1) from the upstream end of Grindstone Island (near Clayton, New York: 44.239°N 76.086°W) downstream to the Morristown area (44.586°N 76.649°W), a water surface area of approximately 43,000 acres (17,400 ha). In this reach the riverine habitat is a complex mix of islands, shoals, bays and channels, with extensive wetland areas and depths to 180 ft (55 m). Although sub-populations of yellow perch may exist, none have been defined and the yellow perch in this area were treated as a single population.

Sampling was conducted annually during the last week in July or first week in August beginning in 1977. Collections were made with anchored, sinking gill nets constructed of multifilament nylon (until 2003) or monofilament nylon (since 2004). Nets of both materials were 200 ft (61 m) long by 8 ft (2.4 m) deep and consist of eight 25 ft (7.6 m) panels of 1.5 in (38 mm) to 6 in (152 mm) stretch measure mesh hung 2:1 (units mesh : unit float line). Sampling was confined to the mid-depths of the river, from 10 to 60 ft (3 to 18 m). Nets were set annually at 32 sites between Clayton and Morristown since 1983; 16 sites in shallow stratum (10 to 30 ft; 3 to 9 m), 16 sites in deep stratum (33-60 ft; 10 to 18 m). Nets were set at 16 sites (8 shallow, 8 deep) annually from 1977 through 1982. Nets were set mid afternoon and were lifted by mid morning the following day, and fished approximately 19-21 hrs.

All fish were identified to species, weighed and measured (total length). All game fish and sub-samples (Ketchen 1949) of pan fish examined had scales, or cleithra for esocids, removed for age determination. Ages were determined from projections of scales or from direct observation of cleithra. Additional information was collected

but not used in this report (McCullough and Gordon 2013).

Abundance

Annual yellow perch abundance indices (1977-2012) are reported as catch per net-night (catch per unit effort or CPUE; multifilament net standard) in McCullough and Gordon (2013). Based on 24 paired nets set in 2004, catch rates of yellow perch differed significantly between the two net types. Since 2004, catch rates of yellow perch in monofilament nets were adjusted by multiplying the observed rate by 0.74. Contribution of each year class to the catch was measured using the sum of CPUE from ages 4 through 7. Age-4 fish of most year classes were fully recruited to the sampling gear. Age data were incomplete for some of the early sample years, so the earliest year class evaluated is 1981.

Year class contribution (YC contrib.$_x$) provided an indicator of relative year class contribution to fishing quality:

YC contrib.$_x$ = $\sum_{age4-age7}$ CPUE YC_x
where $_x$ = year class

Mean July-August water temperatures for 1993-2004 (National Oceanic and Atmospheric Administration data collected at Superior Shoal, downstream of Alexandria Bay) were used to examine the relationship between mean summer water temperature during hatch year (1993-2000 year classes) and later YC contribution. Estimated consumption of yellow perch by double-crested cormorants as related to perch abundance was derived from diet studies at the Griswold Island cormorant colony (Johnson et al. 2003-2010, Johnson 2011). Abundance of alewife (*Alosa pseudoharengus*), as related to perch year class strength, was provided by Thousand Islands warmwater fish assessment data.

Survival / Mortality

Survival and mortality estimates were made using catch curve methods described by Ricker (1975). Instantaneous mortality (Z) from catch curve:

Z= (-) slope of ln CPUE vs Age

S= Annual Total Survival:

$S = e^{-z}$ (Ricker 1975)

where e = the base of the natural log

A= Annual Total Mortality:

$A = 1-e^{-z}$ (Ricker 1975)

Survival was estimated from age 4, full recruitment to the gear, to age 7, after which sample sizes declined dramatically.

Length / Weight

Size (total length) status of the yellow perch population was evaluated according to the structural indices proposed by Anderson (1978) and using the total length categories (traditional) proposed by Gabelhouse (1984):

Stock Size ≥ 130 mm
Quality Size ≥ 200 mm
Preferred Size ≥ 250 mm
Memorable Size ≥ 300 mm

Approximate English equivalents of these breakpoints are 5, 8, 10, and 12 inches.

Stock density indices were included for descriptive purposes, and do not relate to any specific management goals.

Relative weight (Wr) was determined for each fish by calculating the ratio of actual weight to the standard weight of a yellow perch of the same length (Anderson and Neumann 1996). Fish under approximately 90 grams (3.2 oz.) were not weighed accurately in most years. Few fish under 200 mm total (7.9 in) length weighed at least 90 grams (3.2 oz.). Therefore relative weight was calculated only for quality size or larger fish. The length-weight relationship was evaluated using the standard weight equation:

$\log_{10}(Ws) = a + b(\log_{10} TL)$;

where TL = total length and Ws = standard weight (Anderson and Neumann 1996). Metric standard weight parameters for yellow perch were used:

a = -5.386 b = 3.230

which gives:

$\log_{10}(Ws) = -5.386 + 3.230 (\log_{10} TL)$

Growth

Growth rate (G) was calculated as the slope of the linear regression of natural log (ln) of the mean TL_{age} versus age by year class (Chrisman and Eckert 1998). This is a population rate rather than a true (or individual) rate as defined by Ricker (1975) in that it does not account for possible differential mortality of fast growing fish. Mean total length at age-4 was used to provide a point index of recent growth conditions which did not require following a year class for several years. Round goby abundance index, as it relates to prey availability, is based on percent representation in cormorant diet at the Griswold Island colony (Johnson et al. 2003-2011) located near Chippewa Bay.

Results and Discussion

Abundance Trends

During the first 10 years (1977-1986) mean yellow perch CPUE was 21.3 fish/net, constituting 45.3 % of the total catch. During the next 20 years (1987-2006) CPUE varied without trend with a mean CPUE of 13.1 fish per net and constituted an average of 34% of the total catch. Most recently (2007-2012) yellow perch abundance has been relatively low, with a 6 year mean of 11.3 fish per net (Figure 2), 30% of the total catch.

Year Classes

Using the sum of CPUE at ages 4 through 7 as an index of the contribution of a year class to fishery quality, a pattern was apparent with strong year classes produced in the early 1980s, followed by increasingly weak year classes through 1985, and then increasingly strong year classes into the early 1990s. The highest ranking year classes were produced in 1981, 1982, 2002, and 1989The lowest ranking year classes were produced in 1996, 2001, 2000, and 1985.

Annual survival (ages 4 through 7) by year class was variable but trended downward over time (Figure 4). For more recent year classes (1999, 2000, 2003 and 2004), survival was among the lowest in the data series.

For the 1993-2004 year classes there was a positive relationship (r=0.68) between mean summer water temperature and year class contribution (Figure 5). Mean summer water temperature explained almost half (r^2= 0.46) of the variation in year class contribution. Casselman et al. (2002) found a similar relationship for smallmouth bass in eastern Lake Ontario.

Abraham (1994) linked high alewife abundance with high larval yellow perch mortality. Anderson et al. (1998) found a significant positive relationship between larval yellow perch abundance and year class strength. However, at the levels of alewife abundance prevailing in the Thousand Islands, the relationship between alewife abundance and perch year class contribution (Figure 6) was weak (r=0.11).

Growth

The growth rate for Thousand Islands yellow perch, expressed as slope of the ln mean TL vs. age (ages 3-6) regression line, was generally lowest for the 1988 and 1989 year classes (Figure 7), was high in the 1977 and 1993 year classes and was highest for the most recent (2005) year class. Although there was wide variation among year classes (r=0.44) the trend of increasing rate of growth through time was highly significant (p = 0.02). For the 1980 through 1990 year classes, growth appeared to be inversely related to year class strength.

Mean total length at age 4 is a convenient index of yellow perch growth which provides information for each sample year. Mean total

length at age 4 was over 180 mm (7.1 inches) in 1977, generally fluctuated at or below 160 mm (6.3 inches) between 1978 and 1998 and has increased sharply since 2006 reaching 210 mm (8.3 inches) in 2011 (Figure 8). The availability of goby prey in this reach of the St. Lawrence River in 2005, as indicated by double-crested cormorant diet (Johnson et al. 2003-2011), has become a major influence on growth (Figure 9). From 2005 through 2010, availability of gobies accounted for almost half (r^2 = 0.48) of the variation in the age 4 growth index (Figure 10). At the abundance indices observed, there was little evidence of any density dependent effect on perch growth. During the period of goby availability perch abundance accounted for little of the variation in growth (r^2= 0.12). A similar relationship was present during the pre-goby period (r^2=0.09).

Stock Density Indices

Increased growth has resulted in increased abundance of quality, preferred and memorable size perch.

Abundance of stock size (≥130 mm, approx. 5 in) perch has generally declined along with general perch abundance (Figure 11). Stock size abundance peaked in the 1970s and early 1980s then declined and fluctuated at a lower level.

Quality size (≥200 mm, approx. 8 in) perch were abundant 1980s, probably due to a generally abundant perch population, then declined in the mid 1980s and varied at a lower level until the mid 2000s (Figure 12). After 2005 abundance of quality size perch began a marked increase and again reached early 1980s levels by 2011.

Preferred (≥250 mm, approx. 10 in) and memorable (≥300 mm, approx. 12 in) size perch were not common in earlier years, but both increased noticeably beginning in 2005 (Figures 13 & 14).

Proportional Stock Density (PSD) indices for Thousand Islands yellow perch declined from approximately 15 in the 1980s to near 7 in the early 2000s (Figure 15). By 2012 it had risen to 37, which put it into the balanced range (Willis et al. 1993). A balanced population indicates that recruitment and growth are in balance with mortality. In the Thousand Islands yellow perch population, this indicated that faster growth (which tends to increase PSD) had overcome the effect of increased mortality (which tends to depress PSD).

Relative Stock Density for preferred size perch (RSD-p) was near zero from the late 1970s through 2004. It then rose quickly, reaching 17 by 2011-2012 (Figure 15). Relative Stock Density for memorable size perch (RSD-m) followed the same pattern but, since memorable size perch are still relatively uncommon in this population, only reached 0.05 by 2012 (Figure 15).

Condition

Relative weight (Wr) was calculated for quality and preferred size yellow perch. Relative weight could not be calculated for stock size fish because weights for the smaller fish were found to be unreliable and sample size for memorable size fish was too small.

Examination of relative weight indicated that condition in quality and preferred length categories was below standard (100) for nearly all years (Figures 16 & 17). Quality size Wr was greater than or equal 90 eleven times in the 36 year survey period, six times since 2006. Preferred size Wr equaled or exceeded 90 eight times in 36 years, also 6 times since 2006.

Optimal growth in good habitat should result in Wr values near 100 (Wege and Anderson1978). Willis et al. (1991) found that yellow perch populations in northern and Atlantic coastal states are less likely than others to reach this level.

System Changes

Perhaps the most basic change to the aquatic system of the upper St. Lawrence River during the period of study, 1977-2010, was the reduction in productivity resulting from phosphorus control efforts begun in the 1970s. Phosphorus levels in Lake Ontario and the upper St. Lawrence River declined dramatically in the

1970s and early 1990s and have remained low since the mid 1990s (LaPan et al. 2001, Johannson 2003, Farrell et al. 2009, Holeck et al. 2010, 2011). Yellow perch growth may have responded to phosphorus reduction with growth declining in the late 1990s then varying without trend through the mid 1990s (Figure 8). Increased growth in the late 1990s and 2000s appeared to be responding to factors other than basic system productivity. Reduced density of zooplankton, associated with lower phosphorus levels (Farrell et al. 2009) could have had negative effects on larval perch.

Dreissenid mussels, first zebra mussels (*Dreissena polymorpha*) in 1989, then quagga mussels *(D. rostriformis bugensis*) in 1991 (Ricciardi and Whoriskey 2004), were confirmed in the upper St. Lawrence River near Cape Vincent. Within a few years dreissenids had formed dense concentrations, up to 10^4 individuals per meter^2 (1.1 x10^5/sq ft) at several locations (Riccardi and Whoriskey 2004). At high concentrations dreissenid mussels can elicit increased abundance of benthic macroinvertebrates by increasing surface area and enhancing accumulation of benthic organic matter (Horvath et al. 1999). Water clarity also increased following dreissenid proliferation (Farrell et al. 2009, McCullough and Gordon 2013). Although information regarding St. Lawrence River dreissenid effects is not detailed enough to allow analysis of the relationship to yellow perch population characteristics, perch growth was increasing during the later 1990s (Figure). It is possible that increased benthic macroinvertebrate availability as mussels became established (Farrell et al. 2009) contributed to faster yellow perch growth.

Of the various perturbations that have recently impacted the upper St. Lawrence River system, the most quantitatively applicable is the invasion of round goby. Round goby were first confirmed in eastern Lake Ontario in 1999 (Dietrich et al. 2006) and were first detected in the diet of cormorants at Griswold Island in the Thousand Islands area of the St. Lawrence River in 2004 (Johnson et al. 2005).Since cormorants are considered opportunistic predators, taking prey more or less in proportion to their availability (Bur et al. 2007, Carss 2005), the proportion of goby in the diet is a reasonable index of their availability in the system. Goby availability was shown to account for about half (48%) of the variability in yellow perch growth between 2005 and 2011.

An expanding double-crested cormorant population was implicated in suppression of smallmouth bass (Lantry et al. 1999) and yellow perch (Burnett et al. 2002) abundance in the nearby eastern basin of Lake Ontario. Cormorants may also have affected fish populations in the Thousand Islands. Estimated yellow perch consumption at Griswold Island, the major cormorant colony in the Thousand Islands area, has varied without trend since 1999, the period of record for this colony (Figure 18). There was a small positive relationship (r =0.30) between the abundance of yellow perch and perch consumption by cormorants the same year. This is very likely due to cormorants feeding on perch in direct proportion to their availability. There is only a slight (r = -0.12) negative relationship between consumption of perch by cormorants and perch abundance the following year (Figure 19), indicating that cormorant predation is probably not a major controller of Thousand Islands perch abundance.

An outbreak of VHSv, which caused substantial fish mortality, occurred in Lake Ontario and the upper St. Lawrence River in spring 2006 (Bowser 2009). The outbreak was attributed to a new variant of the VHS virus, Type 4b. Other variants of the virus had previously been responsible for fish mortalities in Europe and in North American marine systems. There were reports significant yellow perch mortality in 2006, however, sampling later in the summer indicated a modest increase in perch abundance. Sampling did not show a decline in perch abundance until 2009 (Figure 2). The spring 2006 VHS related mortality event did not seem to have any observable effect on the Thousand Islands yellow perch population.

Draft fish community objectives for St. Lawrence River (LaPan et al. 2001) yellow

perch call for a 5-year moving average CPUE greater than 16.5 fish/net in assessment gill nets, the 1995-1999 average. This target was approached only once since being established, as a point estimate (16.4) in 2009. Although the third and sixth highest contributing yellow perch year classes occurred since 2002, the moving average has not approached the target since 1999 (Figure 2).

Overall yellow perch abundance declined early in the survey period and has fluctuated at a lower level as annual survival declined. Growth, however, has generally increased, especially since 2005. As a result, despite generally reduced abundance, fishing quality may have actually improved as quality and preferred size yellow perch became more available.

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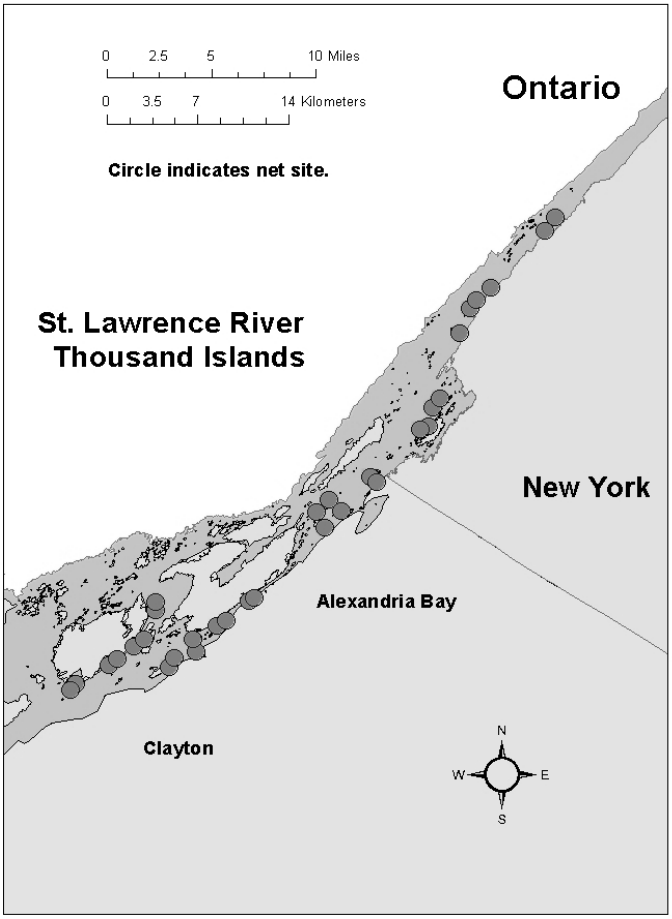

Figure 1. St. Lawrence River Thousand Island sampling area.

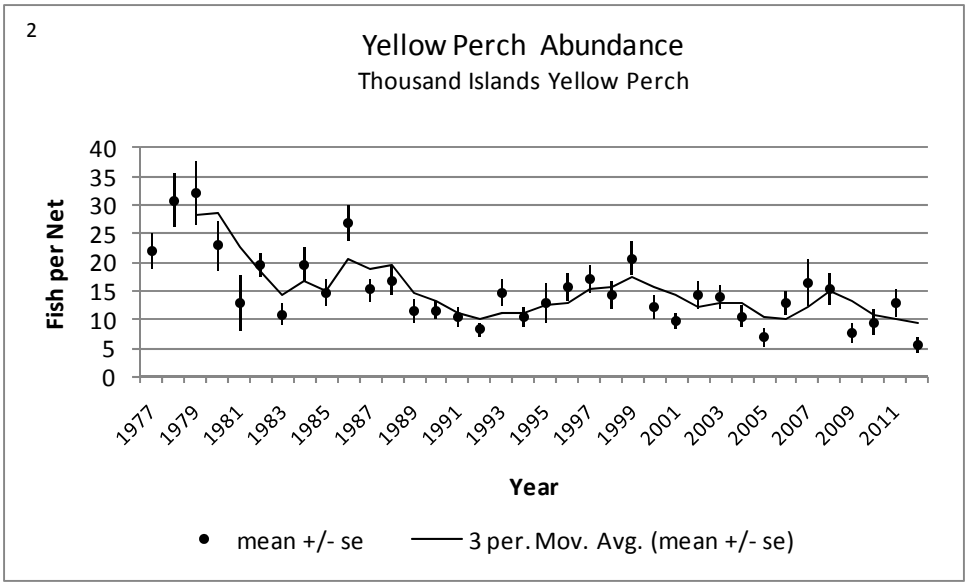

Figure 2. Yellow perch index of abundance (CPUE). Line is a 3-yr moving average.

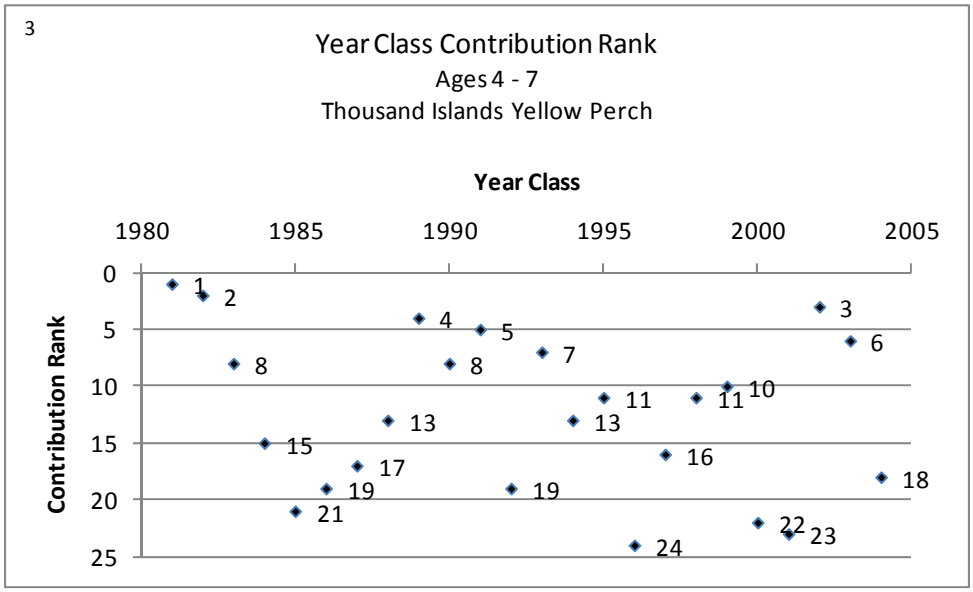

Figure 3. Contribution of yellow perch year classes to the fishery, ages 4 through 7.

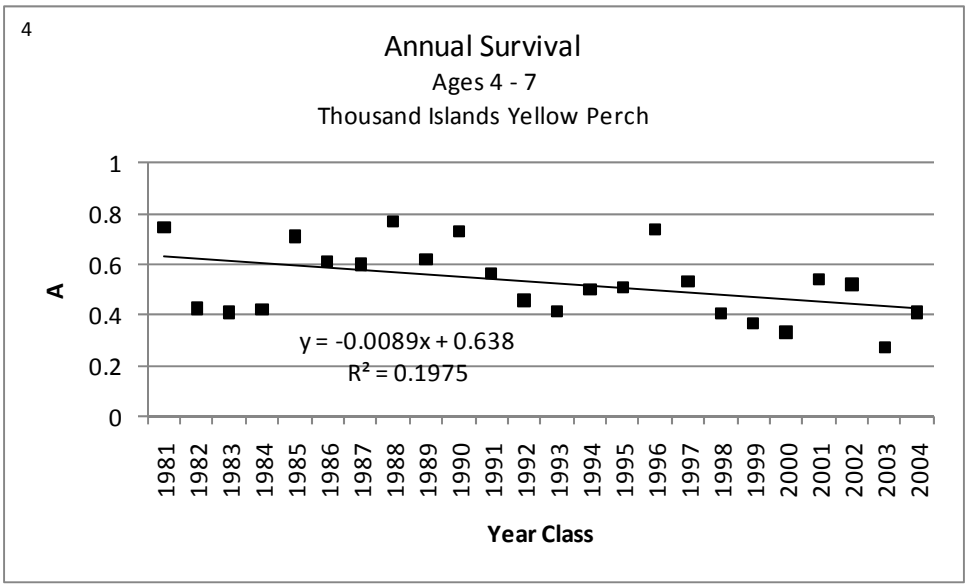

Figure 4. Annual survival of yellow perch from ages 4 through 7 by year class.

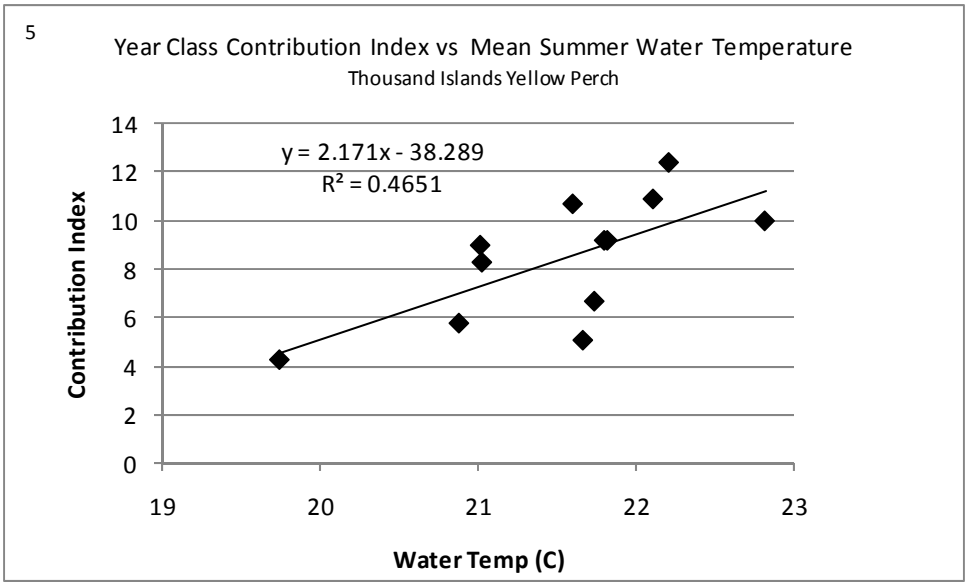

Figure 5. Relationship of yellow perch year class contribution (1990-2004 year classes) index to mean summer water temperature during the year of hatching.

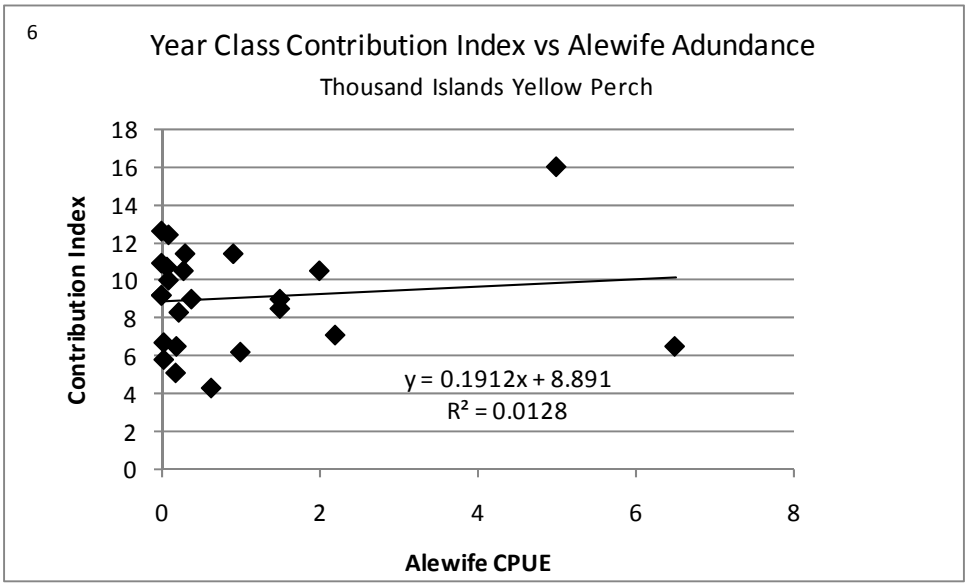

Figure 6. Relationship of yellow perch year class contribution index to alewife abundance during year of hatching.

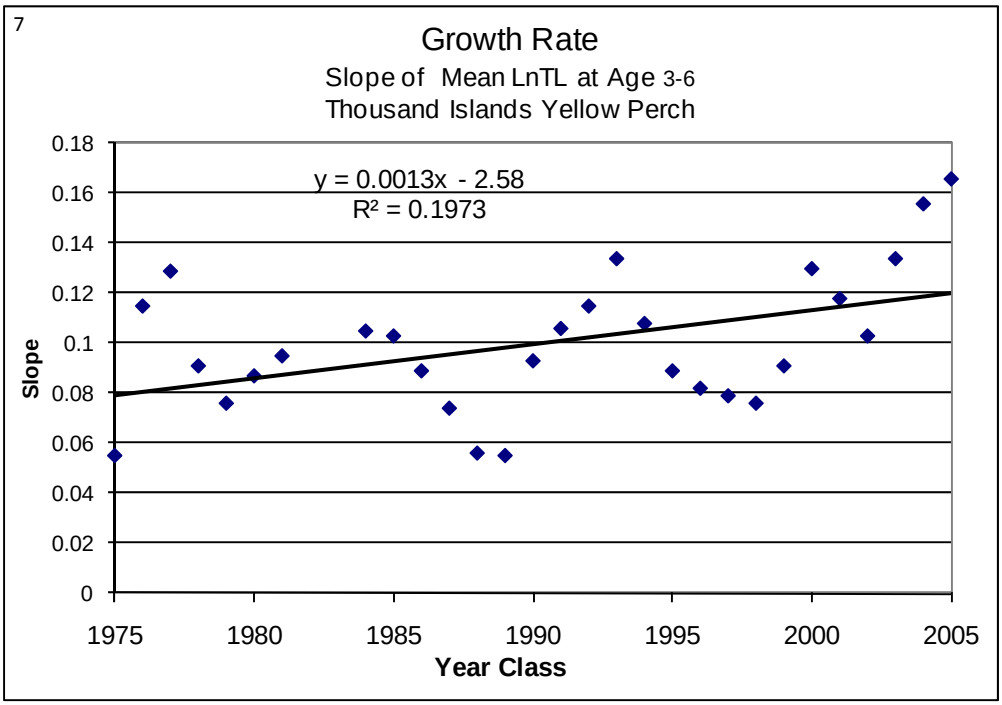

Figure 7. Growth rate of 1975 to 2005 yellow perch year classes.

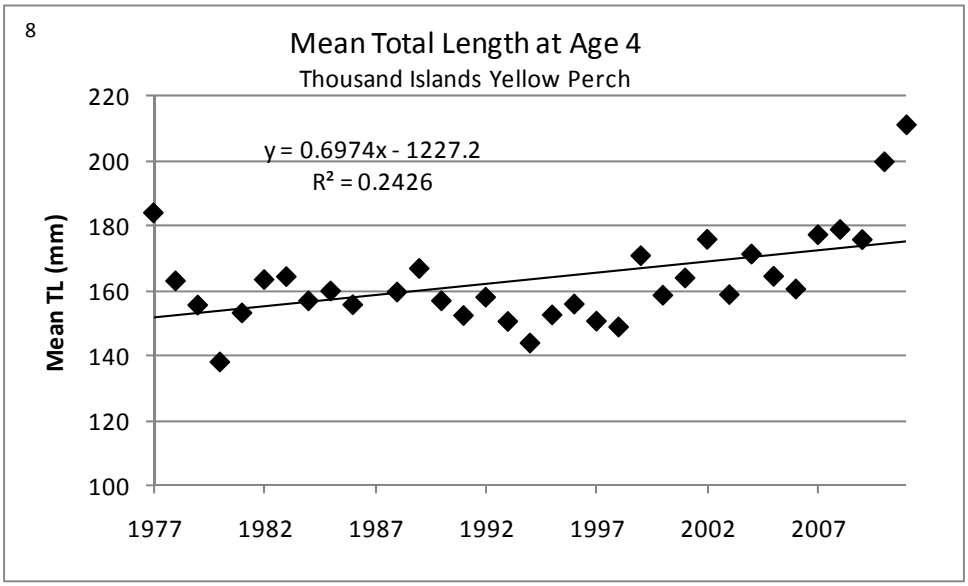

Figure 8. Growth of yellow perch as indicated by mean total length at age 4.

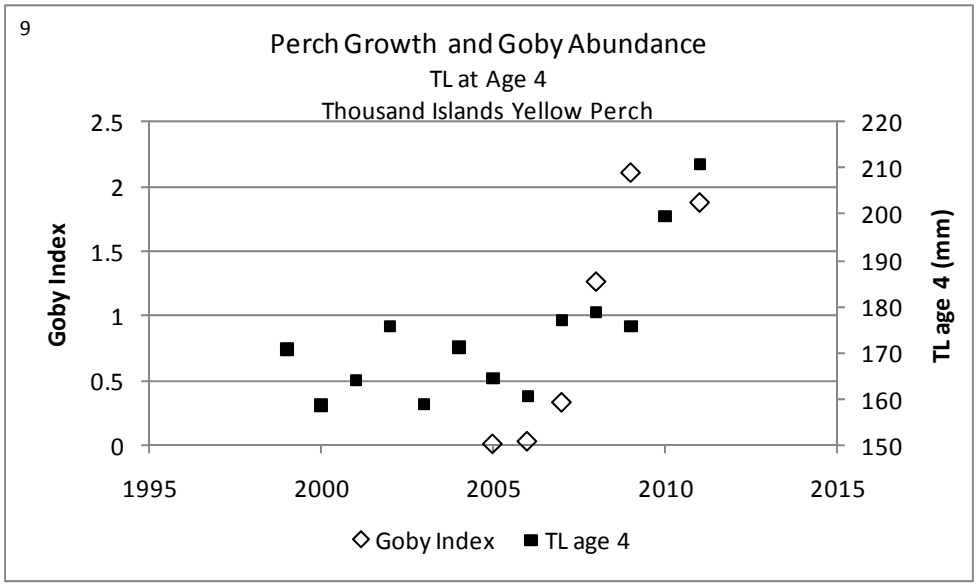

Figure 9. Growth of yellow perch (mean total length at age 4) and abundance of round goby as indicated by local cormorant diets.

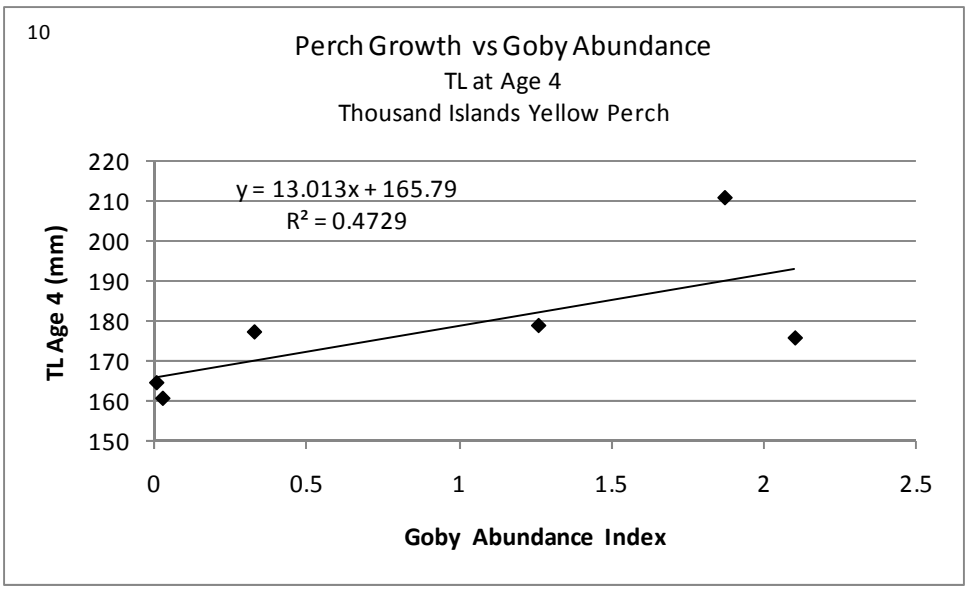

Figure 10. Relationship between yellow perch growth (mean total length at age 4) and abundance of round goby as indicated by local cormorant diet from 2005 to 2010.

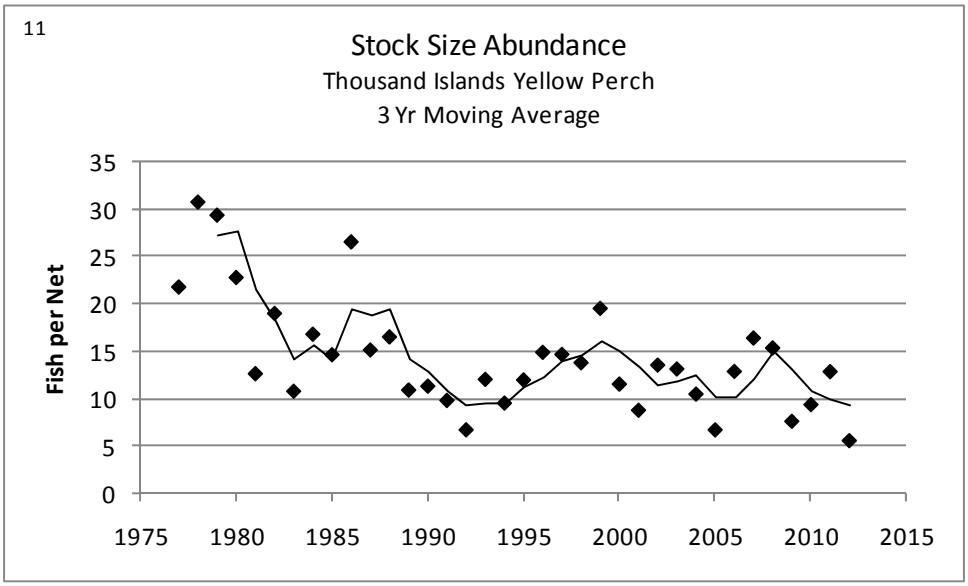

Figure 11. Abundance of stock size (≥ 130 mm; approximately 5 in) yellow perch.

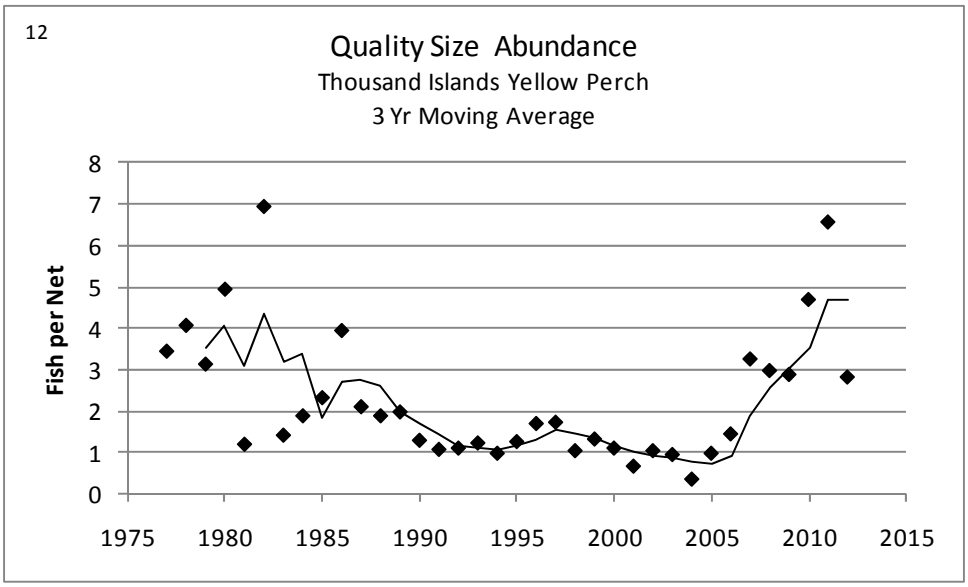

Figure 12. Abundance of quality size (≥200 mm; approximately 8 in) yellow perch.

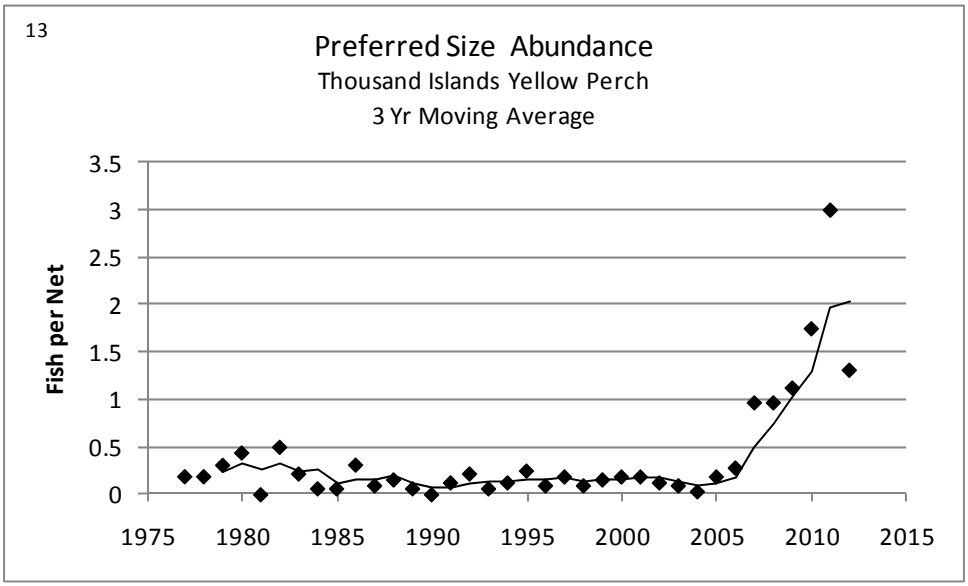

Figure 13. Abundance of preferred size (≥ 250 mm; approximately 10 in) yellow perch.

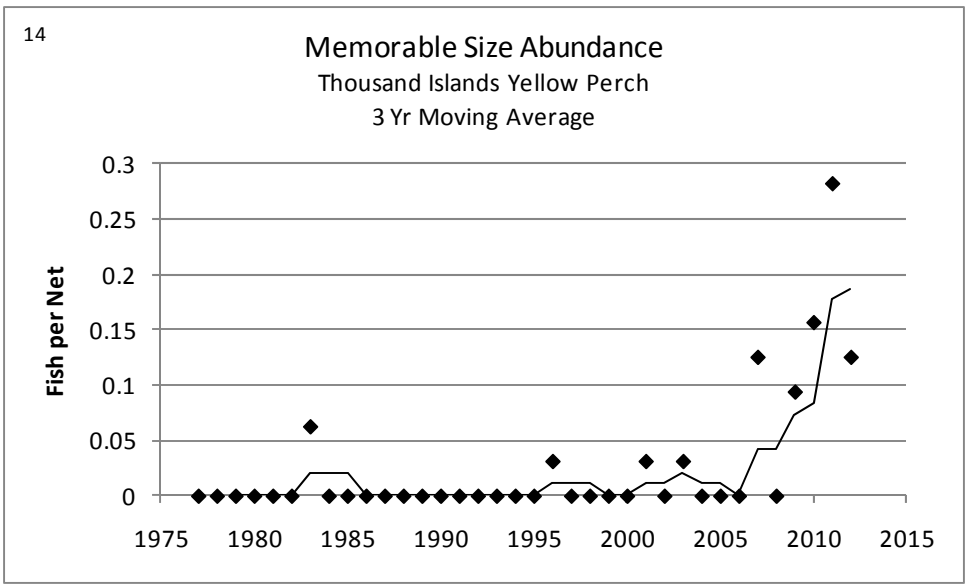

Figure 14. Abundance of memorable size (≥ 300 mm; approximately 12 in) yellow perch.

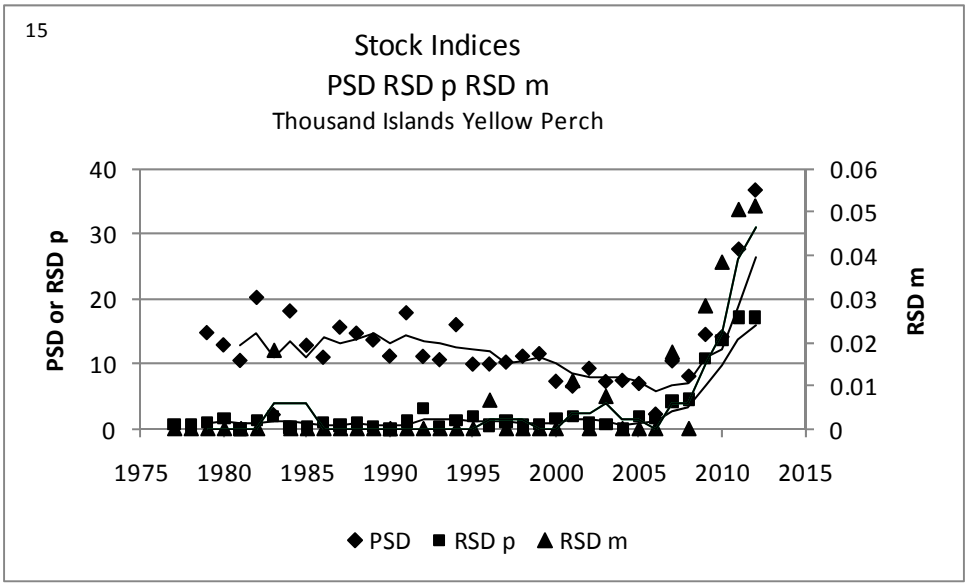

Figure 15. Proportional Stock Density (PSD) and Relative Stock Density for preferred (RSDp) and memorable (RSDm) Thousand Islands yellow perch.

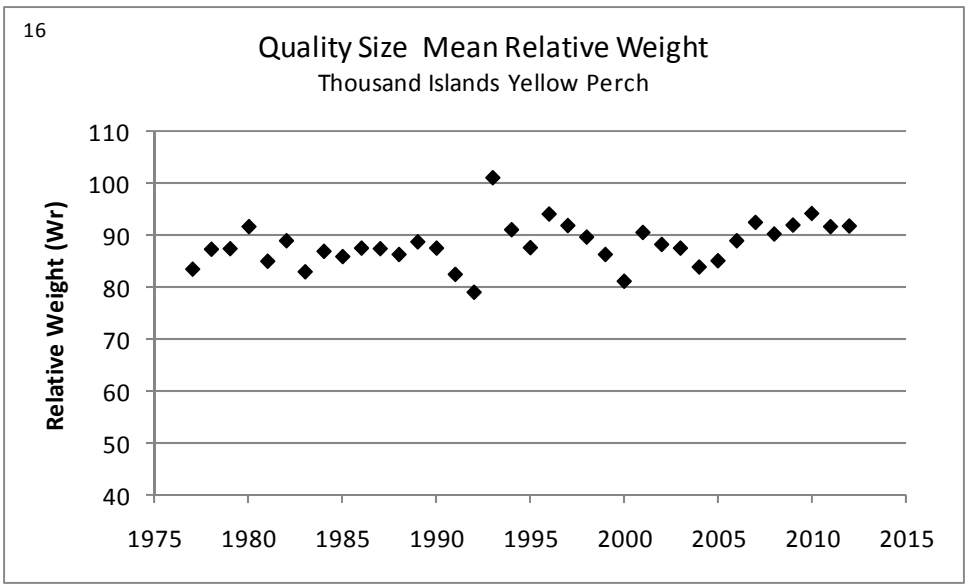

Figure 16. Relative weight (condition) of quality size yellow perch.

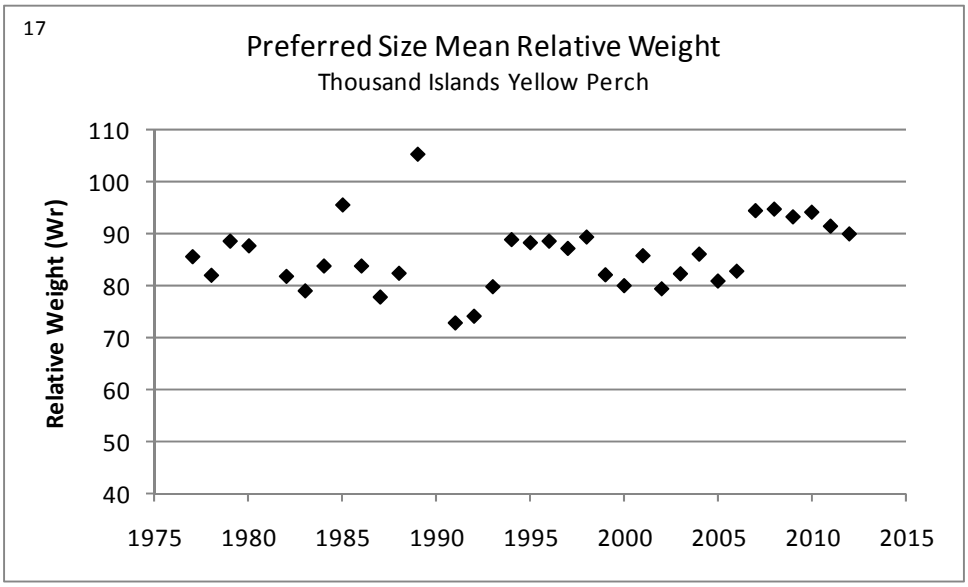

Figure 17. Relative weight (condition) of preferred size yellow perch.

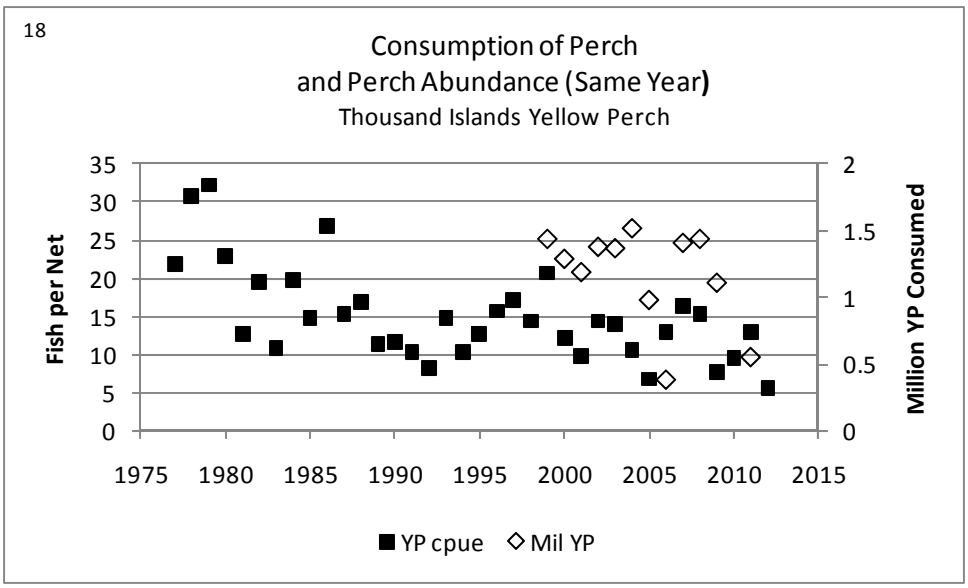

Figure 18. Consumption of yellow perch by local cormorants relative to abundance of perch that year.

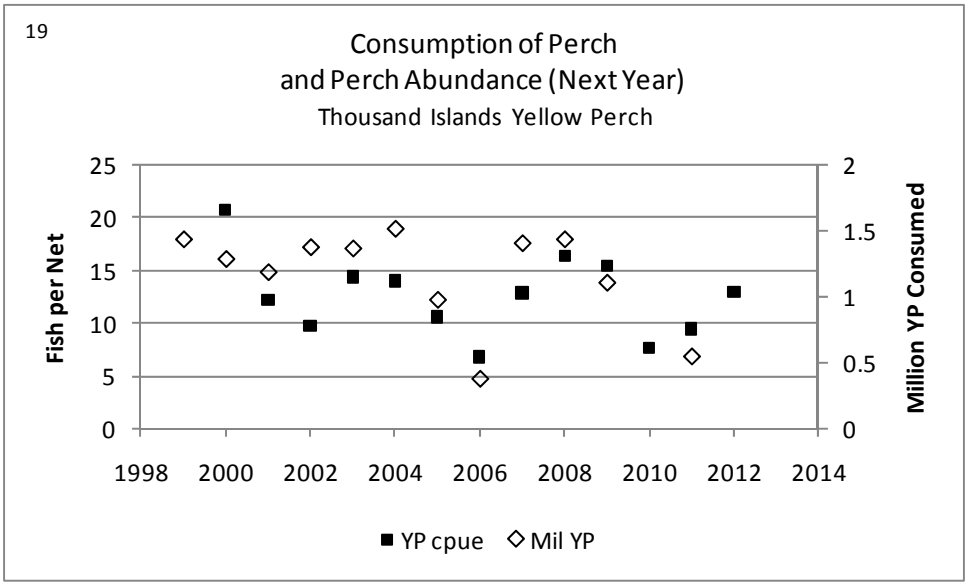

Figure 19. Consumption of yellow perch by local cormorants and abundance of perch the following year.

Assessment of the Lake Ontario Black Bass Fishery Using Cooperator Angler Diaries

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Nearshore waters of Lake Ontario's main basin produced exceptional smallmouth bass fishing from about 1996 to 2003 (Eckert 2004, Eckert 2006). In recent years, the NYS Department of Environmental Conservation (NYSDEC) Regional Fisheries Units and the Lake Ontario Unit received many angler complaints about a decline in smallmouth bass catch rates in areas where quality bass fisheries once existed. The Lake Ontario Fishing Boat Survey documented this decline (Eckert 2006, Lantry and Eckert 2013). In recent years, the majority of interviewed smallmouth bass anglers were catching few bass and primarily catching round goby, an invasive species not reported in angler catches until 2001. Through 2008, however, some of the interviewed bass anglers continued to experience high quality bass angling by successfully avoiding gobies and continuing to catch smallmouth bass. During 2009-2012, the NYSDEC received many reports from anglers who had experienced good quality fishing through 2008, but not subsequently. Concerns about the status of bass in Lake Ontario's main basin led to additional surveys in 2010 and 2011.

The cause(s) for the recent decline in fishing quality is not fully understood nor is the current status of the bass population in Lake Ontario. Additional sampling was conducted during the 2010 season, including gill netting assessments at four sites (Webster, Pultneyville, Fairhaven and Mexico) and initiation of an angler diary program. Further sampling was conducted at Pultneyville in 2011 (Sanderson 2012). A Lake Ontario Black Bass Angler Diary Program (Program) was initiated to provide additional information on fishing quality experienced by anglers targeting smallmouth and largemouth bass in Lake Ontario, its embayments, and tributaries to the first impassable barrier, as well as biological characteristics of bass caught. This report provides a summary of 2012 angler diary results.

Methods

The NYSDEC recruited volunteer bass anglers to participate in the Program. A variety of media were used to notify potential diary keepers of the Program, including the NYSDEC web page, fishing web sites, press releases, newspaper and magazine articles, presentations at sportsman shows, and at meetings of angler groups. Anglers interested in participating sent their name, address, and e-mail address to fwfishlo@gw.dec.state.ny.us. NYSDEC provided each participant with data collection instructions and a NYSDEC angler diary in which the participant would record fishing activity (e.g. date, time, location, length of each bass kept and released) for each bass fishing trip. At the season's end each participant returned their diary to NYSDEC. The diary program began at the start of the traditional open season on June 16, 2012. Diary keepers were instructed to record only trips in which they were targeting bass; therefore, catch rates are considered to be directed effort rates. The diary program is to be conducted annually.

Results and Discussion

In 2012, 54 angler cooperators participated in the diary program and 33 returned diaries to NYSDEC. Seven diary keepers sent letters or e-mails saying they did not fish for bass in 2012. All 33 diarists targeted bass during the 2012 season, and reported a combined total of 256 fishing trips comprising 1,687 angler hours. Participation and angling effort in the Program

grew from 2010 (46 cooperators, 30 returned diaries, 191 trips, and 1,329 hours) to 2011 (55 angler cooperators, 34 returned diaries, 305 fishing trips, 1,670 hours), and remained relatively unchanged in 2012. The 2012 sample size was still lower than that required to detect a statistically significant change in the fishery. Bishop (1993) estimated that 110 angler diary keepers making 1,700 trips on Seneca Lake were needed to detect changes in the salmonid fishery. The Program will be conducted annually; therefore, more angler cooperators are needed to increase sample size and our ability to detect a statistically significant change in the fishery.

During 2012, 161 trips (63%) were made on Lake Ontario, 79 trips (31%) were made on five bays, and 16 trips (6%) were made on four tributaries. No fish were caught on 67 trips (26%), smallmouth bass were caught on 115 trips (45%), largemouth bass were caught on 88 trips (34%), and both species were caught on 14 trips. Among smallmouth bass trips in the open waters of Lake Ontario, 32.3% caught no smallmouth bass. This is lower than that observed during 2010 (58.3%), and similar to 2011 (37.7%) (Sanderson and Lantry 2011 and 2012). In 2011, 58.8% of boats specifically targeting smallmouth bass surveyed in the Lake Ontario Fishing Boat Survey during the traditional open season failed to catch at least one bass, the highest value among the years surveyed (Lantry and Eckert 2012). Lantry and Eckert (2013) reported that in 2012, 53.6% of boats specifically targeting smallmouth bass during the traditional open season failed to catch at least one bass.

The majority of 1,345 bass caught were of legal (74%; > 12") size, but most were released (86.5%). Of 468 largemouth bass caught, 96% were released and 74% of the released fish were of legal size (≥12"). The high bass release rate in 2012 is consistent with 2010 and 2011 results, as well as those observed during creel surveys conducted on Irondequoit Bay (2007), Sodus Bay (2008), and Lake Ontario (Sanderson and Lantry 2012, Sanderson and Lantry 2011, Sanderson 2009, Sanderson 2010, Lantry and Eckert 2012).

Mean lengths of harvested smallmouth and largemouth bass were 16.9 and 15.2 inches, respectively. Mean lengths of released, legal sized smallmouth and largemouth bass were 15.7 inches and 14.3 inches, respectively. Nearly all (98%) of the smallmouth bass were caught from a boat using artificial lures or live bait. Nearly all (98.7%) of those were caught in Lake Ontario. Nearly all (99%) of the largemouth bass were caught using artificial lures.

Individual trip catch rates ranged from 0.00 to 3.00 smallmouth bass per angler hour. Smallmouth bass catch rates were determined for lake, embayment, and tributary anglers (Table 1). Lake Ontario bass anglers accounted for 74% of the total angler hours and 98.7% of the smallmouth bass catch reported, resulting in a directed effort catch rate of 0.70 smallmouth bass per angler hour. This is higher than the catch rate (0.49 bass per angler hour) determined for traditional season, open lake bass anglers interviewed for the 2012 Lake Ontario Fishing Boat Survey (Lantry and Eckert 2013) and the 2010 and 2011 Lake Ontario Black Bass Angler Diary Program (0.47 and 0.45 smallmouth bass per angler hour, respectively). Smallmouth bass catch rate in embayments in 2012 was 0.01, identical to 2011 and lower than in 2010 (0.02 smallmouth bass per angler hour) or rates reported by Sanderson (2009 and 2010) for Irondequoit Bay and Sodus Bay. This low rate, relative to that of lake anglers, was expected given that bass fishing in embayments is primarily targeted at largemouth bass. Smallmouth bass catch rate in tributaries was 0.06 bass per angler hour, which is higher than 2011 (0.02), but considerably lower than in 2010 (0.32, Sanderson and Lantry 2012, Sanderson and Lantry 2011).

In 2012, 65.8% of largemouth bass were caught in embayments and 16.2% were caught in tributaries. In 2011 and 2010, 55.7% and 70% of the largemouth bass were caught in embayments, respectively. During those years, 37.8% and 12.5% were caught in tributaries, respectively (Sanderson and Lantry 2012, Sanderson and Lantry 2011). Individual trip catch rates ranged from 0.00 to 5.45 largemouth bass per angler hour. Largemouth bass catch rates were determined for lake, embayment, and tributary directed effort (0.03, 1.09, and 0.62 largemouth bass per angler hour, respectively; Table 2). In 2012, cooperators caught largemouth bass at an excellent directed effort rate of 1.48 bass per angler hour in Port Bay. Cooperators caught largemouth bass at a directed effort rate of 0.26 bass per angler hour in Irondequoit Bay and 0.65 bass per angler hour in Sodus Bay during 2012.

The 2011 rates were 0.59 and 0.41, respectively. The 2010 rates were 0.73 and 0.51, respectively. Previous direct contact creel surveys found that fishing quality for anglers targeting bass on Sodus Bay in 2008 was excellent (1.09 bass per angler hour) and was greater than the targeted catch rate in Irondequoit Bay in 2007 (0.80 largemouth bass per hour; Sanderson 2009 and 2010). These rates greatly exceed the directed effort catch rates of all size largemouth bass from selected waters in New York State (0.24 bass per hour; Green et al. 1986).

Like 2010 and 2011, a few cooperators experienced good quality smallmouth bass fishing in Lake Ontario in 2012; however, the majority did not. This was also observed in the Lake Ontario Fishing Boat Survey (Lantry and Eckert 2013). A close examination of individual cooperator data revealed that relatively few successful anglers accounted for the vast majority of the smallmouth and largemouth bass catch in 2010-2012, with five or fewer cooperators accounting for >70% of the reported catch.

More cooperators are needed to ensure that Lake Ontario bass catch rate estimates are not biased and to ensure a sample size sufficient to allow for detection of significant year to year changes in the fishery.

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Table 1. Smallmouth bass catch, effort, and catch rate by water and month of cooperating angler diary keepers in 2012.

Month	# Fish Caught	Hours	Catch Rate
	Lake Ontario		
May	13	17.00	0.76
June	96	312.75	0.31
July	192	345.00	0.56
August	121	199.25	0.61
September	235	229.50	1.02
October	118	93.00	1.27
November	91	47.00	1.94
	866	1243.00	0.70
	Embayments		
May	0	0.00	0.00
June	3	86.25	0.03
July	0	124.25	0.00
August	1	82.75	0.01
September	0	26.50	0.00
October	0	2.00	0.00
November	0	0.00	0.00
	4	321.75	0.01
	Tributary		
May	0	0.00	0.00
June	3	24.25	0.12
July	1	37.50	0.03
August	3	34.00	0.09
September	0	19.00	0.00
October	0	7.00	0.00
November	0	0.00	0.00
	7	121.75	0.06
Total	877	1687.00	0.52

Table 2. Largemouth bass catch, effort, and catch rate by water and month of cooperating angler diary keepers in 2012.

Month	# Fish Caught	Hours	Catch Rate
	Lake Ontario		
May	5	17.00	0.29
June	7	312.75	0.02
July	1	345.00	0.00
August	0	199.25	0.00
September	14	229.50	0.06
October	15	93.00	0.16
November	0	47.00	0.00
	36	1243.00	0.03
	Embayments		
May	0	0.00	0.00
June	125	86.25	1.45
July	130	124.25	1.05
August	84	82.75	1.02
September	9	26.50	0.34
October	2	2.00	1.00
November	0	0.00	0.00
	308	321.75	1.09
	Tributary		
May	0	0.00	0.00
June	12	24.25	0.50
July	19	37.50	0.51
August	20	34.00	0.59
September	19	19.00	1.00
October	6	7.00	0.86
November	0	0.00	0.00
	76	121.75	0.62
Total	468	1687.00	0.28

Northern Pike Monitoring and Management in the Thousand Islands Section of the St. Lawrence River

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Northern pike abundance in the NYS Department of Environmental Conservation's (DEC) Thousand Islands Warmwater Fish Stock Assessment (McCullough and Gordon 2013) continues to show population suppression. Smith et al. (2007) demonstrated an overall dampening in the strength of Thousand Islands northern pike year classes beginning in the 1990s. Models of northern pike young of the year (YOY) production developed as part of the International Joint Commission (IJC) St. Lawrence River Water Levels Study indicated a negative effect of water level regulation on reproduction (Farrell et al. 2006). Water level regulation and spawning habitat changes appear to have promoted deep-water pike spawning (over ~5 meters (16.4 ft) water-depth) and 4-6 week delays in the egg deposition period (Farrell 2001). Deep water spawning behavior is believed to be maladaptive and has created a significant reproductive sink, as studies have shown very poor survival of eggs and fry in this habitat. Nearshore pike spawning has been negatively affected by water level regulation by preventing spawner access to wetlands and via the expansion of hybrid cattail (Typha *x* glauca) into riparian wet meadow habitats (Farrell et al. 2010).

To provide improved spawning habitat conditions at the local scale, water level controlled spawning marshes have been used in an attempt to increase natural recruitment (Forney 1968). Three spawning marshes have been managed in the Thousand Islands region to provide improved spring water level conditions with a goal of enhancing regional pike reproduction. Despite some early indications of success with marshes demonstrating significant production of emigrating fingerlings (Farrell et al. 2003), it is hypothesized that low numbers of spawning adults and female skewed sex ratios have caused low levels of YOY production at managed marshes.

Monitoring of northern pike YOY has been conducted in eleven seining survey sites also used to index muskellunge (see Farrell and Barry 2012) and more recently in larger bays and in tributaries. Overall YOY production has declined significantly from levels observed in the 1980s and early 1990s (Farrell, unpublished data). Continued monitoring is necessary to track pike reproductive success and evaluate responses to management activities (managed marshes and habitat enhancements). Other needs fulfilled by the project include a better understanding of early life history processes for northern pike in tributary systems, and the influence of IJC regulated water levels on habitat dynamics and northern pike recruitment processes. Research regarding habitat restoration efforts, in addition to providing options for northern pike management, will be critical to maintaining future populations.

Our objective is to provide an update of current research and monitoring activities related to northern pike management.

Methods

Spawning run trapnet survey

Monitoring of adult northern pike during spring spawning occurred in five index tributaries and one managed spawning marsh. Tributaries included French Creek, Cranberry Creek, Cranberry Creek extension (tributary), Little Cranberry Creek, and Chippewa (Creek) Tributary. The managed marsh was Carpenters Branch of French Creek (Figure 1).

Pike were captured in trapnets and assessed for sex/spawning condition, examined for fin-clips or tags, measured for total length (TL), and tagged with a monel metal jaw tag with an unique alphanumeric code and "RTN TO NYSDEC WAT NY 13601" in the left maxillary of fish greater than 500 mm TL

(19.7 in). Recaptured fish yielded information on distribution, individual growth, and spawning site fidelity. A scale sample was retained from each fish and notes on any physical abnormalities were recorded. Captured pike were transferred upstream of each net following processing. The sex ratio (females to each male) was compared for Carpenter's Branch only.

Water levels were held intentionally higher (~0.6 m or 2 feet) at Carpenters Branch and a second managed marsh, Delaney, which was not included in this spring spawning survey, but was surveyed through the rest of the season for emigrating YOY pike, wetland vegetation, and other indices. This water level management strategy is intended to prevent the fall drawdown associated with the IJC's water level regulation Plan 1958D (Farrell et al. 2010). Managing for higher water levels promotes more natural muskrat populations within sites, resulting in the creation of openings in dense invasive cattail mats within the marsh (Toner et al. 2010). Higher water levels also provide improved spring water level conditions for spawning pike.

US Fish and Wildlife Service (FWS) Partners for Fish and Wildlife Program staff repaired a damaged berm and water control structure at Delaney Marsh in fall 2011 and Ducks Unlimited made improvements to the fish ladder at Carpenters Branch in late winter 2012.

In 2012, the Carpenter's Branch hoopnet was monitored and fish were transferred to the marsh above the control structure. Fish were not trapped belom the Delaney Marsh structure, allowing them to pass freely into the managed marsh. A 6'Oneida trapnet was set at French Bay, Clayton NY to monitor northern pike.

Spawning run egg survey

A northern pike egg survey was conducted in the deep littoral shoal habitat at Governors Island (Figure 1). Eggs were collected in an array of 12 egg traps (Farrell 2001) set and checked weekly during May and early June. Data on GPS position of each egg trap, egg abundance, viability, and hatching success were recorded for each egg trap location.

Emigration of northern pike from managed marshes

In 2012, surveys for emigrating YOY pike from marshes used spillway traps set at Delaney marsh from 5/18-6/25 and 5/21-6/25 at Carpenter's Branch. All fish captured were identified and counted. Pike were measured for total length, and a pelvic fin was removed to evaluate the presence of marsh-origin fish in subsequent summer seining surveys and future spring adult trapnetting.

YOY outmigration data from the spillway trap at Carpenter's Branch in 2003-2012 and at Delaney Marsh were compared to the abundance of female pike captured in spring trapnetting to test for presence of a stock-recruitment relationship. Data were fit with a power function.

Summer seining surveys

Standardized seining for YOY northern pike was conducted in conjunction with YOY muskellunge monitoring. A total of 11 bays were sampled during July with a fine-mesh 9.1 m (30') seine (88 hauls) and during August with a large-mesh 18.3 m (60ft) seine (88 hauls) (for methods details see Murry and Farrell 2007). In addition, 14 bays were sampled in an exploratory series with the fine-mesh seine.

Results and Discussion

Spawning run trapnet survey

A total of 62 northern pike were captured at five index sites from March 14 to April 4, 2012, comprising an effort of 92 net nights, and resulting in a catch per unit of effort (CPUE) of 0.67 fish/night (Table 1). The catch of spawning northern pike at index sites, though higher than last year, remains low since a significant peak in 2008 (3.36 fish per night; n=5; Figure 2). Catches were relatively higher at French Bay (32 pike in 17 net-nights, 1.88 fish per night).

Only seven northern pike were captured in Carpenter's Branch (3 females, 1 male, and 3 of undetermined sex). Current and past trapnet catches indicate a remarkable dominance of female pike in the spawning run at these sites (Figure 5). For 532 pike of known sex captured at Carpenter's Branch in ten seasons since 2003, 373 were female or 2.35 females to each male. Similarly at Delaney Marsh, in four seasons from 2007 to 2011, 71 of 95 pike were female for a 2.96 female to male ratio.

No fin-clipped northern pike adults (that would indicate they were fin-clipped as emigrating YOY) were captured during spring trapnetting at any managed marsh site in 2012.

Spawning run egg survey

Egg traps yielded 28 eggs over an approximately 4.5 week sampling period in May and early June. This sampling provided an index of deep and protracted spawning that is thought to be associated with habitat changes and water levels management (Farrell et al. 2006). However, increases in invasive round goby (*Neogobius melanostomus*), a known egg predator, are now believed to influence the egg catch rates and this effect needs to be assessed.

Emigration of northern pike from managed marshes

The Delaney Marsh site yielded low productivity again in 2012, yielding 62 northern pike YOY over 38 days when emigration traps were monitored (Table 2). At Carpenter's Branch in contrast, only 11 northern pike YOY were captured over 35 days the emigration trap was operated between May 21 and June 25, 2012 (CPUE = 0.31 fish/night). The majority of these fish were marked by fin removal. Overall catch per unit effort at Carpenter's Branch was 0.31 fish emigrating per day for northern pike, approximately one third the productivity observed in 2011. While Delaney YOY pike production increased in 2012, both catch rates are still low relative to historic rates. Low production of northern pike from the Carpenter's and Delaney spawning marshes has continued for four consecutive years (Figure 3).

The number of out-migrating YOY northern pike from Carpenters Branch and Delaney Marsh for all years when data are available was plotted against the number of females captured entering marshes during spring spawning. Data were fitted with a power function and suggest the presence of a stock-recruitment relationship demonstrating increasing YOY production with increasing female spawner density (Figure 4).

Summer seining surveys

The YOY seining survey at eleven index sites targeting muskellunge produced 2 northern pike YOY from the 30' seine series in 88 hauls (standardized CPUE = 0.023 fish; Table 2) and 7 in the 60' seine series (standard CPUE = 0.080 fish/haul). Fourteen upper St. Lawrence River bays were sampled by seining and 13 YOY pike were captured (N=112 hauls; CPUE=0.116). Seine hauls at Delaney Bay (N=12) resulted in a catch of two YOY pike (CPUE = 0.17), neither of which were fin-clipped and indicative of Delaney spawning marsh origin.

Conclusions and Recommendations

Continued low density of adult and YOY northern pike on spawning/nursery grounds suggests that system wide water level regulation induced changes to wetland/nearshore habitats is suppressing natural reproduction. Problems with low adult stock size and skewed sex ratios continue and may confound development of strong pike year classes. Spawning marsh management is a tool to enhance YOY production, but pike runs and marsh production are declining. Relationships of low spawner density and YOY out-migrants were the impetus for transplanting fish in a 1:1 M:F ratio from French Bay to increase numbers at the Carpenter's Branch marsh in 2011; however, techniques employed failed to improve production of YOY. In 2012 no transfers occurred and strength of adult runs and YOY production was low.

Steps continue to be taken by DEC, FWS and Ducks Unlimited (DU) to restore critical spawning and nursery habitat. Steps have also been taken to improve existing water level controlled spawning marshes. The Butterfield Marsh was repaired by FWS in 2012 and spring 2013 and the fish ladder at the Carpenters Branch spawning marsh was repaired by DU in late winter 2013. It is recommended that fish handling during trap and transfer operations be limited to only collecting length, sex and condition data to reduce fish stress, or to consider allowing fish passage systems to operate without trapping and only monitor outmigration of young pike. Northern pike sex ratio imbalance as a factor in the decline needs more research focus; a College of Environmental Science and Forestry graduate student is completing an investigation of potential mechanisms of this anomaly. Stocking of marked, early life stages of pike in managed marshes and "control" sites should be considered to test for differential survival rates.

The long-term monitoring developed in this study will serve as an important indicator to assess effects of a water level regulation plan change, if adopted, and to help guide the IJC adaptive management process.

Acknowledgements

Funding for this project was provided by NYSDEC Federal Aid Grant F-61-R Study 9. Many

technicians, students and volunteers provided significant efforts to collect and maintain this field data. We are also indebted to the Thousand Islands Land Trust for their assistance in terms of personnel, equipment, and access to the Delaney Marsh. We thank NYSDEC for support of this research and for reviews conducted by Steve LaPan. This research was conducted at the Thousand Islands Biological Station.

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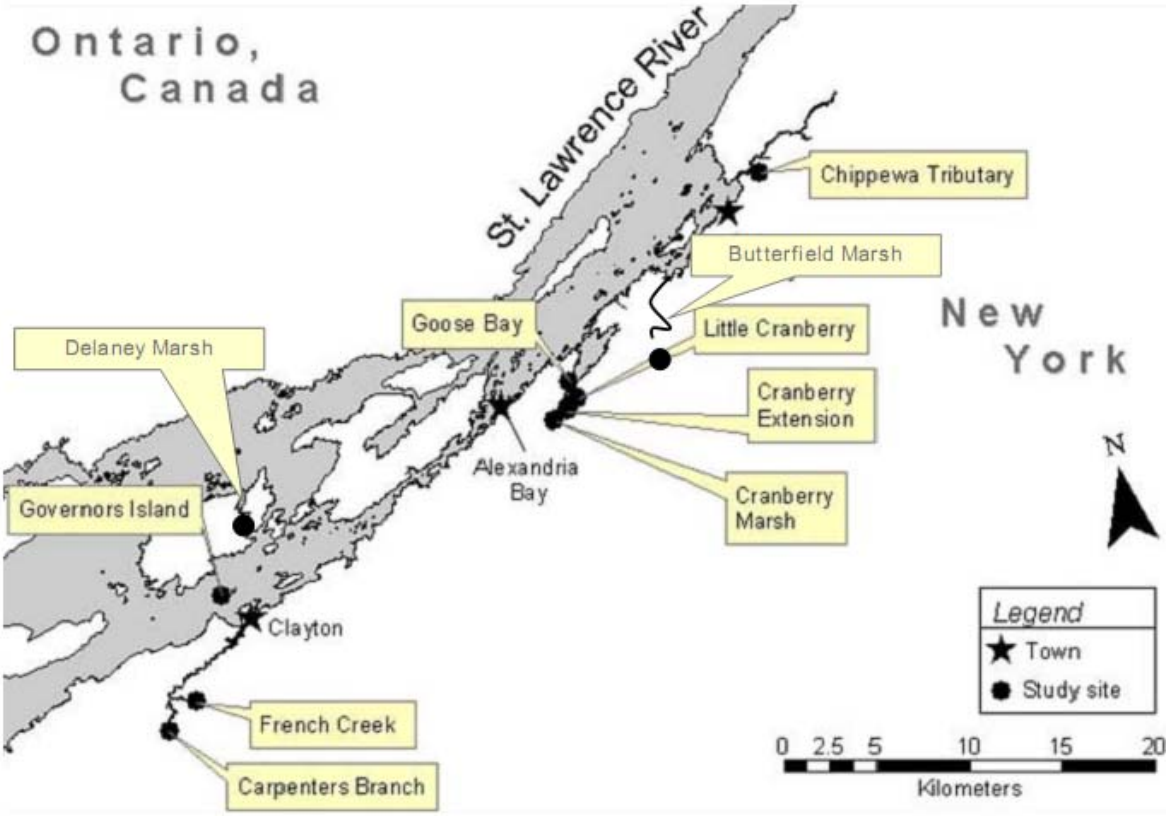

Figure 1. Study sites in the Thousand Islands Region of the upper St. Lawrence River in Clayton and Alexandria Bay, New York, including spawning marshes at Carpenters Branch (French Creek Wildlife Management Area) and Delaney Marsh (Grindstone Island) and sampling index locations at French Creek, Little Cranberry Creek, Cranberry Extension, and Chippewa (Creek) Tributary. Governors Island is the location of the Thousand Islands Biological Station. A spawning marsh at Butterfield Marsh at Crooked Creek has been repaired by the US Fish and Wildlife Service. Additional seining locations (not shown) are index YOY muskellunge monitoring sites and other regional embayments including Goose Bay.

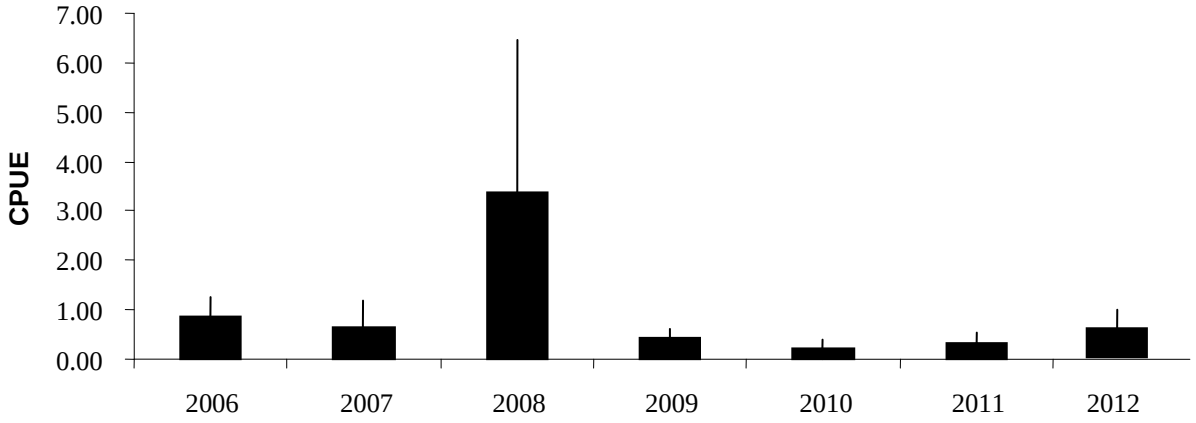

Figure 2. Average catch per net-night of northern pike in five spring spawning index trapnetting locations from 2006 to 2012 with 90% confidence limits.

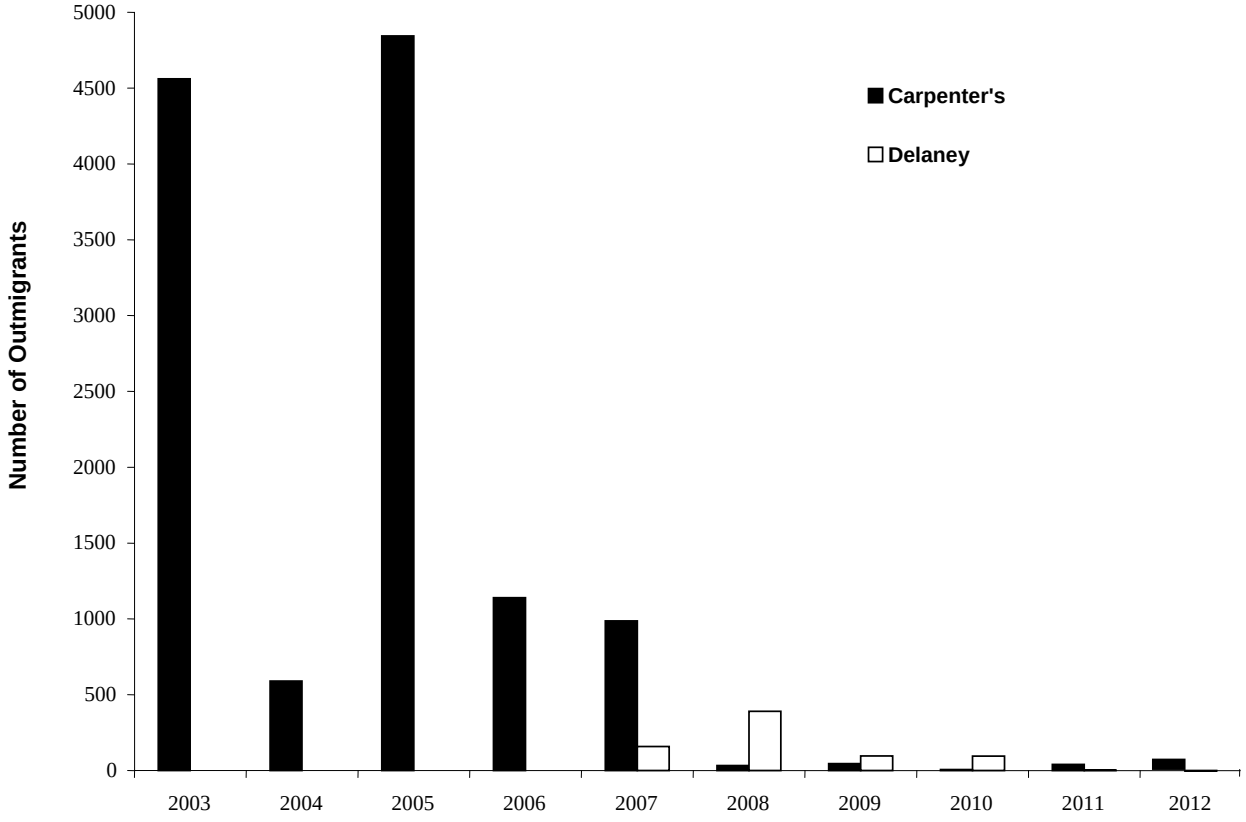

Figure 3. Number of out-migrant northern pike YOY from managed spawning marshes at Carpenter's Branch (2003 to 2012) and Delaney Marsh (2007 to 2012).

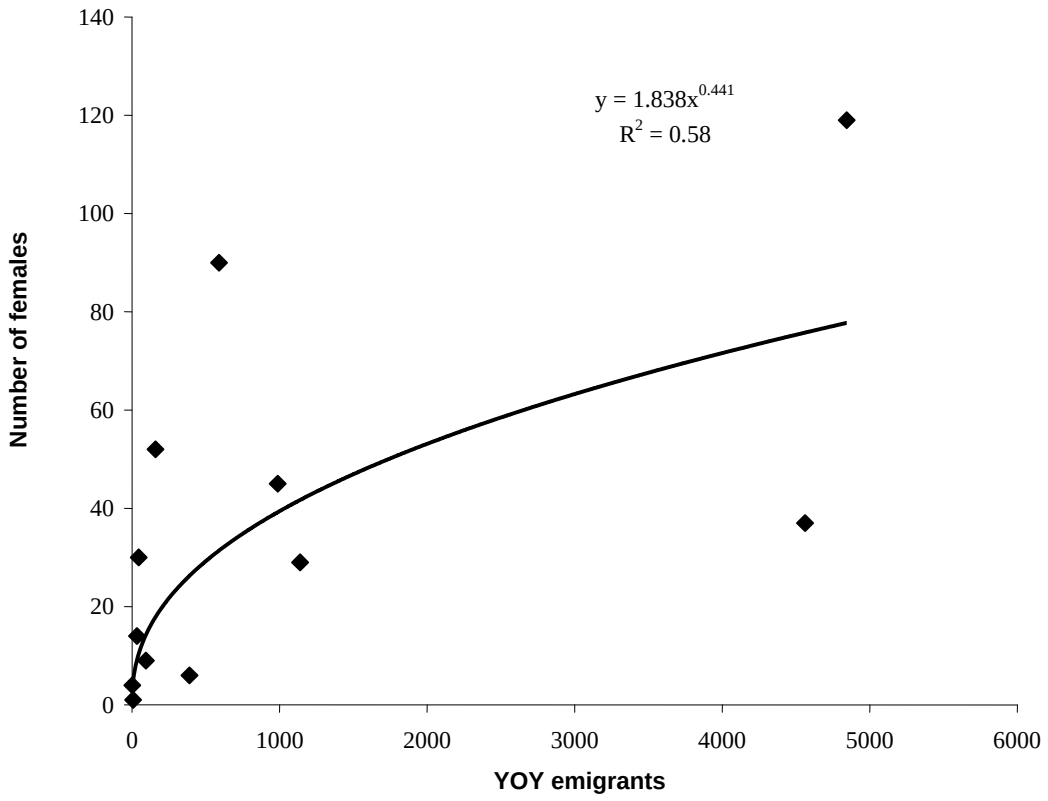

Figure 4. The number of outmigrating YOY northern pike from Carpenters Branch (2003-2012) and Delaney Marsh (2007, 2008, 2010-2011) plotted against number of females captured entering marshes during spring spawning and fitted with a power function.

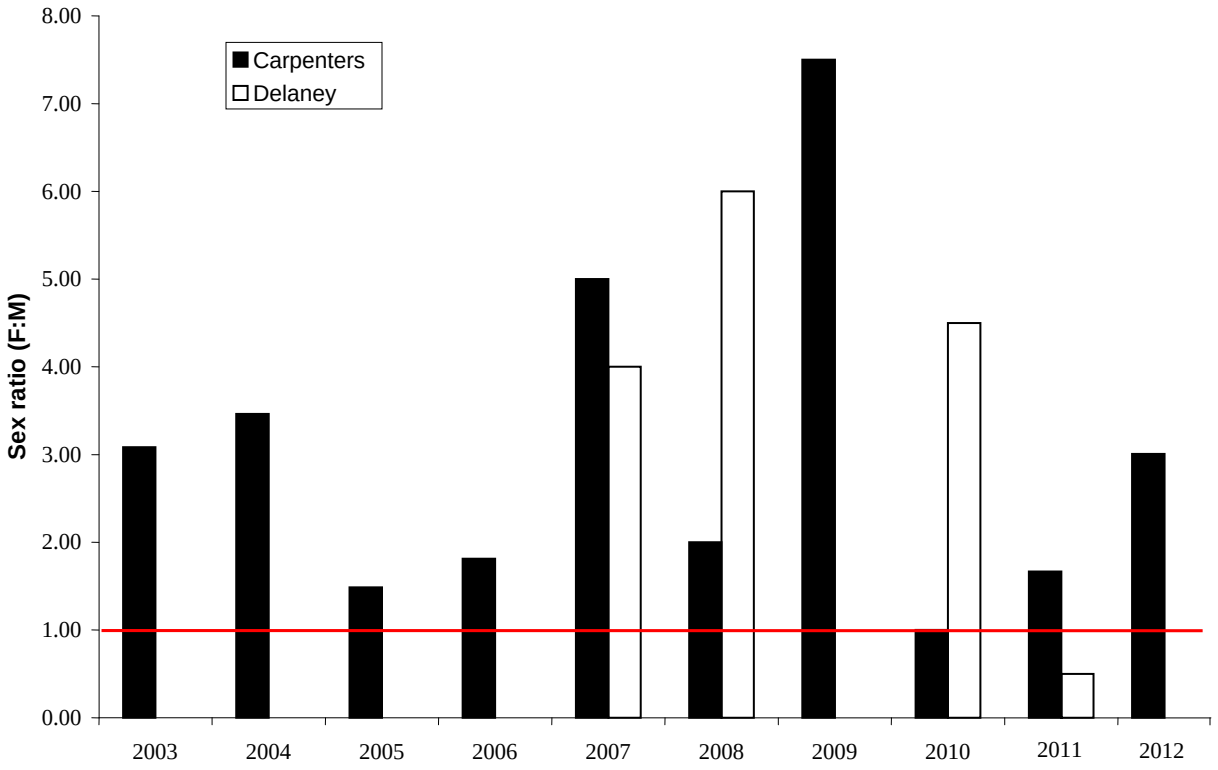

Figure 5. Adult northern pike sex ratios (female to each male) from fish captured in trapnets at Carpenters Branch (2003-2012) and Delaney Marsh (2007-2008, 2010-2011). The red line denotes a 1:1 female to male sex ratio.

Table 1. 2012 upper St. Lawrence River northern pike spawning survey effort and results by site. The only managed marsh sampled in 2012 was Carpenter's Branch.

Site	Gear	Date start	Date end	Net - Nights	NP catch	NP CPUE
		Index sites				
French Creek	Hoop	3/14	4/4	21	4	0.19
Cranberry Extension	Hoop	3/19	4/4	16	17	1.06
Little Cranberry	Hoop	3/16	4/4	19	11	0.58
Cranberry Creek	Oneida	3/17	4/4	18	9	0.50
Chippewa Tributary	Hoop	3/17	4/4	18	21	1.17
Total				92	62	0.67
		Managed marsh				
Carpenter's Branch	Hoop	3/14	4/4	21	7	0.33
		Supplemental site				
French Bay	6' Oneida	4/6	4/23	17	32	1.88
Overall				130	101	0.78

Site	Dates	NP	Net Nights	CPUE
Carpenters Branch	5/21-6/25	11	35	0.31
Delaney Marsh	5/18-6/25	62	38	1.63

Table 2. Catch of YOY northern pike in emigration traps set at spillways associated with two managed spawning marshes at Carpenters Branch of French Creek and the Delaney Marsh on Grindstone Island. Both sites are in the upper St. Lawrence River, Clayton, NY.

Bay	Hauls	Muskie	NP	CPUE Muskie	CPUE NP
30' Index Series					
Affluence Bay	6	0	0	0.00	0.00
Boscobel	6	0	0	0.00	0.00
Cobb Shoal	10	0	0	0.00	0.00
Deer Island	6	0	2	0.00	0.33
Frinks	10	0	0	0.00	0.00
Garlock	10	0	0	0.00	0.00
Lindley	6	0	0	0.00	0.00
Millens	10	0	0	0.00	0.00
Peos	8	1	0	0.13	0.00
Rose	10	0	0	0.00	0.00
Salisbury	6	0	0	0.00	0.00
Total	**88**	**1**	**2**	**0.011**	**0.023**
30’ Exploratory Series					
Grindstone Is. (A2)	6	3	0	0.50	0.00
Grindstone Is. (A3)	4	2	1	0.50	0.25
Blind Bay (Jefferson Co.)	7	0	1	0.00	0.14
Blind Bay (St. Lawrence Co.)	5	0	0	0.00	0.00
Buck Bay	2	0	0	0.00	0.00
Delaney Bay	12	0	2	0.00	0.17
Flynn Bay	16	1	2	0.06	0.13
French Bay	11	0	1	0.00	0.09
Goose Bay	10	0	1	0.00	0.10
Plum Tree Marsh	6	2	2	0.33	0.33
Point Vivian Bay	10	0	1	0.00	0.10
Swan Bay	11	0	2	0.00	0.18
Thurso Bay	6	2	0	0.33	0.00
Affluence Bay	6	1	0	0.17	0.00
Total	**112**	**11**	**13**	**0.098**	**0.116**
60’ Index Series					
Boscobel	6	0	0	0.00	0.00
Cobb Shoal	12	0	3	0.00	0.25
Deer Island	6	1	0	0.17	0.00
Frinks	10	0	0	0.00	0.00
Flynn	6	0	1	0.00	0.17
Garlock	8	1	2	0.13	0.25
Lindley	6	0	0	0.00	0.00
Millens	10	0	1	0.00	0.10
Peos	8	1	0	0.13	0.00
Rose	10	1	0	0.10	0.00
Salisbury	6	0	0	0.00	0.00
Total	**88**	**4**	**7**	**0.046**	**0.080**

Table 3. Seining catch summary for 2012 sampling using a 1/16” fine-mesh 30’ bag seine in index sites (top), exploratory sites (middle), and a ¼” large-mesh bag seine targeting esocids.

Acoustic Assessment of Pelagic Planktivores, 2012

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Alewife (*Alosa pseudoharengus*) and rainbow smelt (*Osmerus mordax*) are the most abundant pelagic planktivores in Lake Ontario, and the most important prey for salmon and trout. Alewife is also important prey for warm water predators, notably walleye, and for double-crested cormorants. Abundance of alewife and smelt has declined over the past decade, likely due to reduced nutrient loading, proliferation of non-native dreissenid mussels, and predation by stocked salmon and trout. More recently, the presence of invasive round goby (*Neogobius melanostoma*) may also be affecting the pelagic fish community.

Concerns over declining numbers of prey fish were addressed by Canadian and U.S. fish management agencies in 1993, when the number of salmonines stocked was reduced to a level that would reduce prey demand by approximately one-half. Since that time, following public consultation on both sides of the border, stocking levels were moderately increased in 1997, and again in 2001. Furthermore, increased rates of natural reproduction of Chinook salmon have been observed (Bishop et al. 2007). Thus alewife and rainbow smelt populations may be experiencing substantial predatory pressure.

Sound management decisions regarding predator-prey balance require continued monitoring of prey fish populations. Starting in 1991, hydroacoustic surveys to estimate lake-wide abundance of pelagic prey fish have been conducted jointly by the Ontario Ministry of Natural Resources (OMNR) and the New York State Department of Environmental Conservation (NYSDEC). Results from the hydroacoustic surveys complement information obtained in spring bottom trawling surveys conducted jointly by NYSDEC and the U.S. Geological Survey (USGS) in the U.S. waters of the lake.

Methods

Before 2005, surveys followed established transects with only minor yearly modifications due mostly to logistics. This was a practical approach dictated by harbor locations, running time, and limited periods of darkness in the summer. A statistically preferable, random-transect design was deemed impractical. In 2005 we modified the fixed transect design to include a random element. Five fixed cross-lake corridors approximately 15 km wide were established (Figure 1) based on logistical constraints, but within these corridors transects are selected at random. A single east-west offset is randomly chosen, determining the relative position of all transects within their respective corridors, and thus the survey is essentially a systematic survey with a random start. The randomly chosen offset in 2012 was 0, meaning that transects were offset 0 times the width of the corridors from their eastern boundaries. In addition to the 5 cross-lake transects, a U-shaped transect is surveyed each year in the eastern basin (Figure 1); however, no offset is applied to this transect.

In 2003, the Simrad EY500 120 kHz split beam echosounder was upgraded to a Biosonics DTX 120 kHz split beam, as well as new analytical software. Comparisons between the two systems suggested that the new sonar/software combination yielded lower estimates than the previous system (by as much as 30%, but generally less). The potential bias of this magnitude does not substantially alter the interpretation of the population trends, and therefore the results from the two time periods have been reported without corrections (Schaner and LaPan 2006).

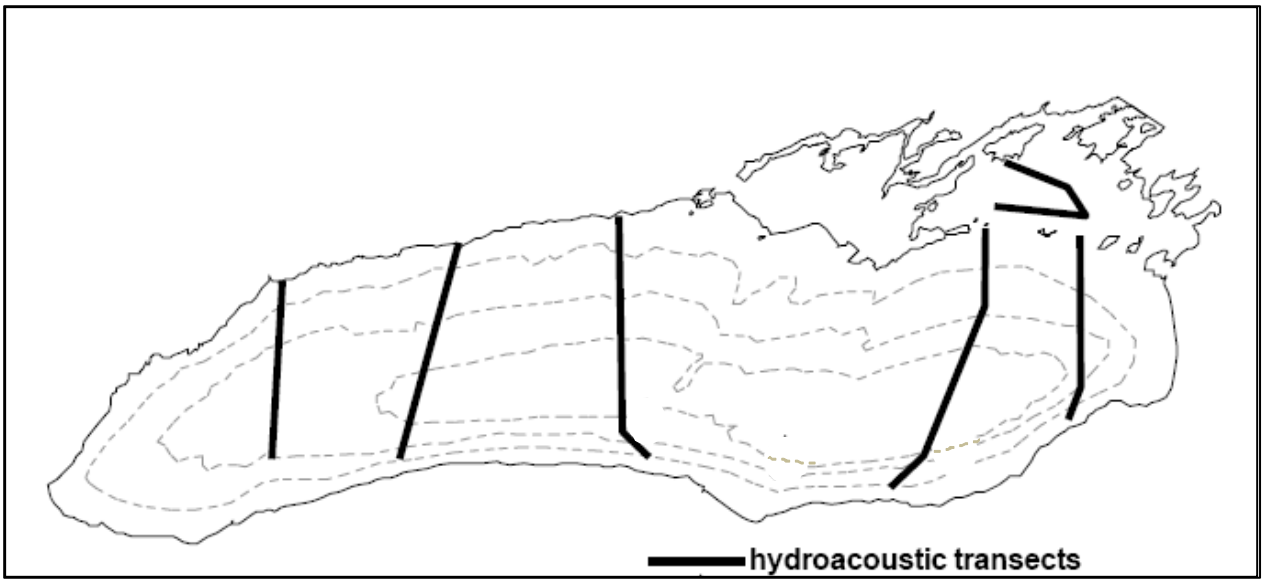

Figure 1. Transects surveyed during the 2012 hydroacoustic survey of Lake Ontario.

The 2012 survey was conducted from July 16-28 consisting of five, north-to-south, shore-to-shore transects in the main lake, and one U-shaped transect in the Kingston Basin (Figure 1). Acoustic data used to estimate population densities were collected using a Biosonics 120 kHz split-beam echosounder set at a rate of 1 ping per second and a pulse width of 0.4 milliseconds. Each night, sampling began approximately one hour after sunset at the 10 m depth contour on one end of the transect, and continued across the lake to the 10 m depth contour on the opposite end. Sampling was completed one hour before sunrise or earlier. A temperature profile was measured at several points along each transect.

Raw acoustic data were stratified based on thermal layer, bottom depth and geographical zone. The data were processed with Echoview software by Sonardata (version 4.2), using -64 dB volume backscattering strength and target strength thresholds. The resulting scaled, integrated voltage estimates of total target abundance were split into 1 dB target strength (TS) bins according to results of single-target analysis. The abundances of yearling and older fish (YAO) were apportioned from the resulting target strength histograms by fitting normal curves to the three modes of the histogram, and then calculating the proportions of each curve relative to the total target strength frequency distribution. In the upper layer (epilimnion plus metalimnion) the histograms were processed to identify the proportions of targets in the mode at or around -41.4 dB (+/- 3.8 dB), which were assumed to be YAO alewife. In the lower layer (hypolimnion), we assume all targets larger than -55 dB to be YAO smelt. Floating, vertical gill nets were used to collect fish to ground-truth the acoustic information and to estimate an average weight of fish targets.

Results and Discussion

Alewife

The 2012 alewife population estimate was 191 million YAO fish (Figure 2). This is very similar to the estimate from 2011 (3.5% greater), and about 98% of the previous 10-year average level. Using the average weight of gill net-caught fish, the biomass estimate was 5,577 MT, which is a 40% increase from the previous year; however, most of the biomass increase can be attributed to an increase in average weight of alewife.

Overall, trends generally show an alewife population fluctuating at lower levels since 2003, with a slight increase in 2012. Results from spring 2012 bottom trawl surveys also indicated an increase in both abundance and biomass of adult (age-2 and older) alewife compared to 2011 values (Walsh and Connerton 2013).

Rainbow smelt

The 2012 rainbow smelt population estimate was 63 million YAO fish (Figure 3), the lowest estimate in the history of the survey. We did not capture sufficient number of smelt during the survey to reliably determine their average weight. Using average weight data from the USGS/ NYSDEC spring 2012 bottom trawls generates a biomass

estimate of only 140 MT. It is important to note, however, that the trawl catches contained a very high proportion of early-season yearling fish, which would result in an unusually low average weight. Abundance of age-1 and older rainbow smelt in spring 2012 bottom trawl surveys increased by 47% relative to 201l, however, the weight index decreased (~25%). The increased abundance but decrease in weight was driven by a large abundance of age-1 rainbow smelt resulting from higher than average reproductive success in 2011 (Weidel and Connerton 2013).

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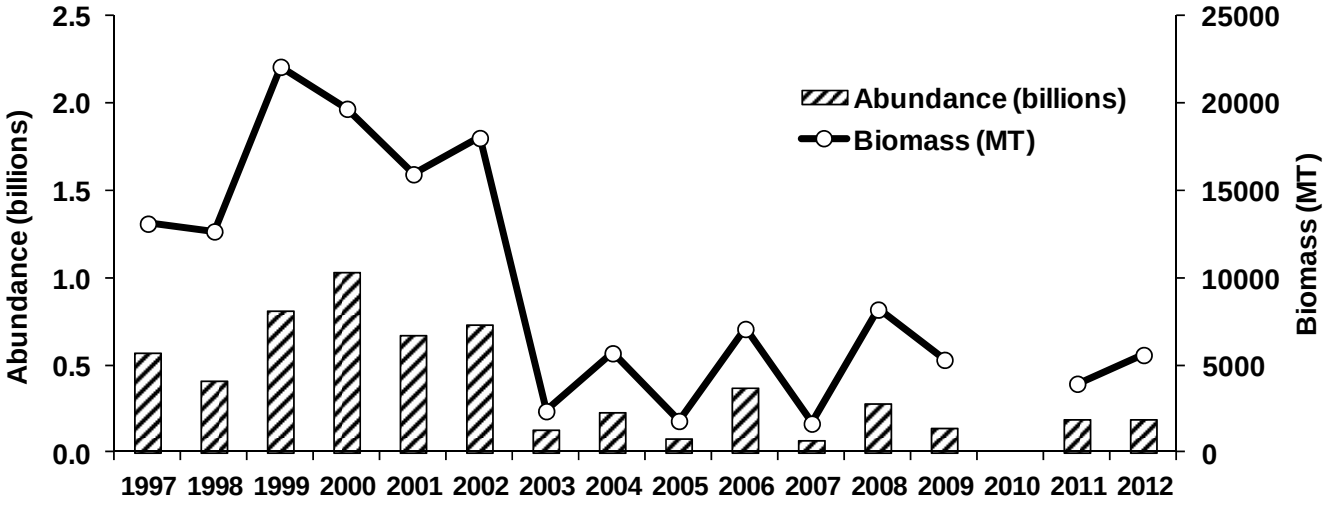

Figure 2. Abundance and biomass of yearling-and-older alewife from 1997-2012. Abundance estimates were obtained directly from hydroacoustic surveys, biomass estimates were obtained by multiplying average weights of alewife measured in midwater trawls to hydroacoustic abundance estimates. Average weights used in biomass calculations in 2002, 2004, 2005, 2008, and 2011 were based on pooled data from other sources. Average weights of alewife caught with vertical gill nets were used in 2012.

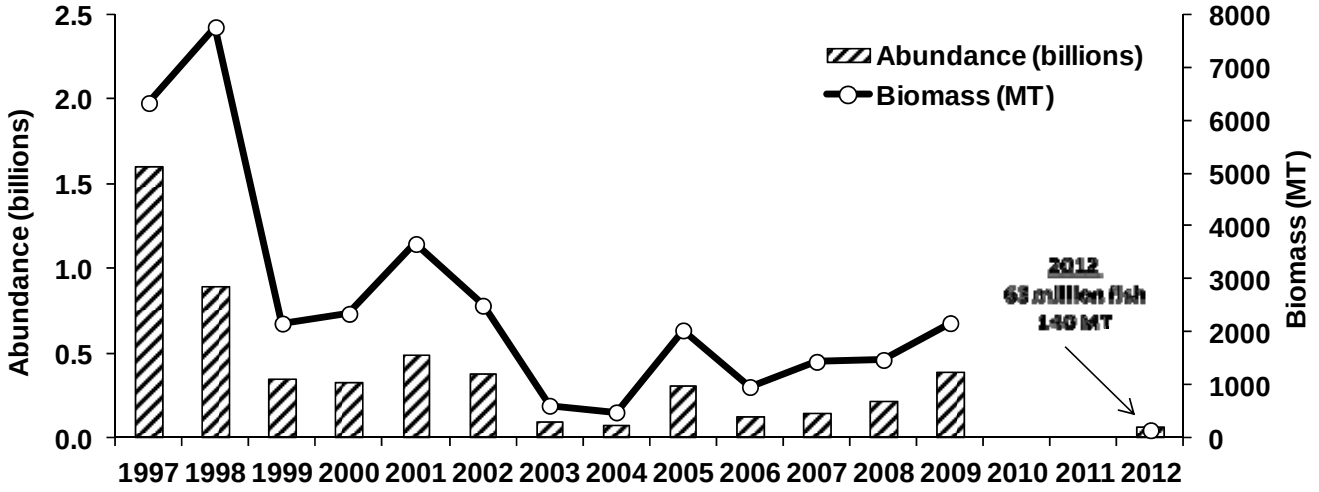

Figure 3. Abundance and biomass of yearling-and-older rainbow smelt from 1997-2012. Abundance estimates were obtained directly from hydroacoustic surveys, biomass estimates were obtained by multiplying average weights to abundance estimates. Data on average weights normally comes from midwater trawls done during hydroacoustic surveys; however other sources were used in 2002, 2004, 2005, 2008 and 2009. The 2012 average weights were obtained from spring bottom trawling surveys.

Sea Lamprey Control in Lake Ontario 2012

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Introduction

This report outlines the actions undertaken during 2012 by the U.S. Fish and Wildlife Service (Service) and Fisheries and Oceans Canada (Department) as partners of the Great Lakes Fishery Commission (Commission) to control sea lamprey (*Petromyzon marinus*) populations in Lake Ontario.

The sea lamprey is a destructive invasive species in the Great Lakes that contributed to the collapse of lake trout (*Salvelinus namaycush*) and other native species in the mid-20th century and continues to affect efforts to restore and rehabilitate the fish-community. Sea lampreys attach to large bodied fish and extract blood and body fluids. It is estimated that about half of sea lamprey attacks result in the death of their prey and an estimated 18 kg (40 lbs) of fish are killed by every sea lamprey that reaches adulthood. The Sea Lamprey Control Program (SLCP) is a critical component of fisheries management in the Great Lakes because it facilitates the rehabilitation of important fish stocks by significantly reducing sea lamprey-induced mortality.

Fish Community Objectives

As part of *A Joint Strategic Plan for Management of Great Lakes Fisheries*, the lake committees developed fish-community objectives for each of the Great Lakes. The fish-community objectives include goals of the SLCP that, if achieved, should establish and maintain self-sustaining stocks of lake trout and other salmonines by minimizing sea lamprey impacts on these stocks.

The Lake Ontario Committee established the following goal for sea lamprey control in Lake Ontario:

- *Suppression of sea lamprey populations to early-1990s levels.*

The Lake Ontario Committee recognized that continued control of sea lampreys is necessary for lake trout rehabilitation and stated a specific objective for sea lampreys:

- *Control sea lampreys so that fresh wounding rates (A1) of lake trout larger than 431 mm is less than 2 marks/100 fish.*

This objective is intended to maintain the annual lake trout survival rate of 60% or greater to support a target spawning stock of 0.5 to 1.0 million adults of multiple year classes. Along with sea lamprey control, angler and commercial exploitation will also be controlled so that annual harvest does not exceed 120,000 fish in the near term.

The target for Lake Ontario sea lamprey abundance was first calculated using the same marking statistics as the other lakes (A1-A3 marks). During 2006, the target and range were revised using A1 marks exclusively, which have been more consistently recorded on Lake Ontario. Also, the target marking rate of less than 2 A1 marks per 100 fish was explicitly identified as producing tolerable

mortality in the lake trout rehabilitation plan. The target and range of adult sea lamprey for Lake Ontario was calculated from the average abundance estimated for the 5-year period, 1993-1997, when marking rates were closest to 2 marks per 100 lake trout >431 mm (1.6 A1 marks per fish >431 mm). The calculated target adult abundance in Lake Ontario is 31,000 ± 4,000 sea lampreys.

The performance of the SLCP is annually evaluated by contrasting adult sea lamprey abundance with the lake trout marking rates against these targets. Lake-wide adult abundance is estimated by the Service and Department using a combination of mark-recapture and trapping efficiency estimates of adults in streams with traps, and regression model-predicted estimates in streams without traps. Lake trout marking rates are assessed and collected by the member agencies that comprise the lake committees and their technical committees.

During 2012, adult sea lamprey abundance in Lake Ontario was estimated to be 57,270 (95% CI; 51,290-65,314), which was greater than the fish-community objective target range. The number of A1 marks on lake trout from standardized fall assessments in 2012 has not yet been analyzed.

Lampricide Control

Tributaries harboring larval sea lampreys are treated periodically with lampricides to eliminate or reduce larval populations before they recruit to the lake as feeding juveniles. Service and Department treatment units administer and analyze TFM, or TFM/Niclosamide mixtures (TFM augmented with Bayluscide 70% wettable powder or 20% emulsifiable concentrate) during stream treatments, and apply 3.2% granular Bayluscide (GB) to control populations inhabiting lentic areas. Specialized equipment and techniques are employed to provide concentrations of lampricides that eliminate about 95% of the sea lamprey larvae while minimizing the risk to non-target organisms.

Since 2006, the control agents have employed strategies to maximize treatment efficacy, while continuing to protect non-target organisms. These strategies include: targeting lampricide concentrations at greater than minimum lethal concentrations (MLC) in all treated stream reaches; extending the duration of lampricide treatment blocks by one or two hours; conducting secondary lampricide applications to treat backwaters, springs, and small feeder streams that offer refuge to larvae from the primary treatment; and scheduling treatments during periods when favorable flow conditions are likely to exist.

Lake Ontario has 659 tributaries (405 Canada, 254 U.S.). Sixty-six tributaries (31 Canada, 35 U.S.) have historical records of larval sea lamprey production, and of these, 40 tributaries (19 Canada, 21 U.S.) have been treated with lampricides at least once during 2003-2012. Twenty-seven tributaries (13 Canada, 14 U.S.) are treated on a regular cycle. Table 1 and Figure 1 provide details on the application of lampricides to Lake Ontario tributaries and lentic areas during 2012.

- Treatments were completed in 14 tributaries (9 Canada, 5 U.S.).

- Larval assessments determined that larval sea lamprey distibution on Farewell Creek had expanded upstream for the first time since 1977. As a result, an additional 11.2 km of this tributary required treatment.

- Orwell Brook was treated for the sixth consecutive year to address residual populations in numerous beaver impoundments. Construction of a sea lamprey barrier was completed in the fall of 2012 and the stream is scheduled to be re-treated in 2013 to target residual larvae that remain upstream of the barrier.

Table 1. Details on the application of lampricides to tributaries of Lake Ontario during 2012 (letter in parentheses corresponds to location of stream in Figure 1).

Tributary	Date	Discharge (m^3/s)	TFM (kg)[1,2]	Bayluscide (kg)[1]	Distance Treated (km)
Canada					
Duffins Cr. (A)	May 30	1.3	424.2	0.1[3]	42.8
Lynde Cr. (B)	May 25	0.4	174.1	0.0	36.3
Oshawa Cr. (C)	May 26	0.6	198.3	0.1[3]	23.4
Farewell Cr. (D)	Jun 2	0.6	150.4	0.1[3]	17.5
Wilmot Cr. (E)	May 28	0.9	327.7	0.0	19.1
Port Britain Cr. (F)	Apr 30	0.2	63.8	0.0	1.4
Salem Cr. (G)	Apr 28	0.2	46.9	0.0	2.2
Proctor Cr. (H)	Apr 27	0.3	88.9	0.0	5.9
Trent R. (I)					
Mayhew Cr.	Apr 25	0.8	202.7	0.0	2.5
Total (Canada)		**5.3**	**1,677.0**	**0.3**	**151.1**
United States					
Black R. (J)	Aug 27	21.6	2,565.4	33.4	9.3
Salmon R. (K)					
Orwell Br.	Apr 26	1.7	219.4	0.0	11.2
Little Salmon R. (L)	Apr 29	4.5	351.5	0.2[3]	38.8
Catfish Cr. (M)	Apr 27	1.7	163.8	0.0	1.2
Sterling Cr. (N)	May 2	3.1	667.1	0.0	27.5
Total (United States)		**32.6**	**3,967.2**	**33.6**	**88.0**
Total for Lake		**37.9**	**5,644.2**	**33.9**	**239.1**

[1] Lampricide quantities are reported in kg of active ingredient.
[2] Includes a total of 29 TFM bars (6.0 kg active ingredient) applied in 4 streams.
[3] Includes 3.2% granular Bayluscide applied in spot treatments or to lentic areas.

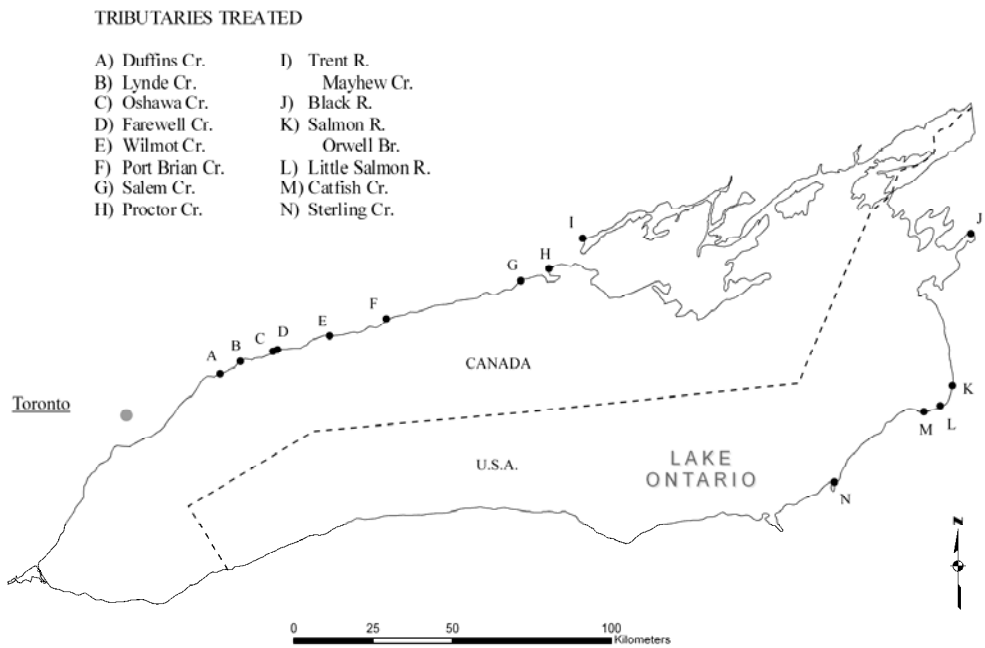

Figure 1. Locations of Lake Ontario tributaries treated with lampricides (corresponding letters in Table 1) during 2012.

Alternative Control

The Commission and its partners continue to research and develop alternatives to lampricide treatments to provide a broader spectum of tactics to control sea lampreys. During 2012, barriers were the only operational alternative control method. Alternative control methods that are currently being investigated include the use of attractants (e.g. pheromones), repellents (e.g. necromones), and new trapping designs.

Barriers

The sea lamprey barrier program priorities are:

1) Operate and maintain existing sea lamprey barriers that were built or modified by the SLCP.
2) Ensure sea lamprey migration is blocked at important non-SLCP barrier sites.
3) Construct new structures in streams where they
   a. provide control where other options are impossible, excessively expensive, or ineffective;
   b. provide a cost-effective alternative to lampricide control;
   c. improve cost-effective control in conjunction with attractant and repellent based control, trapping, and lampricide treatments; and
   d. are compatible with a system's watershed plan.

There are 16 program barriers on Lake Ontario (Figure 2). Of these, 10 were purpose-built by the Commission and 6 were built for other purposes, but have been modified by the Commission to ensure sea lampreys remain blocked.

Beginning in 2007, an intensive effort to inventory and ground truth the information contained in the National Inventory of Dams was conducted to assess the sea lamprey blocking potential of barriers located on U.S. tributaries to the Great Lakes. This information is recorded in the SLCP's Barrier Inventory and Project Selection System (BIPPS) and barrier sites are monitored on a rotating schedule. The data contained in BIPPS are used to select barrier projects, monitor the frequency of inspections and schedule upstream larval assessments. Further, the information can be used to assess the effects of barrier removal or modification requests on sea lamprey populations and identify structures that are important in controlling sea lampreys.

Barrier Inventory and Project Selection System

- No additional structures were visited on tributaries to Lake Ontario to assess sea lamprey blocking potential or add to the information in BIPPS.

Operation and Maintenance

- Routine maintenance, spring start-up, and safety inspections were performed on 11 Canadian barriers.

- Repairs or improvements were conducted on three Canadian barriers:

    - Humber River – Trap lid was replaced. Handrails around the working platform are being fabricated and will be installed in spring 2013 and removed in the summer 2013 to avoid damage from early spring flood debris and ice.

    - Graham Creek – The water intake in the trap was repaired and a Johnson screen was installed.

    - Duffin's Creek – Some of the safety signs were replaced, the water intake was repaired and a Johnson screen was installed.

Ensure Blockage to Sea Lamprey Migration

- Duffins Creek – Escapement of sea lampreys has occurred consistently since 2001 and recent telemetry work indicates that the center section of the crest is too low. There are ongoing safety concerns, with the barrier, exacerbated by its location within a public park. Relocation of the barrier is not feasible and it serves as an important assessment trap site. The Department will investigate ways to improve safety, while restoring its sea lamprey control function.

- Credit River – A Commission-sponsored PIT tagging study was conducted by the Department's Great Lakes Laboratory for Fisheries and Aquatic Sciences staff in 2010 and 2012 to identify pathways of escapement at the Kraft Dam on the Credit River in Streetsville, Ontario, a barrier that was repaired in 2004 to block sea lampreys. Sea lamprey escapement was recorded over the crest of the dam and through the fishway, which is operated by the Credit River Anglers Association during the steelhead migration. Two recommendations were made to control sea lamprey escapement: 1) re-install the missing overhanging plate on the crest; and 2) modify operations at the fishway to prevent sea lamprey escapement Replacement of a coarse mesh screen with a finer-mesh screen in the fishway is also recommended. Consultation with Kraft Canada, who owns the dam, the Ontario Ministry of Natural Resources (Ministry), and the Credit River Anglers Association is planned for 2013.

New Construction

- Orwell Brook – This project represented a collaboration between the Commission, New York Department of Environmental Conservation (NYDEC), Service and Department and was undertaken to eliminate the requirement for annual treatments, which have been conducted since 2007 to control residual larvae. All construction including the barrier, adult sea lamprey trap, access road, gate and fencing was completed during 2012. The barrier's stop logs will be removed outside the period of sea lamprey migration to facilitate the

passage of non-target migratory species. The trap will be monitored by Service personnel during 2013, and at least one additional lampricide treatment will be necessary to eliminate residual larvae upstream of the barrier. It is anticipated that future treatments will be conducted downstream of the barrier on a 3-year cycle.

Assessment of Candidate Streams

- No assessments were conducted.

Assessment

The SLCP has three assessment components that target the larval, juvenile and adult sea lamprey life stages. Terminology for life stages in this report have been standardized from previous years. *Out-migrating juveniles* replaced metamorphosing-phase and transformers, *feeding juvenile*s replaced parasitic-phase, and *adults* replaced spawning-phase. Assessment of the different life stages are described here:

1. The larval component assesses the relative abundance and distribution of larval sea lampreys in streams and lentic areas. These data are used to predict the streams and lentic areas most likely to contain larvae greater than 100 mm total length at the end of the growing season during the year of sampling. These predictions are used to establish the priorities for the lampricide treatment program the following year.

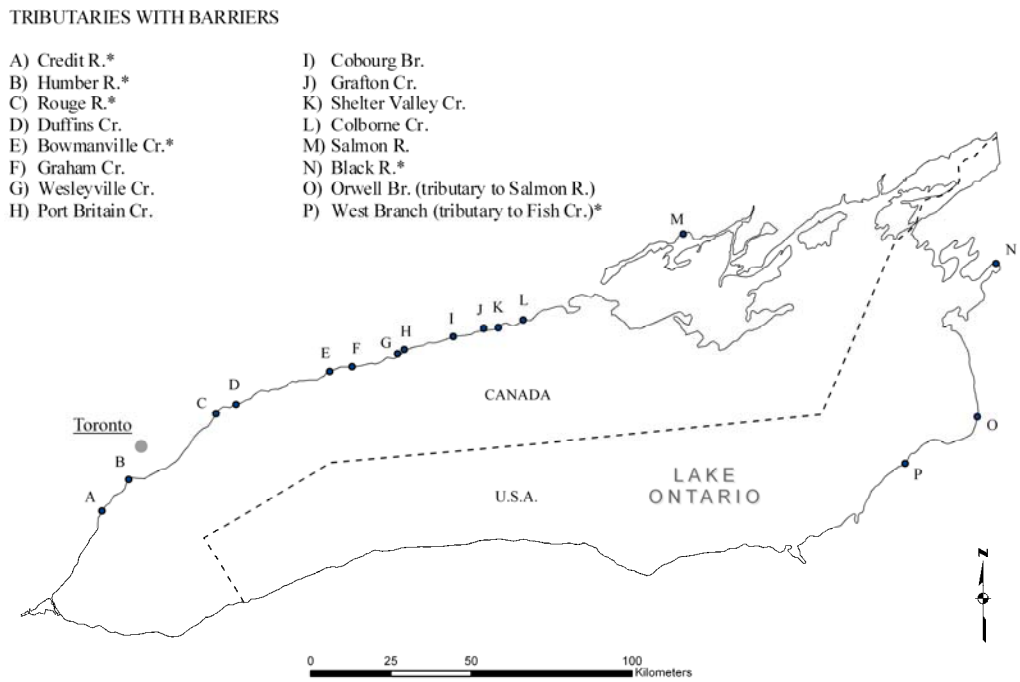

Figure 2. Locations of Lake Ontario tributaries with sea lamprey barriers. Structures that have been modified to prevent the upstream migration of sea lampreys are indicated by an asterisk (*).

2. The juvenile component annually assesses the rates of lake trout marking inflicted by sea lamprey in each of the lakes. Time series data are used to assess the effectiveness of the SLCP for each lake. In addition, several indices of relative abundance of feeding juveniles are used to monitor sea lamprey populations over time.

3. The adult component annually assesses the stock size of adult lampreys in each lake. Because this life stage is comprised of individuals that have evaded or were not exposed to control efforts, the time series of adult abundance is used to evaluate the effectiveness of the SLCP.

Larval Assessment

Tributaries considered for lampricide treatment during 2013 were assessed during 2012 to estimate the density and size structure of larval sea lamprey populations. Assessments were conducted with backpack electrofishers in waters <0.8 m deep. Waters ≥0.8 m in depth were surveyed with GB or deepwater electrofishers. Survey sites were randomly selected in each tributary, larval sea lamprey catches were adjusted for gear efficiency, and lamprey lengths were forecast to the estimated end of the growing season. The number of large larval sea lampreys in each infested area was estimated by multiplying the mean density of larvae ≥100 mm (number per m^2) by an estimated area of suitable habitat (m^2). Infested areas were ranked for treatment during 2013 based on a cost per kill of larval sea lampreys ≥100 mm, as estimated using this index of abundance and average treatment costs. Additional surveys are used to define the distribution of sea lampreys within a stream, detect new populations, evaluate lampricide treatments, and to establish the sites for lampricide application. Lentic areas <2.0 ha are monitored for relative abundance and spatial distribution of larvae.

- Larval assessments were conducted on a total of 49 tributaries (24 Canada, 25 U.S.). The status of larval sea lampreys in historically infested Lake Ontario tributaries and lentic areas is presented in Tables 2 and 3.

- Surveys to estimate abundance of larval sea lampreys were conducted in nine tributaries (four Canada, five U.S.).

- Surveys to detect the presence of new larval sea lamprey populations were conducted in six Canadian tributaries. No new populations were detected.

- Post-treatment assessments were conducted in 12 tributaries (9 Canada, 3 U.S.) to determine the effectiveness of lampricide treatments conducted during 2011 and 2012.

Surveys to evaluate barrier effectiveness were conducted in nine tributaries (six Canada, three U.S.).

Juvenile Assessment

The juvenile life stage is assessed through the interpretation of marking rates by feeding juvenile sea lampreys on lake trout. Used in conjunction with adult sea lamprey abundance to annually evaluate the performance of the SLCP, marking rates on lake trout are contrasted against the targets set for each lake. The target lake trout marking rate in Lake Michigan is 5 A1-A3 marks per 100 lake trout. Marking rates on lake trout are estimated from assessment operations conducted by state, provincial, tribal and federal fishery management agencies associated with each lake, and are updated when the data becomes available. These data provide an indication of juvenile sea lamprey abundance which is not assessed basin-wide.

Recently, the Commission began a process to create an updated lake trout marking database that incorporates the most recent data and regenerates the lake-wide marking rate graphs. The most recent results of these efforts are presented in Figure 3 and were calculated from unweighted data for the whole lake (average number of marks calculated from all lake trout captured of a specific length class). Previous marking rate graphs may not have incorporated all available data and may have been generated using analyses that weighted the data to better allow for inter-lake comparison of marking rates. Therefore, the most recent graphs presented here may differ from those presented in previous

reports. Discussions are still ongoing on whether or not to use weighted or unweighted methods to analyze the data.

- Lake trout marking data for Lake Ontario are provided by the U.S. Geological Survey, the Ministry, and the NYDEC, and analyzed by the Service's Green Bay, Wisconsin, Fish and Wildlife Conservation Office.

- The number of A1 marks per 100 lake trout >431 mm from standardized fall assessments for 2012 has not yet been analyzed

- Based on standardized fall assessment data, the marking rate during 2011 was 1 A1 mark per 100 lake trout >431 mm. The marking rate is less than the target and has been for the previous four years (Figure 3).

Table 2. Status of larval sea lampreys in Lake Ontario tributaries with a history of sea lamprey production and estimates of abundance from tributaries surveyed during 2012.

Tributary	Last Treated	Last Surveyed	Status of Larval Lamprey Population (surveys since last treatment) Residuals Present	Recruitment Evident	Estimate of Overall Larval Population	Abundance Estimate of Larvae >100mm	Expected Year of Next Treatment
Canada							
Niagara R.	Never	Jul-10	---	Yes	---	---	Unknown
Ancaster Cr.	May-03	Sep-11	No	No	---	---	Unknown
Grindstone Cr.	Never	Sep-11	No	No	---	---	Unknown
Bronte Cr.	Apr-10	Jul-12	No	Yes	---	---	***2013***[1]
Sixteen Mile Cr.	Jun-82	Sep-11	No	No	---	---	Unknown
Credit R.	Jul-11	Jul-12	Yes	No	16,957	3,374	2015
Humber R.	Never	Jul-12	---	No	---	---	Unknown
Rouge R.	Jun-11	Jul-11	No	No	---	---	2014
Petticoat Cr.	Sep-04	Jul-11	No	No	---	---	Unknown
Duffins Cr.	May-12	Aug-12	No	Yes	---	---	2015
Carruthers Cr.	Sep-76	Apr-09	No	No	---	---	Unknown
Lynde Cr.	May-12	Aug-12	No	Yes	---	---	2015
Oshawa Cr.	May-12	Aug-12	No	Yes	---	---	2015
Farewell Cr.	Jun-12	Aug-12	No	No	---	---	2015
Bowmanville Cr.	May-11	Aug-12	No	Yes	4,478	488	2014
Wilmot Cr.	May-12	Aug-12	No	Yes	---	---	2015
Graham Cr.	May-96	May-10	No	No	---	---	Unknown
Wesleyville Cr.	Oct-02	Aug-12	No	No	---	---	Unknown
Port Britain Cr.	Apr-12	Aug-12	No	No	---	---	2015
Gage Cr.	May-71	Aug-09	No	No	---	---	Unknown
Cobourg Br.	Oct-96	Aug-11	No	Yes	---	---	Unknown
Covert Cr.	Jul-10	Aug-12	No	Yes	46,919	1,166	***2013***
Grafton Cr.	Oct-07	Aug-11	No	Yes	---	---	Unknown
Shelter Valley Cr.	Sep-03	Aug-11	No	No	---	---	Unknown
Colborne Cr.	May-09	Aug-11	No	No	---	---	Unknown
Salem Cr.	Apr-12	Aug-12	No	Yes	---	---	2015
Proctor Cr.	Apr-12	Aug-12	No	Yes	---	---	2015
Smithfield Cr.	Sep-86	Jun-12	No	No	---	---	Unknown
Trent R. (Canal System)	Sep-11	Jun-12	No	No	---	---	Unknown

Tributary	Last Treated	Last Surveyed	Status of Larval Lamprey Population (surveys since last treatment) Residuals Present	Recruitment Evident	Estimate of Overall Larval Population	Abundance Estimate of Larvae >100mm	Expected Year of Next Treatment
Mayhew Cr.	Apr-12	Jun-12	No	---	---	---	2015
Moira R.	Jun-11	Jun-12	Yes	Yes	---	---	Unknown
Salmon R.	Jun-00	Jun-12	No	Yes	1,170	234	Unknown
Napanee R.	Never	May-11	---	No	---	---	Unknown
United States							
Black R.	Aug-12	May-11	No	Yes	---	---	2016
Stony Cr.	Sep-82	May-11	No	No	---	---	Unknown
Sandy Cr.	Never	Apr-12	---	No	---	---	Unknown
South Sandy Cr.	May-11	Aug-12	No	Yes	292,201	4,917	***2013***
Skinner Cr.	Apr-05	Jul-11	No	No	---	---	Unknown
Lindsey Cr.	May-11	Aug-12	Yes	Yes	38,435	8,219	***2013***
Blind Cr.	May-76	Jul-10	No	No	---	---	Unknown
Little Sandy Cr.	Jun-10	Aug-12	No	Yes	---	---	***2013***[1]
Deer Cr.	Apr-04	Apr-12	No	No	---	---	Unknown
Salmon R.	May-11	Aug-12	Yes	Yes	334,833	1,290	2014
Orwell Brook	Apr-12	Jul-12	Yes	Yes	---	---	***2013***[1]
Trout Brook	Apr-10	Apr-12	Yes	Yes	75,618	13,497	***2013***
Grindstone Cr.	Apr-10	Aug-12	Yes	Yes	---	---	***2013***[1]
Snake Cr.	May-11	Aug-12	No	No	---	---	2015
Sage Cr.	May-78	Apr-10	No	No	---	---	Unknown
Little Salmon R.	Apr-12	Jul-12	Yes	---	---	---	2015
Butterfly Cr.	May-72	Apr-12	No	No	---	---	Unknown
Catfish Cr.	Apr-12	Jul-11	---	---	---	---	2015
Oswego R.							
Black Cr.	May-81	Jun-11	No	No	---	---	Unknown
Big Bay Cr.	Sep-93	Apr-12	No	No	---	---	Unknown
Scriba Cr.	Jun-10	Apr-12	No	No	---	---	Unknown
Fish Cr.	Jun-10	Jul-12	No	Yes	---	---	***2013***[1]
Carpenter Br.	May-94	Apr-12	No	No	---	---	Unknown
Putnam Br./ Coldsprings Cr.	May-96	Oct-10	No	No	---	---	Unknown
Hall Br.	Never	Oct-10	---	No	---	---	Unknown
Crane Br.	Never	Apr-12	---	No	---	---	Unknown
Skaneateles Cr.	Never	Oct-10	---	No	---	---	Unknown
Rice Cr.	May-72	Apr-10	No	No	---	---	Unknown
Eight Mile Cr.	Apr-07	Apr-12	No	No	---	---	Unknown
Nine Mile Cr.	May-11	Jul-11	No	No	---	---	2014
Sterling Cr.	May-12	Aug-12	No	No	---	---	2015
Blind Sodus Cr.	May-78	Apr-09	No	No	---	---	Unknown
Red Cr.	Apr-10	Aug-12	No	No	---	---	2015
Wolcott Cr.	May-79	Apr-11	No	No	---	---	Unknown
Sodus Cr.	May-10	Aug-12	No	Yes	1,145	191	2014
Forest Lawn Cr.	Never	Jul-11	---	Yes	---	---	Unknown
Irondequoit Cr.	Never	Aug-12	---	No	---	---	Unknown

Tributary	Last Treated	Last Surveyed	Status of Larval Lamprey Population (surveys since last treatment) Residuals Present	Recruitment Evident	Estimate of Overall Larval Population	Abundance Estimate of Larvae >100mm	Expected Year of Next Treatment
Larkin Cr.	Never	Aug-12	---	No	---	---	Unknown
Northrup Cr.	Never	Aug-12	---	No	---	---	Unknown
Salmon Cr.	Apr-05	Aug-12	No	Yes	---	---	Unknown
Sandy Cr.	Apr-09	Jul-11	No	Yes	---	---	Unknown
Oak Orchard Cr. Marsh Cr.	May-08	Aug-12	No	Yes	899	245	Unknown
Johnson Cr.	Apr-10	Jul-11	No	No	---	---	Unknown
Third Cr.	May-72	Oct-11	No	No	---	---	Unknown
First Cr.	May-95	Apr-11	No	No	---	---	Unknown

[1]Stream is being treated based on expert knowledge.

Table 3. Status of larval sea lampreys in historically infested lentic areas of Lake Ontario during 2012.

Tributary	Lentic Area	Last Surveyed	Last Survey Showing Infestation	Last Treated
Canada				
Duffins Cr.	Duffins Cr. - lentic	Aug-12	Aug-12	Never[1]
Oshawa Cr.	Oshawa Cr. - lentic	Oct–81	Oct–81	Never
Wilmot Cr.	Wilmot Cr. - lentic	Aug-11	Aug-11	Never[1]
United States				
Black R.	Black River Bay	Oct-10	Jul-10	Never[1]

[1] Low-density larval population monitored with 3.2% granular Bayluscide surveys.

Adult Assessment

The long-term effectiveness of the SLCP has been measured by the annual estimation of the lake-wide populations of adult sea lampreys. Traps and nets are operated to capture migrating adult sea lampreys during the spring and early summer. Abundance is estimated using a combination of mark-recapture and trapping efficiency estimates of adults in streams with traps, and regression model-predicted estimates in streams without traps.

- A total of 7,835 sea lampreys were trapped at 11 sites on 10 tributaries (Table 4, Figure 4).

- The estimated population of adult sea lampreys was 57,270 (95% CI; 51,290-65,314) and was greater than the fish-community objective target range of 31,000 ± 4,000 (Figure 5).

- The Humber River and Duffins Creek traps were jointly operated through a partnership with the Toronto and Region Conservation Authority, the Cobourg Brook fishway and trap through a partnership with the Ganaraska River Conservation Authority, and the Salmon River trap through a partnership with the Mohawks of the Bay of Quinte.

- A three-year field-scale management experiment using the mating pheromone to enhance trap captures was completed in 19 Great Lakes tributaries, including the Humber River, Duffins, Bowmanville, and Graham creeks, and Cobourg Brook in Lake Ontario. Results of this research are currently being analyzed.

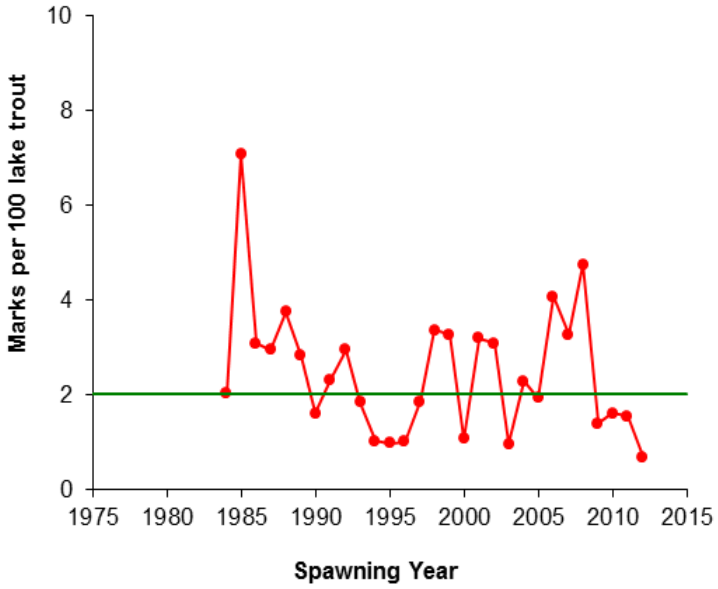

Figure 3. Number of A1 marks per 100 lake trout >431 mm from standardized fall assessments plotted on sea lamprey spawning year (marking recorded in the fall is inflicted by the cohort of sea lampreys that spawns the next spring). Horizontal line represents the fish-community objective target of 2 A1marks per 100 fish.

Table 4. Stream name, number caught, adult sea lamprey estimate, trap efficiency, number sampled, percent males, and biological characteristics of adult sea lampreys captured in assessment traps or nets in tributaries of Lake Ontario during 2012 (letter in parentheses corresponds to location of stream in Figure 4).

Tributary	Number Caught	Adult Estimate	Trap Efficiency	Number Sampled[1]	Percent Males[2]	Mean Length (mm) Males	Mean Length (mm) Females	Mean Weight (g) Males	Mean Weight (g) Females
Canada									
Humber R. (A)	3,118	5,312	59	3,118	52	477	476	258	253
Duffins Cr. (B)	1,763	3,831	46	1,763	53	503	488	269	263
Bowmanville Cr. (C)	177	450	39	60	50	495	487	273	267
Graham Cr. (D)	140	399	35	43	44	500	495	260	260
Cobourg Cr. (E)	332	715	46	60	47	482	485	245	291
Salmon R. (F)	1	---	---	---	---	---	---	---	---
Total or Mean (Canada)	**5,531**	---	---	**5,044**	**52**	**487**	**481**	**262**	**257**
United States									
Black R. (G)	2,228	14,529	15	109	60	491	512	242	278
Grindstone Cr. (H)	160	---	---	1	100	528	---	289	---
Little Salmon R. (I)	36	---	---	---	---	---	---	---	---
Sterling Cr. (J)	36	---	---	---	---	---	---	---	---
Sterling Valley Cr.	5	---	---	---	---	---	---	---	---
Total or Mean (U.S.)	**2,465**	**---**	**---**	**110**	**60**	**491**	**512**	**242**	**278**
Total or Mean (for lake)	**7,996**	---	---	**5,154**	**52**	**487**	**482**	**261**	**258**

[1] The number of sea lampreys used to determine percent males, mean length, and mean weight.
[2] Gender was determined by using external characteristics.

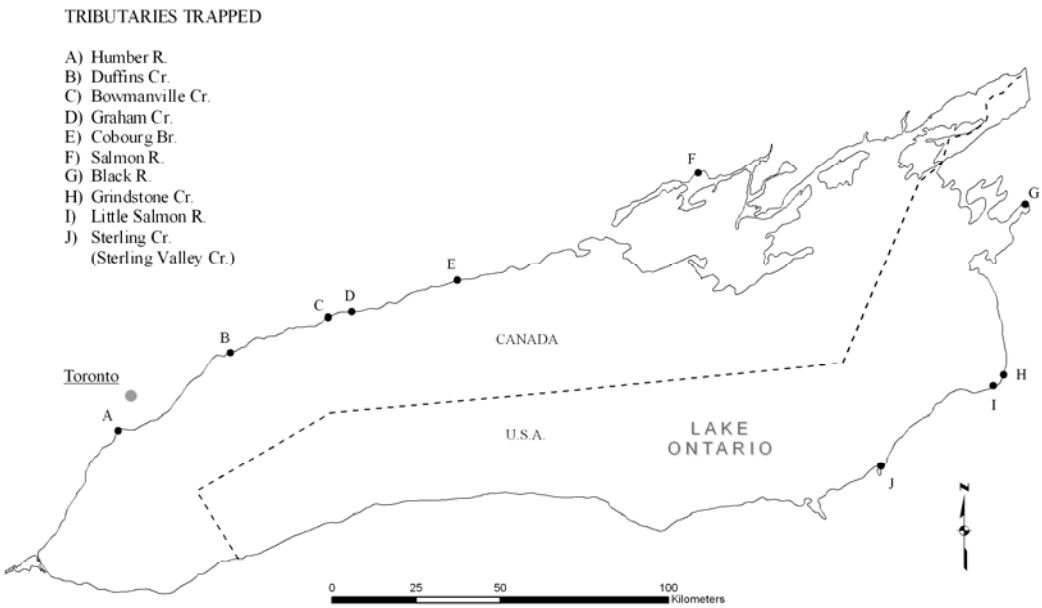

Figure 4. Locations of Lake Ontario tributaries where assessment traps were operated corresponding letters in Table 4) during 2012.

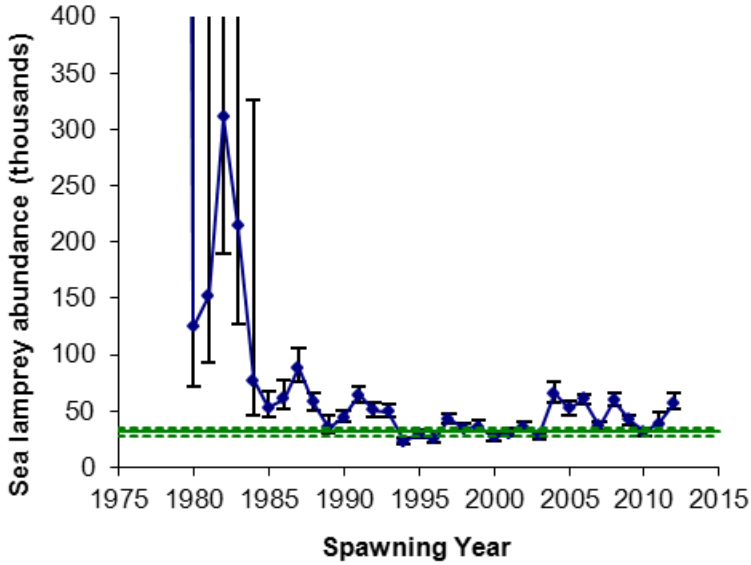

Figure 5. Annual lake-wide population estimates of adult sea lampreys in Lake Ontario, 1980 – 2012 with 95% confidence intervals (vertical error bars). Target level is indicated by the solid horizontal line with 95% confidence intervals (dashed horizontal lines).

Population Assessment of Lake Sturgeon in the Lower Niagara River

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Prior to European settlement, lake sturgeon (*Acipenser fulvescens*) was a dominant species of large rivers and nearshore areas throughout the Great Lakes. Due to a variety of issues including overfishing and degradation of spawning habitat, the species has been greatly reduced compared to historic levels (Carlson 1995). The lower Niagara River is home to one of the remaining remnant populations of lake sturgeon in Lake Ontario, where they are officially listed as "threatened" in New York State and the Province of Ontario. Ecologically, an abundance of lake sturgeon is indicative of a healthy ecosystem. Many of the Great Lakes states and provinces have or are developing lake sturgeon management plans promoting inventory, protection, stocking and habitat restoration for this species.

Assessing lake sturgeon population status is labor-intensive, and requires comprehensive datasets including information on all life stages. A population assessment of lake sturgeon in the lower Niagara River conducted from 1998 to 2003 indicated that the population may be recovering, but due in part to a lack of continued monitoring, their current status is not well known. In order to effectively understand, manage and guide restoration efforts for this population, this study seeks to estimate population parameters including abundance, age structure, growth, reproductive age structure/sex ratios, and movement patterns.

Methods

Collection

Lake sturgeon were captured in the lower Niagara River between June and September of 2010, and between March and September of 2011 and 2012. Sampling was performed across presumed foraging, staging, and spawning areas in the lower Niagara River and Niagara Bar in Lake Ontario using 80-m setlines, set on the bottom between 7 and 12 m depth, with baited 12/0 circle hooks following methods of Thomas and Haas (1999) and Hughes et al. (2005). Rainbow smelt (*Osmerus mordax*), emerald shiners (*Notropis atherinoides*), round goby (*Neogobius melanostomus*) and alewife (*Alosa pseudoharengus*) were the primary baits used, though common shiners (*Luxilis cornutus*), golden shiners (*Notemigonus crysoleucas*), white suckers (*Catostomus commersoni*), and crayfish (Cambaridae) were used infrequently. Locations of setlines were based on those selected during 1998-2003 and effort was systematically distributed across the lower Niagara River from the Niagara Bar (Lake Ontario) to Lewiston, NY/Queenston, ON.

Measurement, tissue collection, and tagging

Each captured fish was marked with a passive integrated transponder (PIT) tag under the third dorsal scute (12.5 mm, 134.2 kHz, full duplex, Biomark) and an external T-bar tag (2010-2011) or cinch tag (2011-2012) at the base of the dorsal fin. Upon capture, total length, fork length, weight, girth, and any injuries, lamprey wounds or deformities were recorded for all lake sturgeon. Length and

girth were measured to the nearest millimeter, and weight to the nearest 0.5 kilogram. A fin ray sample from the caudal fin was taken for genetic analysis and a section of the leading fin ray was removed from the left pectoral fin for age estimation. Upon recapture, a section of the right pectoral fin ray was taken for comparison.

A subset of 30 lake sturgeon was tagged with internal, trailing-whip, very high frequency (VHF) radio transmitter tags (150 - 152 MHz, 27 g, F1850B, ATS, Isanti, MN). Each fish was placed under anesthesia using a buffered MS-222 solution of 200 mg/L for 5 minutes, and then switched to a maintenance dose of 87 mg/L. Tags and surgical tools were sterilized in a 2% Chlorohexadine bath solution overnight. Tags were then rinsed with de-ionized (DI) water prior to insertion, and surgical tools were boiled in DI water for at least 10 minutes. Surgical tools were then cooled and dried before use. The incision site was carefully dabbed using sterile gauze and 2% Chlorohexadine solution followed by DI water rinse. Transmitters were implanted through a 5 cm incision to the left side of the ventral mid-line between the third and fifth scute anterior to the pelvic girdle. The anterior ends of radio tags were affixed to the inside of the body wall using a single suture to minimize tag migration and risk of expulsion. Incisions were closed with 3-4 sutures of PDS II absorbable monofilament with a CT-0 or CT-1 needle. Fish were held in a nearshore net pen and released on-site after equilibrium was restored (approx. 15-30 minutes). We collected 0.5 cm^3 gonadal biopsies from 39 lake sturgeon for histological sex and maturation stage determination. To minimize the number of surgeries and to confirm sex and stage of radio-tagged fish, biopsy samples were taken from radio-tagged fish during tag implantation. For the remaining 9 biopsies, gonad tissue samples were retrieved though a 1.5 cm incision. Anesthesia, incision site, suturing, and recovery methods were identical to those for radio-tag implant surgeries.

Age estimation

Cross-sections were cut from the proximal end of pectoral fin ray samples (4-6 sections, 0.1 – 0.3 mm width) using a low-speed saw (TechCut 4, Allied High Tech Products, Inc.) and mounted on microscope slides for processing. Spine sections were photoarchived using a Jenoptik ProgRes CT3 CMOS Digital Microscope Camera mounted on a Zeiss compound microscope under 0.63x magnification. Ages were assigned by Greg Jacobs at the USFWS Northeast Fishery Center, and a subset of 50 age estimates were independently aged by an outside reader experienced in aging lake sturgeon (Ed Baker, Michigan DNR, Marquette, MI) to test for systematic bias. Of these fish, 51 % of estimated ages were identical, 84 % of ages were within 1 year, and 92% of ages were within 2 years. We found no trend in aging error between the two readers' age estimates.

Sex and stage monitoring

In 2012, we implemented minimally-invasive methods for sex and maturity determination based on blood plasma concentration of sex steroids, validated using gonadal tissue processed histologically (Allen et al. 2009, Webb et al. 2002, Webb and Doroshov 2010). During April and May of 2012, when water temperatures were between 4 °C and 11 °C, a 6 ml blood sample was taken from the caudal vasculature of each fish using a heparinized vacutainer. Blood samples were centrifuged at 3,400 rpm for 5 minutes, and blood plasma was separated and stored at -20 °C until analysis. The steroids testosterone (T) and estradiol-17ß (E2) were extracted from plasma following the method of Fitzpatrick et al. (1987) and plasma concentrations of T and E2 were measured by RIA as described in Fitzpatrick et al. (1986) as modified by Feist et al. (1990). All samples were analyzed in duplicate. A slightly more concentrated charcoal solution (6.25 g charcoal and 4.0 g dextran/L PBSG) was used for all assays to reduce non-specific binding. The intra- and inter-assay coefficients of variation for all assays were less than 5 and 10%, respectively. Steroid levels were validated by verifying that serial dilutions were parallel to standard curves.

Gonad biopsies, paired with blood samples, were used to determine population specific relationships between sex steroid concentration and sex and stage of maturity in lake sturgeon in the lower Niagara River. Gonadal tissue was processed histologically by embedding in paraffin, sectioning at 5 µm, and staining by Periodic Acid Schiff stain (PAS; Luna 1968). Slides were examined under a compound microscope (10-100x, Leica DM2000), and the germ cells were scored for stage of maturation (Table 1)

according to the modified protocol of Webb and Erickson (2007).

Radio-telemetry

Lake sturgeon tagged with radio transmitting tags were released in the lower Niagara River between April 15, 2012 and May 7, 2012. Eight ATS R4500 data logging radio-telemetry receivers with paired 2 m Yagi antennas (fixed stations, hereafter) were deployed along the lower Niagara River from the U.S. Coast Guard station at the mouth of the Niagara River in Youngstown, NY, to just downstream of the Whirlpool in Whirlpool State Park, Niagara Falls, NY (Figure 1). Fixed stations provided 24-hour surveillance for presence of tagged lake sturgeon from April 19, 2012 to December 13, 2012 (Sites: A, C, F, and H), or from May 9, 2012 to December 13, 2012 (Sites: B, D, E, and G). For the purposes of this report, the start day for all receivers is assumed to be May 9, 2012. Summary statistics of fish biological data and observation data were calculated to characterize movement dynamics of tagged lake sturgeon during 2012.

Data Analysis

Length, weight, and age data from fish captured in 2010 and 2011 were compared against data collected from 1998 to 2003 to test for differences in von Bertalanffy growth parameters. Catch per unit effort (CPUE, fish·hour^{-1}·1000 hooks^{-1}), catch-at-age, and age structure were compared among sampling periods to investigate population trends. Sampling conducted from 1998 to 2003 used several different collection techniques including setlines, gillnets, and diver captures to provide sturgeon for population analysis. We compared biological data from all fish captured from that sampling period with the fish sampled from 2010-2011 except when we compared CPUE. When comparing CPUE, only sturgeon catches from setlines of similar design were used for analysis.

A discriminant function analysis (DFA) was used to develop a set of discriminating functions to predict sex and maturity (Webb et al. 2002). Quadratic DFA was conducted using log-transformed T and E2 concentration to determine the number of observations and percent classified into groups of sex and stage of maturity. The error rate associated with predicting sex and maturity using the chosen discriminant functions was accomplished through cross-validation (see Khattree and Naik 2000).

For preliminary mark-recapture analysis, we constructed and annual capture history for 2010-2012. Capture probability and mortality were estimated using a Cormack-Jolly-Seber (CJS) model framework in program MARK. Selection of the most parsimonious CJS model between parameterizations with time-variant and time-invariant catch probability parameters was conducted using AIC. Due to the short study duration, only parameterizations with time-invariant mortality were investigated. Second, population size was estimated using the POPAN formulation of the Jolly-Seber (JS) model in program MARK, the parameter set for which included time-variant and time-invariant capture probabilities, and 4 parameterizations of mortality: time-variant, time-invariant, fixed at CJS-estimated mortality, and fixed at catch-curve-estimated mortality.

Results and Discussion

We captured, PIT-tagged, and released 28 Lake Sturgeon in 2010, 193 in 2011, and 140 in 2012. During 2011, we recaptured one lake sturgeon from the 2010 sampling season and one lake sturgeon tagged earlier during the 2011 season. During 2012, we recaptured 1ake sturgeon from 2010, 9 lake sturgeon from 2011, and 6 lake sturgeon tagged earlier during 2012. During 1998-2003, 122 lake sturgeon were collected. The CPUE for 2010 was 0.94 fish·hour^{-1}·1000 hooks^{-1} and was similar to the highest value observed (2002: 0.91) during the earlier sampling period (Figure 2). The CPUE for 2011 and 2012 was 1.51 and 0.98 fish•hour^{-1}•1000 hooks^{-1}, respectively. Although catch per unit effort has increased, this result may be driven by the presence of a few large cohorts that have only recently become fully recruited to our sampling gear.

Lake sturgeon sampled with gill nets and set lines from 1998-2003 had a mean total length of 1,019 mm (40 in; range 311 to 1,573 mm [12-62 in]; n=122) and a mean age of 8 years (range 1 to 28 years; n=122). Lake sturgeon caught on setlines only during 1998-2003 had a mean age of 7.6 years (range 3 to 22 years; n = 85) and a mean length of 1,028 mm (40 in; range 695 to 1,436 mm [27-57 in]; n=361). The mean age of lake sturgeon sampled in 2010-2012 was 13.2 years (range 4 to 32 years;

n=213). The mean total length for lake sturgeon from 2010-2012 was 1,315 mm (52 in; range 760 to 1,660 mm [30-65 in]; n=217) (Figure 3). There is a significant relation between age and length using the von Bertalanffy growth equation (r^2=0.75, p<0.0001). The growth parameters from the von Bertalanffy growth equation for all (1999-2003, 2010-2012) lake sturgeon are L_∞=1465 (SE= 18.79, p<0.0001) and k=0.16 (SE=0.006, p<0.0001). The parameter t_0 was assumed to be 0. Comparison between von Bertalanffy growth parameters between early 2000s and 2010-2012 catch data show no statistical differences (Figure 4) indicating that growth of lake sturgeon from the lower Niagara River did not change between sampling periods. When compared with von Bertalanffy growth parameters from other lake sturgeon populations discussed in Vélez-Espino and Koops (2009) asymptotic length in the lower Niagara River was lower than all but two populations in the Hudson Bay drainage whereas the lower Niagara River population had the highest k parameter value. We hypothesize that the high k estimate is a function of high growth rates of fish in the lower Niagara, while the relative dearth of large adults in the lower Niagara results may result in an underestimate of $L\infty$.

The inclusion of gill nets in 1998-2003 likely resulted in increased catch of smaller, younger lake sturgeon, relative to 2010-2012 setline surveys. Thus, we would expect to observe a higher proportion of smaller, younger fish in 1998-2003 versus 2010-2012, even if there was no difference in age structure. However, there has been a decline in spring setline CPUE of age-5, 6, and 7 lake sturgeon between time periods, which may indicate reduced recruitment of year classes produced after the 1990s, though more research is required to test this.

In addition, only 6 lake sturgeon greater than age 20 were captured during both periods combined, indicating that this population has a much lower proportion of large spawning adults than other more established lake sturgeon populations (Craig et al. 2005; Dieterman et al. 2010; Smith and Baker 2005). This suggests that this population is dominated by relatively few cohorts from the mid- to late-1990s. During the early 2000's sampling, a larger proportion of the catch was made up of 5, 6, and 7 year old fish whereas in the 2010-2011 sampling, the largest proportion of the catch is made up of 12-16 year old fish. The modes of these distributions may correspond to common year classes, as estimated year classes indicated that the majority of the lake sturgeon were from year classes from 1992 to 2002 (Figure 5).

Twenty-eight of the 39 gonadal biopsies contained germ cells. There were 12 Stage 2 (non-reproductive), 2 Stage 3 (early vitellogenic), 1 Stage 4 (mid-vitellogenic), and 2 Stage 5 (ripe) females. Ten males were spermiating/ripe (Stage 5) and another male was post-spermiation (Stage 6). The stage 6 male had non-detectable steroid concentrations and was thus removed from the DFA of sex and maturity. The lack of non-reproductive males (Stage 2) in the sampled population is most likely due to a failure to collect germ cells from these individuals; collecting gonads from immature males is the most difficult.

The reproductive structure of this subsampled female population was 70% non-reproductive (2+ years away from spawning), 18% vitellogenic (1 year away from spawning), and 12% spawning. The reproductive structure is similar to other healthy populations of sturgeon such as the white sturgeon population below Bonneville Dam on the Columbia River (Webb et al. 2002). However, the average age of mature females (16.5 years; range: 15 - 18; n = 2), and to a lesser extent that of mature males (14 years; range: 12 - 18; n = 11) was lower than expected for lake sturgeon (age at first maturity of 14 and 21 for males and females, respectively) (Bruch 2008).

Due to low sample sizes and the absence of the immature male class in our data, DFA results are considered preliminary for the purposes of this report. For the discrimination of lake sturgeon using log-transformed plasma T and E2, the derived discriminant functions led to the correct classification of 8% of the Stage 2 females and 100% of each of the other classes of maturity (Table 2). The cross-validation confirmed the 0% error rate associated with predicting sex and stage of maturity into three groups and a 92% error rate associated with predicting Stage 2 females as Stage 5 males. Our preliminary DFA resulted in the correct classification of all mature fish as male or female, though due to the failure to correctly differentiate immature females from mature males clearly implied

that this discriminant function is not broadly applicable as a predictive tool. Additional sampling of paired hormone-histology samples in 2013, including the successful collection of immature males, is necessary to further develop the predictive tool necessary to accurately identify sex and maturity of lower Niagara River lake sturgeon using only blood plasma sex steroid concentration.

During 2012, 28 of 30 radio-tagged fish were detected by fixed stations in the lower Niagara River between May 9 and December 13. Tagged fish averaged 1,399 mm total length, 21.5 kg weight, and 14.85 years of age. Of these fish, 9 were sexually mature males, 2 were sexually mature females, 9 were immature females, and 10 were unidentified. Among the 28 detected fish, there were 5,350 detections. Six fish had fewer than 10 detections each and one fish (a mature female presumed to have expelled her tag) was detected 3,274 times. A summary is included below, including all observations except those after the first furthest upstream location from the presumably expelled tag (Table 3). There was considerable among-individual variation in the number of observations, number of days, and number of locations where sturgeon were located. Receivers at fixed stations G and H recorded many observations of known mature fish during May, when water temperatures were appropriate for sturgeon spawning. Few of these mature fish were subsequently recorded at any receiver for the remainder of the receiver deployment period, suggesting that these fish were migratory spawners. In contrast, many known immature fish were only detected lower in the river at sites A, B, and C more consistently throughout the year, which implies that these fish were not migrants and that their occupancy in the river was based on something other than spawning. However, individual heterogeneity in movement behavior among our tagged fish was quite high; some mature fish were never observed near suspected spawning sites, for example, whereas some immature fish seemed to have a preference for it. Mixed effects modeling of movement dynamics will be required to explicitly partition individual heterogeneity from population level trends in movement and habitat use, and will require additional radio-telemetry tagging and monitoring in 2013 .

For mark-recapture analysis, the best CJS model was a time-invariant model where estimated apparent survival was 96.3%, and estimated capture probability was 4.2%. As a caveat, deviance/degrees of freedom for this model were < 1, indicating underdispersion. Jolly-Seber models with within-model-estimated survival probabilities had a lower AICc value than fixed-survival-parameter models, as CJS-model-estimated mortality differed markedly from JS model estimates; the best JS model estimated 56.8% annual survival, 7.4% capture probability, and an estimated super-population size of 2,856 (Table 4). Though there is some uncertainty associated with survival and abundance estimates, these preliminary results can provide useful baseline information that may inform future research, and may be used to build hypothetical population models of lake sturgeon in the lower Niagara River.

Increases in catch rates of sub-adult fish in 2010-2012 from 1998-2003 levels may indicate a positive trend in the abundance of mature Lake Sturgeon in the lower Niagara River. However, additional research is necessary to improve upon preliminary survival, abundance, and movement analysis, and to investigate recruitment. Although some concerns still exist, such as the possibility of reduced recruitment over the last ten years and continued low catch rates of old mature adult sturgeon, strong cohorts from the late 1990's are reaching sexual maturity and may eventually contribute additional large pulses of recruitment.

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Table 1. Stages of gonadal development in lake sturgeon from Webb and Erickson (2007).

	Developmental Stage	Description
Females		
Differentiation	1	Clusters of oogonia
Previtellogenic	2	Endogenous growth of oocyte, small translucent oocytes
Early vitellogenic	3	Enlarged oocytes with thin vitelline envelope surrounded by granulosa cell layer and yolk globules, cream to grey colored
Mid-vitellogenic	4	Fully differentiated follicular layer and yolk platelets, pigmented ovarian follicles
Post-vitellogenic	5	Fully grown ovarian follicles with differentiated chorion and germinal vesicle displaced to animal pole, fully pigmented ovarian follicles
Oocyte maturation	6	Ovulated oocytes that have undergone germinal vesicle breakdown
Post-ovulatory	7	Ovaries contain numerous postovulatory follicles and the next generation of oocytes similar to Stage 2
Atretic	8	Atretic vitellogenic follicles containing residual yolk, atretic mature follicles containing residual yolk and dark pigment, presence of atretic bodies
Males		
Differentiation	1	Clusters of primary spermatogonia
Pre-Meiotic	2	Spermatogonia undergoing mitosis
Onset of Meiosis	3	Spermatogonia (~50%) and spermatocytes
Meiotic	4	Majority of cysts contain spermatocytes and spermatids, less than 25% of cysts contain spermatogonia
Spermiation	5	Cysts and ducts contain spermatozoa
Post-spermiation	6	Residual spermatozoa in testicular lobules

Table 2. Classification summary for determination of sex and stage of maturity in 4 classes of lake sturgeon captured in the Niagara River using log-transformed plasma testosterone and estradiol concentrations. Values in bold are percentage of fish correctly classified, while values not in bold are percentage of fish misclassified (see Table 1 for the description of developmental stages).

True Sex	**Classified Using Predictors**				
	Stage 2 Female	Stage 3+4 Female	Stages 5 Female	Stage 5 Male	Total
Stage 2 Female	**8** (n=1)	0 (n=0)	0 (n=0)	92 (n=11)	100 (n=12)
Stage 3+4 Female	0 (n=0)	**100 (n=3)**	0 (n=0)	0 (n=0)	100 (n=3)
Stages 5 Female	0 (n=0)	0 (n=0)	**100** (n=2)	0 (n=0)	100 (n=2)
Stage 5 Male	0 (n=0)	0 (n=0)	0 (n=0)	**100** (n=10)	100 (n=10)

Table 3. Summary statistics for lower Niagara River lake sturgeon fixed station telemetry during the 218 day period from May 9 to December 13, 2012. Median river kilometer observed was calculated for each fish individually, and by-group summary statistics are listed below.

	Mean	n	SD	Range
Age	14.85	26	2.0	12 – 18
TL	1398.8	30	92.1	1242 – 1646
Wt	21.5	30	6.4	14 – 36
Girth	617.4	30	72.4	506 – 786
Day of Year Tagged	113.5	30	7.3	106 – 128
Observations	70.2	30	18.7	0 – 367
Days Observed	16.5	30	3.8	0 – 81
Median River Kilometer Observed				
Mature Males	6.8	9	1.9	0 – 17
Mature Females	9	2	2.6	0 – 11.6
Immature Females	7.1	8	1.0	5 – 12.5
Unknown	4.4	9	0.9	0 – 7.5

Note: results exclude 2,907 observations from one fish after it was assumed to have expelled its radio tag.

Table 4. Best Jolly-Seber model (POPAN formulation) of the lower Niagara River lake sturgeon population from 2010 to 2012. Model parameters include φ (survival), p (capture probability), b_1 (probability of entry from super-population between time period 1 and 2), and N (super-population size).

Parameter	Estimate	SE	95% Confidence Interval
φ	0.568	0.065	0.439 - 0.688
p	0.074	0.023	0.040 - 0.134
b_1	0.871	0.025	0.813 - 0.913
N	2,825.8	846.2	1,636.9 - 5,093.4

The b_2 parameter is confounded in this model formulation.

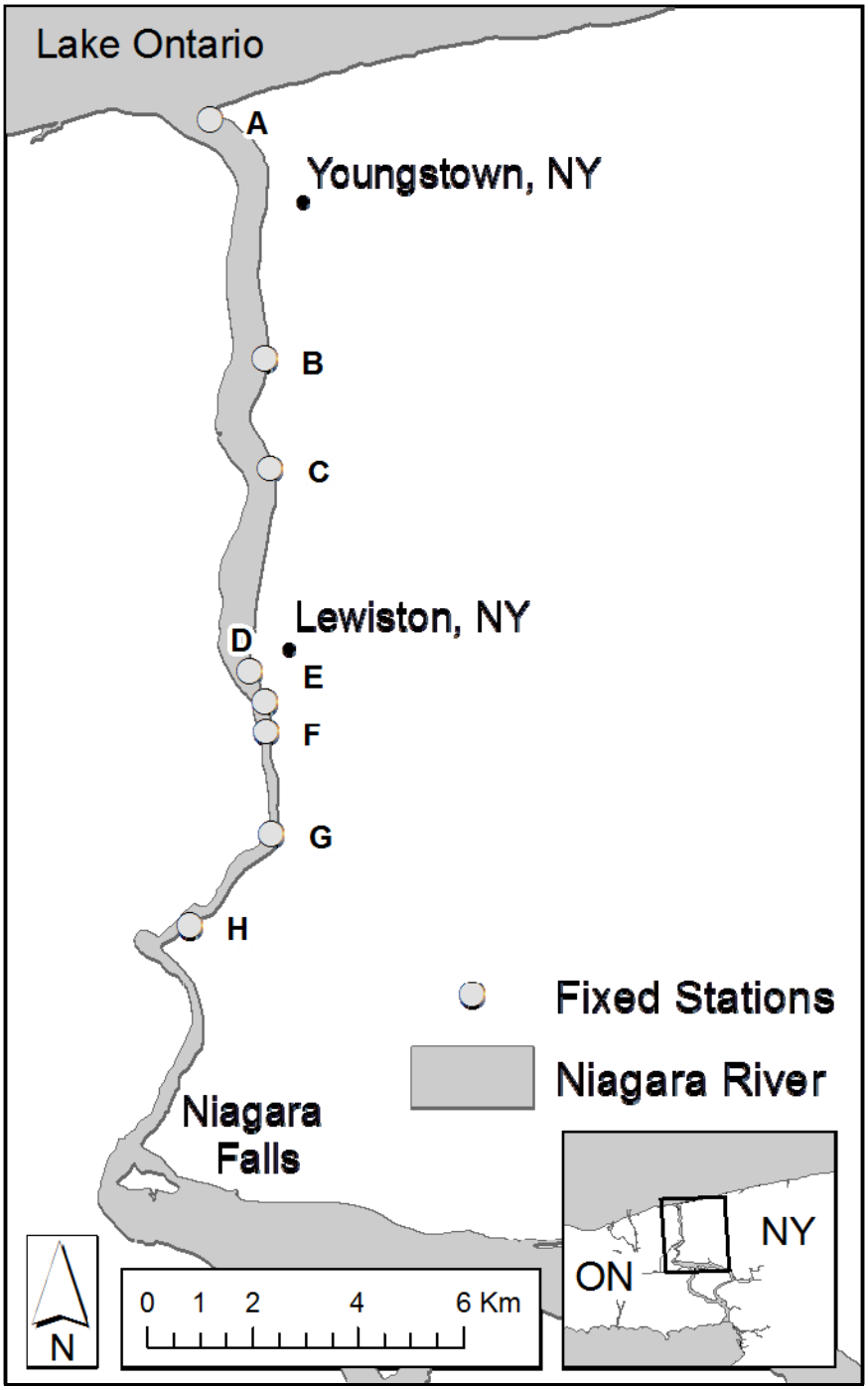

Figure 1. Catch per unit effort (fish·hour^{-1}·1000·hooks^{-1}) for each sampling year restricted to setline catch data only.

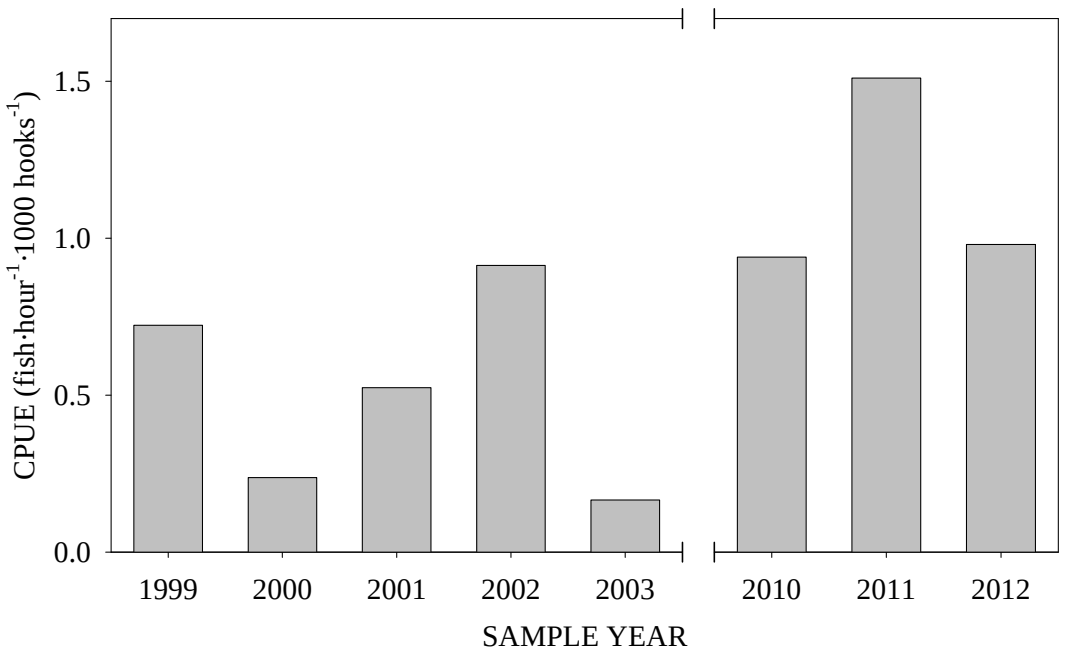

Figure 2. Catch per unit effort (fish•hour^{-1}•1000 hooks^{-1}) for each sampling year restricted to setline catch data only.

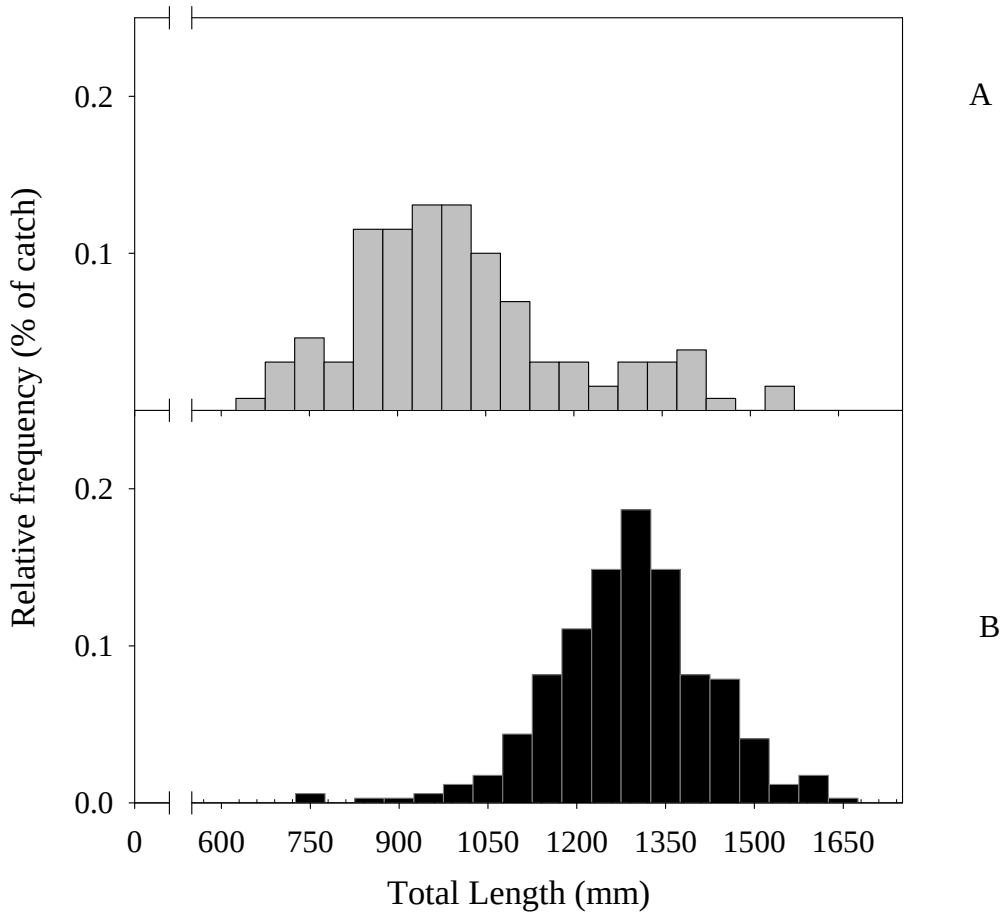

Figure 3. Relative length distributions (in mm) of lake sturgeon captured from (A) 1998-2003 (n=122) and (B) 2010-2012 (n=361).

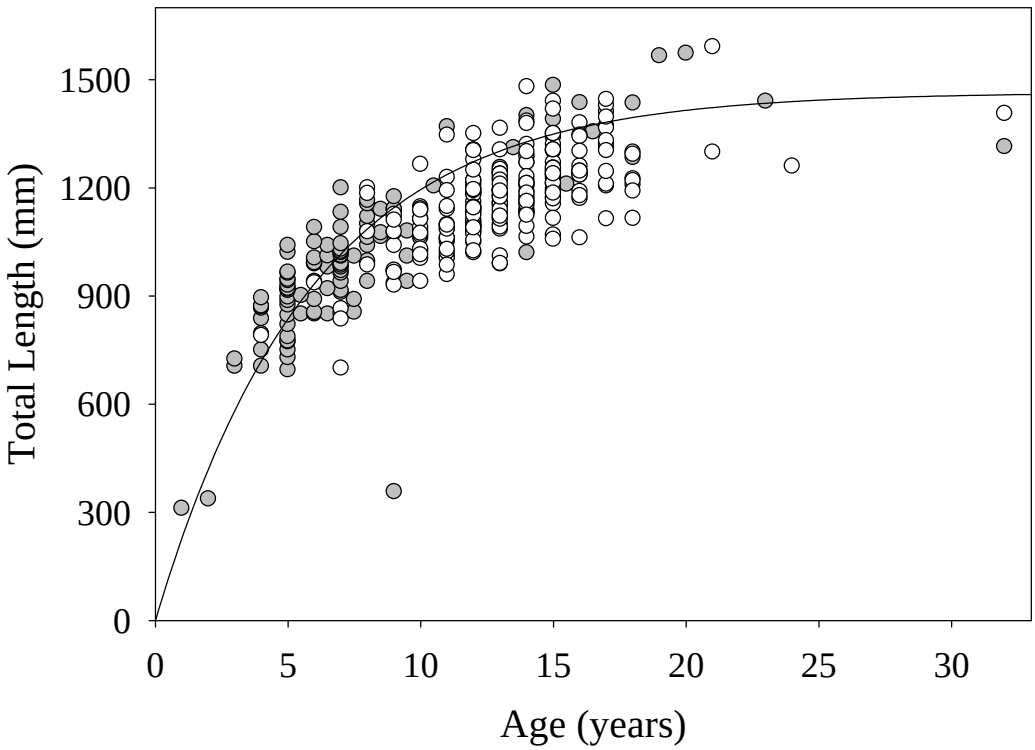

Figure 4. Length at age data for lake sturgeon captured during 1999-2003 sampling and 2010-2012 sampling. Curve and parameters show growth characteristics of the population for the two time periods. There was no significant difference in length-at-age between time periods.

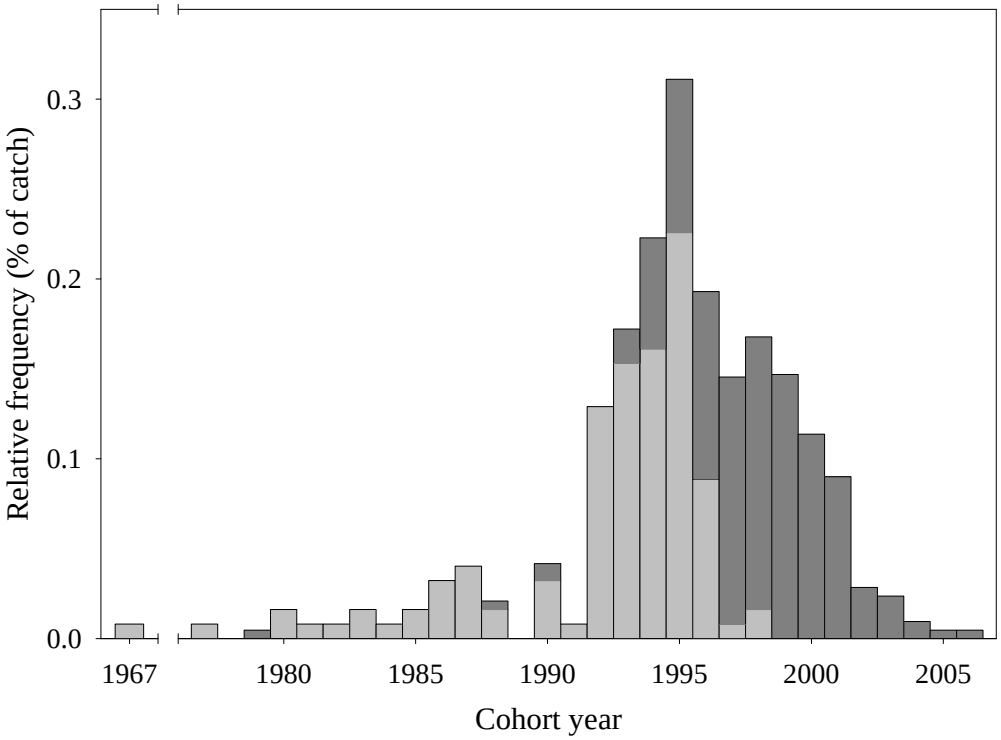

Figure 5. Frequency distribution of the cohort year of lake sturgeon caught during both the 1999-2003 and 2010-2012 sampling periods based on the year of recruitment estimated from fin-ray aging002E