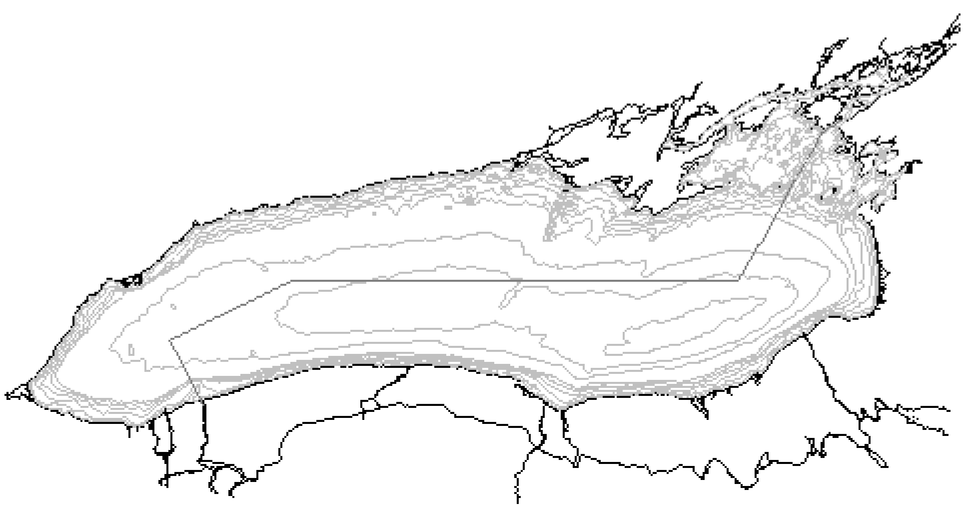
New York State of Opportunity | Department of Environmental Conservation

# 2016 ANNUAL REPORT

## Bureau of Fisheries

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



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New York State Department of Environmental Conservation
625 Broadway, Albany, New York 12233-4753

**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, 12, 14, 15, 16 and 21**

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*New York State Department of Environmental Conservation*
*Lake Ontario and St. Lawrence River Units*
*Cape Vincent, NY 13618 and Watertown, NY 13601*

Presented at the Lake Ontario Committee Meeting
Ypsilanti, Michiagn
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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. 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. 2013). 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 the 1990s, the Lake Ontario ecosystem experienced dramatic changes resulting primarily from the introduction of exotic zebra and quagga mussels. In addition, improvements in wastewater treatment have reduced excessive nutrient concentrations in the open lake to historic, more natural levels, thereby lowering the productive capacity of the Lake Ontario ecosystem. Zooplankton biomass in Lake Ontario’s offshore upper thermal layer declined drastically over the last 30 years (as much as 99% by the early 2000s), attributable to reduced lake productivity and invasive predatory zooplankton (i.e., *Bythotrephes* and *Cercopagis*, discovered in 1985 and 1998, respectively). Since 2005, offshore zooplankton biomass improved but remains well below historic levels. The abundance and distribution of the native deepwater amphipod, *Diporeia* deteriorated markedly, likely due to range expansion of quagga mussels into deeper waters. The exotic round goby was first documented in New York waters of Lake Ontario in 1998, and spread throughout Lake Ontario and the St. Lawrence River rapidly. Goby abundance and biomass grew exponentially, then stabilized at lower levels. Round gobies have dominated the diets of Double-crested cormorants from colonies in eastern Lake Ontario and the St. Lawrence River for nearly a decade. 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. The effects of these ecosystem changes on the Lake Ontario fish community have not been manifested completely, nor are they fully understood.

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. The invasive “bloody red shrimp” is a small freshwater shrimp 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. Two consecutive severe winters (2013/2014 and 2014/2015) followed by below average summer water temperatures resulted in very small 2013 and 2014 (record low) alewife year classes, which contributed to a markedly reduced adult alewife population in 2016. Concerns over the impacts of the two consecutive poor alewife year classes to the future adult alewife population prompted the NYS Department of Environmental Conservation (DEC) and the Ontario Ministry of Natural Resources and Forestry (OMNRF) to reduce Chinook salmon and lake trout stocking by 20% each in 2017.

This report summarizes cooperative research and monitoring activities conducted on Lake Ontario and the St. Lawrence River by the DEC, U.S. Geological Survey, OMNRF, U.S. Fish and Wildlife Service, Fisheries and Oceans Canada, SUNY College of Environmental Science and Forestry and Cornell University in 2016.

**Lower Trophic Level Monitoring**

- From 1995-2016, 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).
- Spring total phosphorus declined in the longer data series (since 1981), but not since the inception of the biomonitoring program in 1995 indicating stable nutrient loading into Lake Ontario for nearly two decades. Phosphorus levels averaged 7.8 parts per billion (ppb) in the nearshore and 6.0 ppb in the offshore in 2016, below the 10 ppb target set by the Great Lakes Water Quality Agreement of 1978 for offshore waters of Lake Ontario.
- Chlorophyll-*a* and Secchi depth values (a measure of water clarity) are indicative of oligotrophic conditions in Lake Ontario's nearshore and offshore habitats. Offshore summer chlorophyll-*a* declined significantly in both the short- (2000-2016) and long-term (1981-2016) time series. Nearshore chlorophyll-*a* increased 1995 - 2004 but then declined 2005 - 2016. Epilimnetic (upper water column) chlorophyll-*a* averaged between 1.4 and 2.5 ppb across sites, and offshore and nearshore concentrations were the same (1.9 ppb). Seasonal Secchi depth ranged from 16.4 ft to 42.7 ft at individual sites and, on average, was greater in offshore sites (32.8 ft) when compared to nearshore (21.3 ft) in 2016.
- Summer nearshore zooplankton density and biomass declined significantly 1995 – 2004 and then increased significantly 2005 – 2016. The decline was due to reductions in bosminids and cyclopoids and the increase was due mostly to a rebound in bosminids. Summer offshore zooplankton density and biomass increased significantly 2005 – 2016. The increase was due to an increase in bosminids and cyclopoids. In 2016, offshore summer epilimnetic zooplankton biomass was 22 $mg/m^3$ less than half that observed in 2015, but still slightly higher than the mean from 2005 – 2016 (21 $mg/m^3$).
- In 2016, April/May – October epilimnetic zooplankton density and biomass were not different between the offshore and the nearshore, but calanoid copepod and *Limnocalanus* biomass were higher in the offshore (4.7 $mg/m^3$ vs 2.6 $mg/m^3$ and 0.7 $mg/m^3$ vs 0.1 $mg/m^3$), and bosminid biomass was higher in the nearshore (1.1 $mg/m^3$ vs 0.3 $mg/m^3$). Zooplankton size was significantly higher in the offshore than the nearshore (0.66 mm vs 0.49 mm).
- Whole water column samples show a stable zooplankton biomass but changing community composition since 2010. Most zooplankton biomass was found in the metalimnion in July and September in the hypolimnion in October. *Limnocalanus* dominated the metalimnion in July while other calanoids and daphnids comprised most of the biomass in September. *Limnocalanus* and other calanoids dominated the October hypolimnion.

**Prey Fish Assessments**

- Each year Lake Ontario preyfish populations (primarily alewife, smelt, and sculpins) are assessed with bottom trawls (Sections 12a and 12b) and hydroacoustics (sonar; Section 15).
- In 2016, 142 bottom trawls were performed in U.S. waters, and for the first time 46 trawls were conducted in Canadian waters.
- The 188 total trawls represent a substantial increase in effort from historic methods and the depth range sampled (20 ft – 738 ft) increased relative to historic surveys. The 2016 depth distribution of tows across depths more closely matches the distribution of depths available in the lake.
- In 2016, the reported alewife abundance time series was truncated to only include values since 1997, which were collected with the same trawl and eliminated the need to adjust values for historic trawl gear. In spring 2016 bottom trawl surveys, abundance of adult (age-2 and older) alewife declined from 2015 levels, and was the second lowest value recorded since 1997. Abundance of yearling (age-1) alewife increased relative to 2014-2015.
- Adult alewife condition, measured in the fall of 2016, increased from 2015 and was substantially above the 38-year survey mean (1978-2015 mean=32.8g, 2016=36.6 g). (Section 12a).
- In 2016, the abundance index for rainbow smelt in US waters increased slightly relative to 2015 and was 11% higher than the previous five year average (Section 12a).
- In 2015, the benthic prey fish bottom trawl survey was expanded to include north shore waters in Ontario. In 2016, 142 trawls were performed at 18 transects, and spanned depths from 20 ft– 738 ft. Trawl catches indicated the benthic and demersal prey fish community was dominated by round goby, however the proportional importance of native deepwater sculpin is increasing. (Section 12b).
- Benthic prey fish surveys showed slimy sculpin abundance in 2016 was similar to 2015 and both values are among the lowest observed, but deepwater sculpin abundance continued to increase to the highest level reported since their re-emergence in 1998. Round goby abundance was similar to 2015 and within the range of recent values (Section 12b).
- The 2016 hydroacoustic survey of Lake Ontario preyfish populations consisted of the typical five cross-lake transects and an Eastern Basin transect, as well as five additional shallow water transects and eight additional mid-water trawling transects. Estimated yearling and older alewife abundance increased by 214% in 2016 and was 44% higher than the previous ten-year average. The survey was expanded in 2016 to include mid-water trawling that targeted cisco. Cisco catches only occurred within the eastern portion of the sampling area but cisco densities were estimated to be 36 fish per hectare with mid-water trawling and 25 fish per hectare with acoustics. The rainbow smelt abundance estimate declined by 15% relative to 2015, and was 68% of the previous ten-year average. Ongoing research comparing hydroacoustic data collected with a hull-mounted transducer pointing downward (traditional approach; "downlooking") and a transducer at depth pointing upward (new approach; "uplooking") revealed substantial numbers of alewife at or near the surface on some nights. These fish were not previously detectable with "downlooking" hydroacoustics. (Section 15).

**Coldwater Fisheries Management**

- Fish stocking in the New York waters of Lake Ontario in 2016 included 1.88 million Chinook salmon, 316,447 coho salmon, 664,720 rainbow trout, 384,250 lake trout, 495,620 brown trout, 156,357 Atlantic salmon, 149,353 bloater, and 22,109 cisco. Of these, 152,410 brown trout and all lake trout were stocked offshore by military landing craft in an ongoing effort to reduce predation on newly stocked fish by double-crested cormorants and predatory fish (Section 1).
- Average weights and condition (a measure of "stoutness") of salmonids at a given age serve as a potential index of relative balance between the number of predators (primarily salmonids) and

preyfish; however, water temperatures also influence fish growth and condition. Average weights and condition are calculated for salmonids examined from the open lake fishery (Section 2) and as spawning adults at the Salmon River Hatchery (Section 9).

- Chinook salmon growth measured from the open lake fishery was good to excellent in recent years, however, was below average in 2014 and 2015. The August 2016 mean length (36.2 in) of age-3 Chinook salmon was 0.6 in shorter than the long term average. However, Chinook salmon condition or relative "stoutness" in 2016 was one of the heaviest values observed for Chinook salmon ≥ 20 in. These results indicate that the recent long, cold winters (2013-2014 and 2014-2015) followed by below average summer temperatures may have negatively impacted growth in length, however, the good condition of Chinook salmon ≥ 20inches indicated that alewife (the primary forage of Chinook salmon) abundance was sufficient to maintain Chinook condition (Section 2).
- At the Salmon River Hatchery, average weight of age-1 Chinook males (jacks) sampled in 2016 was 5.4 pounds, the eighth highest value in the time series. Age-2 males (11.8 lbs) were 1.6 pounds below average and age-2 females (12.5 lbs) were 2.2 pounds below average. Age-3 males (17.0 lbs) were nearly 2.2 pounds below average weight and age-3 females (17.2 lbs) were 1.9 pounds below the long-term average (Section 9). Chinook salmon condition (based on the predicted weight of a 36 inch long Chinook salmon) in fall 2016 was similar to the long term average and the previous eight years sampling (Section 9).
- Steelhead are sampled in the spring at the Salmon River Hatchery and, unlike Chinook and coho salmon, do not reflect growth during the 2016 growing season. Weights reported here reflect conditions prior to and including 2015. The mean weights of age-3 males and females were 6.4 and 8.2 lbs, respectively, which were both above their respective long-term averages. The mean weights of age-4 males and females were 8.7 lbs and 8.1 lbs, respectively, with males 0.1 lbs and females 0.2 lbs lighter than their long-term averages (Section 9).
- 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. Sampling in 2016 produced the highest mean peak catch, daily total catch, and single site catch for one day in the history of the program.The earlier than usual peak daily catch in 2016 was likely attributable to the mild winter of 2015-16. Mean catch per seine haul (1,067 fish/haul) was estimated using the catches from the first 3 weeks of May. Had the survey included the last week of April, that catch would have likely exceeded that of the third week of May and driven the mean peak catch estimate higher. (Section 8).
- The nineteenth year of pen-rearing steelhead and Chinook salmon along the New York shoreline of Lake Ontario was successful due to low fish mortality and a substantial percentage of the Chinook salmon reaching target weights. A total of 56,000 Washington strain steelhead were raised at seven pen sites, comprising 9.6% of DEC's Lake Ontario yearling steelhead stocking allotment in 2016. Seven pen-rearing sites raised a total of 450,800 Chinook salmon, representing 23.9% of DEC's 2016 Chinook salmon stocking allotment (Sections 1 and 10).
- In 2008, the DEC purchased an automated fish marking trailer (AutoFish) capable of adipose clipping and/or applying coded wire tags (CWTs) to salmon and trout automatically at a high rate of speed and accuracy. To evaluate the relative performance of pen-reared and traditional, shore-stocked Chinook salmon, DEC marked sub-samples of Chinooks stocked at pen-rearing sites with CWTs in 2010, 2011, and 2013 (Section 3).
- Results from the 2010, 2011 and 2013 Chinook salmon year classes (YCs) indicate that pen reared Chinook salmon provided an average of 1.9, 2.4, and 2.7 times greater contribution, respectively, to the lake fishery than their direct stocked counterparts.

- Results from the 2010, 2011 and 2013 YCs indicate that pen reared Chinook salmon provide better returns to tributaries (imprinting) than direct stocking at some sites in some years.
- Site specific Chinook salmon harvests in the lake in May-July were comprised of Chinook stocked at sites throughout the lake, indicating a well-mixed population prior to the staging period in September.
- The majority of Chinook caught by tributary anglers in October were Chinook that were stocked at those sites. Of eight tributary sites sampled in October, 68% of harvested Chinook salmon on average were stocked at those tributaries, indicating good imprinting of both pen and direct-stocked fish. The majority of Chinook strays in tributaries were Chinook stocked at nearby sites.

**Lake Trout Restoration**

- Restoration of a naturally reproducing population of lake trout is the focus of a major international effort in Lake Ontario. Each year several surveys measure progress toward lake trout rehabilitation (Section 5).
- Adult lake trout abundance in index gill nets increased each year from 2008-2014, recovering from historic lows recorded during 2005-2007. Adult abundance in 2016 was similar to 2015, but approximately 20% below the peak in 2014.
- The sea lamprey wounding rate on lake trout caught in gill nets was 1.4 fresh (A1) wounds per 100 lake trout, below the target of 2.0 wounds per 100 lake trout.
- The survival indices at age 2 for lake trout stocked in 2015 (2014 year class) was the highest observed since 1990.
- Naturally reproduced lake trout were documented in 22 years since 1994. The largest catches of naturally produced lake trout occurred from 2014 – 2016.
- Adult lake trout condition in 2016 was the second highest observed for the 1984 – 2016 time series. However, the condition of juvenile lake trout in 2016 was among the lowest values recorded for the 1979-2016 time series.
- In 2016, angler catch (36,336 fish) and harvest (18,426 fish) were more than 1.7 and 2-fold higher than their respective previous 10-year averages.

**Status of Sea Lamprey Control**

- The sea lamprey is a destructive invasive species in the Great Lakes that contributed to the collapse of lake trout and other native species in the mid-20$^{th}$ 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 is a critical component of Great Lakes fisheries management, facilitating the rehabilitation of important fish stocks by significantly reducing sea lamprey-induced mortality (Section 11).
- In 2016, 11 Lake Ontario tributaries (six Canada, five NY) were treated with lampricides. Treatments in New York included South Sandy Creek, Little Sandy Creek, Grindstone Creek, Oswego River and Fish Creek. A total of 4,004 sea lampreys were trapped in eight tributaries, five of which are index locations.
- The estimated population of adult sea lampreys was 7,191, which was less than the fish community objective target of 11,368.
- Larval assessments were conducted on a total of 58 tributaries (20 Canada, 38 NY). Surveys to estimate abundance of larval sea lampreys were conducted in six tributaries (two Canada, four NY). Surveys to detect the presence of new larval sea lamprey populations were conducted in 23 tributaries (5 Canada, 18 NY) with no new populations detected.

- Post-treatment assessments were conducted in 10 tributaries (five Canada, five NY) to determine the effectiveness of lampricide treatments conducted during 2015 and 2016.
- Surveys to evaluate barrier effectiveness were conducted in seven tributaries (four Canada, three U.S.).
- The rate of wounding by sea lamprey on lake trout caught in gill nets was 1.4 fresh (A1) wounds per 100 lake trout, below the target of 2 wounds per 100 lake trout (Section 5). There were an estimated 12.2 lamprey observed per 1,000 trout or salmon caught by anglers, the lowest estimated since 2002, however, still over 2-fold higher than the 1986-1995 average rate (Section 2).

**Warmwater Fisheries**

- A total of 68,250 fingerling walleye were stocked in the lower Niagara River (23,200) and Sodus Bay (45,050) (Section 1).
- The Eastern Basin warmwater index gill netting survey is conducted annually to assess relative abundance and population characteristics of warm and coolwater fish species. Total catch-per-unit-effort (CPUE or relative abundance) of all species in 2016 was 16.5 fish/gill net, a 10.7% increase from 2015, but a 44.7% decrease compared to the previous 10-year (2006-2015) average. Smallmouth bass and white perch were the most commonly caught species (Section 4).
- Smallmouth bass abundance was 5.0 fish/net, similar to 2014 and 2015 but only 18% higher than the record low during 2000-2004. Historically, the Eastern Basin smallmouth bass population periodically experienced years of strong natural reproduction, and these individual "year classes" often sustained the population and sportfisheries for many years. For example, fish resulting from strong natural reproduction in 1983 (1983 year class) were still contributing strongly to the sportfishery in 1998 as age 15 fish. In spite of conditions favoring strong reproduction in recent years, data indicate that the Eastern Basin smallmouth bass population is no longer producing strong year classes.
- Walleye CPUE in 2016 was 1.3 fish/net night, a 14% increase from 2015 but a 22.5% decrease from the previous 5-year average. Strong year classes produced in 2003, 2005, 2008, 2011 and 2014 were well-represented in 2016 catches.
- Following six years of improved yellow perch catches (2008-2013), yellow perch CPUE declined in 2014 (1.7 fish/net) and 2015 (0.8 fish/net) to the lowest levels observed. CPUE in 2016 increased to 3.1 fish/net, but remained well below the previous ten-year average.
- Round gobies first appeared in this assessment in 2005 in both gillnet catches and smallmouth bass diets. In 2016, 78.9% of the 95 non-empty bass stomachs contained goby. Gobies were present in walleye diets each year from 2006-2010 and 2012-2016, and have been found in northern pike, brown trout, lake trout, and lake whitefish.
- At least one lake sturgeon was collected in the Eastern Basin in 16 of the last 22 years, suggesting improved population status.
- Similar to the Eastern Basin index gill netting survey, surveys are conducted annually on the St. Lawrence River to assess warm and coolwater fish populations in the Thousand Islands and Lake St. Lawrence (Sections 6 and 7, respectively).
- Thousand Islands smallmouth bass abundance increased from low 1996-2006 levels, varied at relatively high levels from 2007 to 2012, then declined to a near record low by 2015. However, abundance increased substantially in 2016 and was similar to 2007-2012 levels. Yellow perch abundance in 2016 was similar to 2014 and 2015. From 1996 to 2016, northern pike abundance has remained relatively low. Ongoing poor recruitment of northern pike is likely related to spawning habitat limited by water level regulation, and possibly by Double-crested Cormorant predation (Section 6).
- Lake St. Lawrence yellow perch abundance was variable at a higher level from 2007-2016 as

compared to most years during the 1990s and 2000s. Abundance declined 18% from 2015 but was similar to 2012 - 2015. Smallmouth bass catch has been variable since 2005, reached its second highest level in 2013, and was below the long-term average in 2016. Catches of age 1 and age 2 smallmouth bass were well above the previous ten-year average, suggesting potentially strong year classes. Walleye abundance increased 8% in 2016, but remained below the long-term average (Section 7).

- Abundance of spawning adult and young-of-the-year (YOY) northern pike in the Thousand Islands region of the St. Lawrence River continues to be suppressed likely due to habitat degradation resulting from long-term management of Lake Ontario/St. Lawrence River water levels. Overall, natural reproduction at natural and managed spawning marshes remains poor, due to low abundance of spawning adults and sex ratio dominance of females. Habitat restoration efforts including excavated channels and spawning pools has shown success for natural reproduction of YOY at many sites. (Section 17).
- 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 YOY 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 Lake Ontario, Black River Bay, and the St. Lawrence River in 2016 produced a total catch of 218 fish. Passive integrated transponder (PIT) tags, which allow for future identification of individual fish, were implanted in 168 fish to monitor fish growth, movements, and to manage brood stock genetics in restoration stocking efforts. Forty-nine previously tagged sturgeon were re-captured in 2016 (Section 18).

**Sport Fishery Assessment**

- Each year from 1985-2016 the DEC 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 the salmonid fishery and provide valuable information on other fish species (Section 2).
- During 2016, there were periods and locations of both excellent and poor fishing quality (measured as catch rate, i.e., number of fish caught per hour of angling). With the variety of trout and salmon species present in Lake Ontario, anglers were able to target another species when catch rates for their preferred target declined. This resulted in a good catch rate for all trout and salmon combined (3.6 fish per boat trip) in 2016; however, this relatively high rate is partly attributed to the high catch rate of lake trout (0.9 per boat trip). The charter boat catch per angler hour was 0.21 for all trout and salmon, comparable to the previous ten-year average. Total trout and salmon catch (138,231 fish) and harvest (79,334 fish) were dominated by Chinook salmon (44% and 43%, respectively) and lake trout (26% and 23%, respectively). Brown trout and rainbow trout were the third and fourth most sought after species with coho and atlantic salmon representing only a small component of the fishery.
- The highest Chinook salmon catch rates among charter boats occurred during 2003-2016. Fishing quality in 2016 (0.09 fish/hour) was comparable to the 2003 – 2015 average.
- In 2016, the charter boat catch rate of coho salmon (0.003 fish/hour) was well below the long-term average (-69.6%).
- Each year from 2008-2014 rainbow trout catch rates were among the highest recorded. In 2016, charter boats caught 0.02 rainbow trout per angler hour, a 24.5% decrease compared to the long term average.
- The charter boat catch rate for brown trout in 2016 was 0.03 fish/hour, 15.5% below the long-term

average.

- During 2016, the charter boat catch rate of lake trout was 0.06 fish/hour, a 42.2% increase compared to the long term average.
- In 2016, total estimated fishing effort was 46,339 fishing boat trips (787,588 angler hours), the lowest observed in the time series**.** Effort targeting trout and salmon remained relatively stable for more than a decade but was the lowest on record in 2016. An estimated 38,776 boat trips targeted trout and salmon in 2016, a 24%% decrease compared to the previous 10-year average.
- Smallmouth bass was the most commonly caught species in the survey each year 1985-2006. In 2016, smallmouth bass was the third most commonly caught species.
- An estimated 5,295 fishing boat trips targeted smallmouth bass during the 2016 traditional open season (3rd Saturday in June through September 30 when the creel survey ends), comparable to the previous five-year average. Bass catch rates were relatively stable from 1985 through the early 1990s (mean=1.0 bass per angler hour), increased to the highest level in 2002 (2.0 bass per angler hour), then declined to record low levels. Smallmouth bass catch rate per angler hour in 2016 was 0.57, slightly higher than the previous ten-year average but 71.9% below the record high in 2002. Several factors may have contributed to poor fishing quality, including expansion of round goby populations and possible smallmouth bass mortality from Viral Hemorrhagic Septicemia virus.
- An angler survey was conducted on 21 major Lake Ontario tributaries from September 2015 through April 2016 (Section 14). The total estimated effort for 21 tributaries was 256,894 trips comprising 989,437 angler hours. The Salmon River accounted for 735,402 angler hours (74% of total) and 129,018 angler trips (50% of total). Four other tributaries accounted for at least 20,000 estimated angler hours each: Eighteenmile Creek and Niagara River in Niagara County, South Sandy Creek in Jefferson County, and Oak Orchard Creek in Orleans County.
- Sixteen of 21 tributaries surveyed had reported catches of Chinook salmon. The total estimated catch and harvest of Chinook salmon in 2015 was 43,589 and 26,045, respectively. The 2015 catch of Chinooks declined drastically from the three previous survey (fall 2005, 2006, and 2011) estimates that ranged from 125,180 to 155,960 fish caught.
- Coho salmon were a small component of the 2015 tributary fishery, with an estimated 6,061 fish caught in nine of the 21 tributaries surveyed. Coho catches varied considerably in previous surveys, ranging from 5,804 in 2006 to 30,676 in 2011. The Salmon River accounted for 95% of the catch (5,738) and 89% of the harvest (2,307).
- Thirteen of the 21 tributaries surveyed had reported catches of steelhead with the total estimated catch and harvest of 48,893 and 6,023 fish, respectively. The Salmon River had the highest estimated catch (25,170 or 51% of total) and harvest (3,405 or 57% of total). The release rate for steelhead was 88% for all tributaries combined.
- Twelve of the 21 waters surveyed had reported catches of brown trout. The total estimated brown trout catch and harvest was 18,182 and 3,512, respectively. The estimated catches from the previous three comprehensive fall surveys ranged from 27,419 in 2006 to 40,192 in 2005.

**Double-crested Cormorant Management and Impacts on Sportfish Populations**

- Cormorant population management, along with a major cormorant diet shift to round goby, has essentially met objectives related to cormorant predation for protecting fish populations, other colonial waterbird species, private property and other ecological values (Section 13).
- For the 18th consecutive year, cormorant population control was continued through oiling of eggs with food grade vegetable oil at the Little Galloo Island colony. No culling of adult birds was necessary in 2016. Nest destruction was employed to discourage nesting on Gull Island (n=149), 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 2016, cormorant feeding days at the Little Galloo Island colony were estimated at 934,552, substantially above the target of 780,000 and a 15% increase from 2015.
- In May 2016 a federal court vacated an extension of the Public Resource Depredation Order, which had allowed DEC and other agencies to conduct cormorant management activities. As a result all cormorant management activities were terminated in May which resulted in a much reduced and less effective management effort this year.

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# New York Lake Ontario and Upper St. Lawrence River Stocking Program 2016

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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 2016 by species, strain, and life stage, and compares those totals with the 2016 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 2000-2016. New York stocking history from 1968-1990 is reported in Eckert (2000). Table 3 provides specific information for each group of fish stocked in 2016. 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).

**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 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:

| | |
|---|---|
| CC | Casco Fish Hatchery, ME |
| CV | Cape Vincent Fisheries Station, Jefferson Co. |
| BH | Bald Hill Fish Culture Station, VT |
| EW | Ed Weed Fish Culture Station, VT |
| NAA | Niagara River Anglers Association |
| PMP | Powder Mill Park Hatchery, Monroe Co. |
| FC | Fish Creek Club, Point Rock, NY |
| MC | Morrisville College, Morrisville, NY |
| TUN | USGS Tunison Laboratory of Aquatic Sciences |

U.S. Fish and Wildlife Service Hatcheries:

| | |
|---|---|
| AL | Allegheny National Fish Hatchery, PA |
| EI | D.D. Eisenhower National Fish Hatchery, VT |
| GN | Genoa National Fish Hatchery, WI |
| IR | Iron River National Fish Hatchery, WI |

PT[1] Pittsford National Fish Hatchery, VT
SC Sullivan Creek National Fish Hatchery, MI
WR White River National Hatchery, VT

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

**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 2015 are 2016 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.

HPW (Huron Parry Sound Wild): “Lean”-type lake trout strain originated from a remnant population on the Canadian side of Georgian Bay in Lake Huron. A captive HPW broodstock is maintained at SC and is the source eggs for HPW reared at AL for stocking into Lake Ontario. Fall fingerling HPW were stocked in 2014 and 2015 by AL. HPW yearlings were stocked in 2015 and 2016 by AL.

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 included Swedish Gull Spang strain, as well as West Grand Lake (outlet spawners) and Sebago (inlet spawners) strains from Maine. Beginning in 2007, Adirondack Hatchery began to transition to Sebago strain only (see SEB below). In 2015-2016, AD stocked SEB/LC hybrids.

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. LCH-D yearlings were reared and stocked by AL in 2013 and EI in 2013-2015. LCH-D spring yearlings and fall fingerlings were stocked by EI in 2015 and LCH-D spring yearlings were stocked by EI in 2016. 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.

LO (Lake Ontario): Wild, self-sustaining populations from Lake Ontario used to describe both cisco and walleye strains. Cisco eggs were collected in Chaumont Bay, Jefferson County and reared at U.S. Geological Survey (USGS) Tunison Laboratory of Aquatic Sciences (TUN) from 2011-present. 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. From 2009-present, however, no walleye production occurred.

LM (Lake Michigan): Wild, self-sustaining population of bloater from Lake Michigan. In each year from 2012-present, eggs were collected from wild fish in Lake Michigan near Dorr County, WI or Milwaukee, WI and were incubated and reared at TUN and stocked into Lake Ontario.

MEP (Lake Mephromagog): A naturalized freshwater strain of landlocked Atlantic salmon originally derived

[1] Pittsford N.F.H. renamed D.D Eisenhower (EI) in 2009

from the West Grand Lake, ME strain, an outlet spawner. Fry stocked by State University of New York College of Environmental Science and Forestry in 2014 were produced from a captive broodstock held at BC.

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 to spawn. 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. Originally the state of Michigan obtained its Chinook eggs mainly from the Green River, WA (Weeder 1997) and its coho eggs from the Cascade River, Oregon and Toutle River, WA initially and later from the Platte River, WA (Keller et al. 1990).

SEB (Sebago): Landlocked strain of Atlantic salmon derived from Maine. SEB were stocked in 2011-2015 by TUN from eggs originating from Ed Weed Fish Culture Station, VT (2011-2015), Casco Fish Hatchery, ME (2013), Bald Hill Fish Culture Station (2015) and from NYSDEC Adirondack Hatchery (2014-2016). In 2015, TUN stocked fry from BH, fall fingerlings from AD, and yearlings from EW. In 2016, TUN stocked fall fingerling and yearling SEB from AD and BH sources. Atlantic salmon raised at AD are transitioning to SEB strain, and this should be complete in 2017.

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 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 (EI). Concerns over 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 EI) 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. Production of SEN strain at AL resumed with the 2012 year class, and AL stocked SEN as yearlings in 2013-2016 and as fall fingerlings in 2015. 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.

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.

SKW (Klondike Reef): 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). Stocking of SKW resumed in 2014 with fall fingerlings produced at AL (eggs from broodstock at IR). Stocking of SKW by AL also occurred in 2015 as fall fingerlings and in 2015 and 2016 as yearlings. 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.

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 IR and is no longer 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 SAW, and STW in the USFWS stocking database; and as SUP, STW and SAW in the NYSDEC Lake Ontario Unit reports.

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 adipose 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 from which were derived.

**Mos (Months):** Age of the fish to the nearest half month from the time the fish 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 "Remarks" in Table 3.

| | |
|---|---|
| AD | adipose fin clip |
| ALZ | alizarin |
| LV | left ventral fin clip |
| LP | left pectoral fin clip |
| SCU | Scute clip (sturgeon) |
| CWT | coded wire tag |
| OTC | oxytetracycline - 6 hour immersion |
| CAL | calcein |
| 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), lake trout or rainbow trout (both 6-digit).

Pen Reared (date, size): Fish held and reared in a pen 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.

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, 2012-2016), 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.

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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 2016, and comparisons with the NYSDEC 2016 stocking policy.**

| Species | Stage | | Strain | DEC Stocking Policy | Actual Number Stocked |
|---|---|---|---|---|---|
| **Atlantic Salmon** | Ylg | | SEB/LC | 50,000 | 50,000 |
| | FF | 1 | SEB | - | 74,298 |
| | Ylg | 1 | SEB | - | 32,059 |
| **Atlantic Salmon Total** | | | | 50,000 | 156,357 |
| **Bloater** | FF | 1 | LM | - | 149,353 |
| **Brown Trout** | FF | | RL-D | - | 31,300 |
| | Ylg | | RL-D | 391,755 | 464,320 |
| **Brown Trout Total** | | 2,3 | | 391,755 | 495,620 |
| **Chinook Salmon** | SF | 4,5 | SAL-W | 1,761,600 | 1,882,500 |
| **Cisco** | FF | 1 | LO | - | 22,109 |
| **Coho Salmon** | FF | | SAL-W | 155,000 | 158,087 |
| | Ylg | | SAL-W | 90,000 | 99,150 |
| | SF | 6 | SAL-W | - | 59,210 |
| **Coho Salmon Total** | | | | 245,000 | 316,447 |
| **Lake Sturgeon** | FF | | SLR | - | 500 |
| **Lake Trout** | Ylg | | HPW | 160,000 | 87,090 |
| | Ylg | | LCH-D | 160,000 | 122,290 |
| | Ylg | | SEN-W | 40,000 | 79,190 |
| | Ylg | | SEN | 80,000 | 40,890 |
| | Ylg | | SKW | 80,000 | 54,790 |
| **Lake Trout Total** | | 7,8 | | 520,000 | 384,250 |
| **Rainbow Trout** | Ylg | | FL-W | 7,500 | 7,200 |
| | Ylg | | RA-D | 75,000 | 75,000 |
| | Ylg | | SKA-W | 43,000 | 75,190 |
| | Ylg | 4 | WAS-W | 497,700 | 507,330 |
| **Rainbow Trout Total** | | | | 623,200 | 664,720 |
| **Walleye** | PF | | ONL-W | 97,200 | 68,250 |
| **Salmon and Trout Total** | | | | **3,591,555** | **3,899,894** |
| **Grand Total** | | | | **3,688,755** | **4,140,106** |

[1] Stocked by U.S. Geological Survey- Tunison for research (Atlantic salmon) or restoration (Cisco and Bloater) projects.
[2] Brown trout stocking policy was adjusted to 86.1% of the prior policy (455,000) based on the previous ten-year average of brown trout stocked into Lake Ontario. This new policy reflects a more realistic production capacity of the hatcheries since the 2-year old brown trout program was instituted statewide.
[3] In 2016, surplus brown trout were stocked at ten sites.
[4] No Chinook salmon or Rainbow trout (WAS-W) were stocked into pens at Sandy Creek due to unsuitable pen site in 2016. All fish were direct stocked at this site.
[5] 100,000 Chinook salmon stocked at Lower Niagara River to compensate for shortage in Province of Ontario hatcheries in 2016.
[6] Surplus Coho salmon stocked as spring yearlings at Niagara River and Salmon River.
[7] High mortality during winter 2015/16 at Alleghany Hatchery led to stocking shortfall in 2016.
[8] Experimental stocking to evaluate relative survival of fall fingerlings vs spring yearling planned for 2016 was cancelled.

***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 2016. Numbers stocked 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Co Ylg | 97 | 94 | 96 | 92 | 119 | 98 | 95 | 90 | 90 | 99 | 101 | 105 | 95 | 95 | 99 |
| Co FF | 132 | 155 | 100 | 223 | 172 | 196 | 155 | 155 | 137 | 155 | 155 | 155 | 155 | 155 | 155 |
| Co AF | 0 | 290 | 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 |
| Ck f | 2835 | 2798 | 1603 | 1000 | 1150 | 1300 | 1605 | 1596 | 1596 | 1654 | 1629 | 1633 | 1622 | 1836 | 1809 |
| Ck FF | 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 |
| LT FF | 160 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LT Ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | <1 | 0 | 0 | 0 | 0 | 0 |
| BT Ylg | 382 | 415 | 445 | 402 | 382 | 361 | 426 | 426 | 429 | 421 | 405 | 382 | 414 | 367 | 391 |
| BT FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 0 | 0 | 136 | 39 | 0 | 66 |
| BT AF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 114 | 0 | 0 | 0 | 10 |
| BT f | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 |
| RT Ylg | 82 | 85 | 88 | 92 | 24 | 70 | 93 | 92 | 97 | 75 | 60 | 71 | 75 | 64 | 75 |
| RT FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 20 | 10 | 0 | 0 | 0 |
| RT f | 29 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 40 | 0 | 0 |
| RT Ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | 0 | 0 | 0 | 0 |
| Sthd Ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | <1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sthd Ylg | 551 | 515 | 454 | 487 | 534 | 543 | 555 | 528 | 521 | 533 | 583 | 535 | 560 | 558 | 570 |
| Sthd FF | 40 | 0 | 0 | 0 | 50 | 60 | 110 | 0 | 107 | 0 | 0 | 15 | 0 | 0 | 0 |
| Sthd f | 175 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 6 | 0 | 0 |
| ST FF | 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 |
| AS Ad | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 4 | 6 | 1 | <1 | <1 | <1 | 1 | 0 |
| AS Ylg | 178 | 169 | 135 | 151 | 130 | 97 | 76 | 73 | 84 | 78 | 75 | 75 | 50 | 51 | 50 |
| AS FF | 0 | 0 | 30 | 38 | 34 | 34 | 25 | 25 | 25 | 25 | 25 | 0 | 0 | 0 | 0 |
| AS AF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 0 |
| AS f | 0 | 0 | 0 | 0 | 60 | 171 | 73 | 0 | 156 | 84 | 62 | 17 | 32 | 0 | 0 |
| Sal Total | 5479 | 5029 | 3453 | 2997 | 3158 | 3282 | 3715 | 3430 | 3749 | 3615 | 3729 | 3655 | 3594 | 3619 | 3450 |
| Wal AF | 122 | 52 | 202 | 100 | 104 | 264 | 250 | 194 | 155 | 129 | 10 | 10 | 211 | 71 | 104 |
| Wal FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Stur FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| Bloater FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cisco FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| TOTAL | 5601 | 5081 | 3655 | 3097 | 3262 | 3546 | 3964 | 3623 | 3904 | 3745 | 3739 | 3665 | 3807 | 3691 | 3555 |

Abbreviations:

Ad: Fish age 2 or older (adults)
Ylg: Yearlings, normally stocked between January and June
FF: Fall fingerlings, stocked between September and Dec.
AF: Advanced fingerlings, stocked between mid-June and Sep
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

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

***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 2016. Numbers stocked from 1968-1990 can be found in Eckert (2000).***

| Species Life Stage | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Co Ylg | 110 | 90 | 124 | 95 | 114 | 141 | 120 | 69 | 130 | 90 | 99 |
| Co FF | 155 | 155 | 104 | 155 | 155 | 155 | 0 | 155 | 0 | 141 | 158 |
| Co AF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Co f | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 59 |
| Ck f | 1827 | 1813 | 799 | 1757 | 1531 | 1769 | 1511 | 1772 | 1970 | 1762 | 1883 |
| Ck FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| LT Ylg | 118 | 453 | 501 | 511 | 332 | 488 | 0 | 523 | 443 | 521 | 384 |
| LT FF | 0 | 0 | 0 | 0 | 122 | 0 | 123 | 0 | 528 | 455 | 0 |
| LT Ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BT Ylg | 391 | 385 | 370 | 418 | 409 | 424 | 419 | 331 | 397 | 449 | 464 |
| BT FF | 0 | 0 | 0 | 70 | 57 | 6 | 0 | 0 | 27 | 0 | 31 |
| BT AF | 0 | 0 | 50 | 6 | 116 | 0 | 0 | 0 | 41 | 0 | 0 |
| BT f | 0 | 0 | 0 | 46 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| RT Ylg | 72 | 68 | 74 | 78 | 80 | 82 | 82 | 83 | 42 | 76 | 75 |
| RT FF | 0 | 0 | 0 | 15 | 0 | 27 | 0 | 0 | 0 | 0 | 0 |
| RT f | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 | 0 | 0 | 0 |
| RT Ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sthd Ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sthd Ylg | 572 | 538 | 570 | 561 | 702 | 615 | 554 | 546 | 521 | 382 | 583 |
| Sthd FF | 0 | 0 | 0 | 80 | 188 | 0 | 337 | 0 | 0 | 149 | 0 |
| Sthd f | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| ST FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *ST SF | 0 | 0 | 0 | 54 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AS Ad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| AS Ylg | 29 | 52 | 49 | 50 | 50 | 50 | 60 | 67 | 65 | 70 | 82 |
| AS FF | 0 | 0 | 0 | 24 | 37 | 66 | 73 | 61 | 71 | 74 | 74 |
| AS AF | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 |
| AS f | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 8 | 0 |
| Sal Total | 3263 | 3554 | 2,641 | 3920 | 3891 | 3853 | 3293 | 3606 | 4239 | 4177 | 3900 |
| Wal AF | 123 | 31 | 50 | 118 | 12 | 118 | 23 | 149 | 138 | 70 | 68 |
| Wal FF | 0 | 0 | 5 | 0 |  | 0 | 0 | 0 |  | 0 | 0 |
| Stur FF | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 9 | 9 | 0.5 |
| Bloater FF | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 7 | 20 | 62 | 149 |
| Cisco FF | 0 | 0 | 0 | 0 | 0 | 0 | 9 | 9 | 145 | 100 | 22 |
| TOTAL | 3382 | 3585 | 2696 | 4037 | 3903 | 3972 | 3327 | 3773 | 4551 | 4417 | 4140 |

Abbreviations:
Ad: Fish age 2 or older (adults)
Ylg: Yearlings, normally stocked between January and June
FF: Fall fingerlings, stocked between September and Dec.
AF: Advanced fingerlings, stocked between mid-June and Sep
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

* 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 2016.***

| SPECIES | LOCATION | GD/KY | STK_DATE | HTCH | YCL | STRAIN | MOS | STAGE | WT(g) | MARK | NUMBERS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Atlantic Salmon | Beaverdam Brook | O.53-8 | 6-Apr-16 | AD | 2015 | SEB/LC | 13.5 | Ylg | 47.1 | none | 30,000 | |
| Atlantic Salmon | Salmon River | O.53-8 | 26-Sep-16 | TUN | 2016 | SEB | 7.1 | FF | 10.7 | AD | 8,908 | stocked from Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 27-Sep-16 | TUN | 2016 | SEB | 7.2 | FF | 10.5 | AD | 9,106 | stocked Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 28-Sep-16 | TUN | 2016 | SEB | 7.2 | FF | 12.8 | AD | 8,411 | stocked from Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 29-Sep-16 | TUN | 2016 | SEB | 7.2 | FF | 10.7 | AD | 8,369 | stocked from Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 30-Sep-16 | TUN | 2016 | SEB | 7.3 | FF | 10.3 | AD | 9,979 | stocked from Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 3-Oct-16 | TUN | 2016 | SEB | 7.4 | FF | 9.7 | AD | 9,567 | stocked from Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 4-Oct-16 | TUN | 2016 | SEB | 7.4 | FF | 11.3 | AD | 8,506 | stocked from Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 5-Oct-16 | TUN | 2016 | SEB | 7.4 | FF | 10.3 | AD | 11,452 | stocked from Beaverdam Brook to upper fly zone, source of eggs from AD and BH hatcheries |
| Atlantic Salmon | Salmon River | O.53-8 | 31-Mar-16 | TUN | 2015 | SEB | 13.5 | Ylg | 47.9 | AD-VIE | 2,373 | These fish were produced from eggs taken from Lake Ontario salmon returning to Salmon River. Adipose clipped and red and yellow elastomer tag behind left eye. |
| Atlantic Salmon | Salmon River | O.53-8 | 31-Mar-16 | TUN | 2015 | SEB | 13.5 | Ylg | 47.9 | AD-VIE | 6,170 | adipose clipped and red elastomer tag behind left eye |
| Atlantic Salmon | Salmon River | O.53-8 | 1-Apr-16 | TUN | 2015 | SEB | 13.6 | Ylg | 56.5 | AD-VIE | 9,083 | adipose clipped and red elastomer tag behind left eye |
| Atlantic Salmon | Salmon River | O.53-8 | 7-Apr-16 | TUN | 2015 | SEB | 13.8 | Ylg | 72.6 | AD-VIE | 6,239 | adipose clipped and red elastomer tag behind left eye |
| Atlantic Salmon | Salmon River | O.53-8 | 14-Apr-16 | TUN | 2015 | SEB | 14.0 | Ylg | 72.2 | AD-VIE | 8,194 | adipose clipped and red elastomer tag behind left eye |
| Atlantic Salmon | Point Breeze | 713 | 16-May-16 | AD | 2015 | SEB/LC | 14.8 | Ylg | 51.1 | none | 20,000 | too rough for boat stocking, stocked from 14425 Lakeshore Road |
| **Atlantic Salmon Fall Fingerlings Total** | | | | | | | | | **10.7** | | **74,298** | |
| **Atlantic Salmon Yearling Total** | | | | | | | | | **53.6** | | **82,059** | |
| **Atlantic Salmon Total** | | | | | | | | | **33.3** | | **156,357** | |

***Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2016.***

| SPECIES | LOCATION | GD/KY | STK_DATE | HTCH | YCL | STRAIN | MOS | STAGE | WT(g) | MARK | NUMBERS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Brown Trout | Black River | O.19 | 3-May-16 | SR | 2015 | RL-D | 17.7 | Ylg | 116.3 | none | 4,310 | |
| Brown Trout | Stony Point | 423 | 10-May-16 | SR | 2015 | RL-D | 17.9 | Ylg | 100.8 | none | 47,410 | Barge/LCM |
| Brown Trout | Stony Creek | O.40 | 3-May-16 | SR | 2015 | RL-D | 17.7 | Ylg | 116.3 | none | 2,590 | |
| Brown Trout | Salmon River | | 24-May-16 | SR | 2015 | RL-D | 18.4 | Ylg | 90.7 | none | 5,800 | surplus, stocked at five locations from Pulaski to upper fly |
| Brown Trout | Sunset Bay | 623 | 11-May-16 | SR | 2015 | RL-D | 18.0 | Ylg | 92.6 | none | 35,000 | Barge/LCM |
| Brown Trout | Oswego | 622 | 12-May-16 | SR | 2015 | RL-D | 18.0 | Ylg | 108.0 | none | 35,000 | Barge/LCM |
| Brown Trout | Oswego | 622 | 10-Nov-16 | RA | 2016 | RL-D | 11.1 | FF | 66.7 | none | 13,000 | surplus, stocked at Oswego Port Authority |
| Brown Trout | Oswego | 622 | 2-Jun-16 | RM | 2015 | RL-D | 18.2 | Ylg | 96.9 | none | 5,000 | surplus, stocked at Oswego Port Authority |
| Brown Trout | Fair Haven | 720 | 12-May-16 | SR | 2015 | RL-D | 18.0 | Ylg | 100.8 | none | 35,000 | Barge/LCM |
| Brown Trout | Sodus Point | 819 | 13-May-16 | RM | 2015 | RL-D | 17.6 | Ylg | 92.8 | none | 13,790 | off west pier |
| Brown Trout | Sodus Point | 819 | 13-May-16 | RM | 2015 | RL-D | 17.6 | Ylg | 92.8 | none | 15,480 | off west pier |
| Brown Trout | Sodus Point | 819 | 12-May-16 | RM | 2015 | RL-D | 17.5 | Ylg | 92.8 | none | 15,480 | off west pier |
| Brown Trout | Pultneyville | 818 | 20-May-16 | SR | 2015 | RL-D | 18.3 | Ylg | 96.5 | none | 20,690 | |
| Brown Trout | Webster | 816 | 1-Jun-16 | RM | 2015 | RL-D | 18.2 | Ylg | 100.8 | none | 7,770 | Off Joe Abrahams |
| Brown Trout | Webster | 816 | 17-May-16 | RM | 2015 | RL-D | 17.7 | Ylg | 95.1 | none | 15,500 | Off Joe Abrahams |
| Brown Trout | Webster | 816 | 2-Jun-16 | RM | 2015 | RL-D | 18.2 | Ylg | 100.6 | none | 16,000 | surplus |
| Brown Trout | Irondequoit | 815 | 31-May-16 | CD | 2015 | RL-D | 17.6 | Ylg | 144.0 | none | 7,750 | Off Peter Frank's |
| Brown Trout | Irondequoit | 815 | 31-May-16 | CD | 2015 | RL-D | 17.6 | Ylg | 132.6 | none | 7,750 | Off Peter Frank's |
| Brown Trout | Irondequoit | 815 | 16-May-16 | RM | 2015 | RL-D | 17.7 | Ylg | 95.1 | none | 15,520 | Off Peter Frank's |
| Brown Trout | Rochester | 815 | 5-May-16 | CD | 2015 | RL-D | 16.8 | Ylg | 141.3 | none | 23,270 | Kodak Water Treatment Plant |
| Brown Trout | Braddocks Bay | 815 | 6-May-16 | CD | 2015 | RL-D | 16.8 | Ylg | 156.4 | none | 23,270 | |
| Brown Trout | Hamlin | 713 | 5-May-16 | RM | 2015 | RL-D | 17.3 | Ylg | 92.4 | none | 23,270 | |
| Brown Trout | Point Breeze | 711 | 24-May-16 | RM | 2015 | RL-D | 17.9 | Ylg | 97.1 | none | 16,380 | |
| Brown Trout | Point Breeze | 711 | 9-May-16 | CD | 2015 | RL-D | 16.9 | Ylg | 149.7 | none | 16,380 | |
| Brown Trout | Olcott | 708 | 23-May-16 | CD | 2015 | RL-D | 17.4 | Ylg | 144.4 | none | 18,810 | |
| Brown Trout | Olcott | 708 | 27-May-16 | CD | 2015 | RL-D | 17.5 | Ylg | 132.6 | none | 2,740 | |
| Brown Trout | Wilson | 707 | 18-May-16 | CD | 2015 | RL-D | 17.7 | Ylg | 94.7 | none | 21,550 | |
| Brown Trout | Lower Niagara River | O.158/EN-T0000 | 26-Apr-16 | CD | 2015 | RL-D | 16.5 | Ylg | 126.7 | none | 4,310 | Lewiston Sand Docks |
| Brown Trout | Lower Niagara River | O.158/EN-T0000 | 10-Nov-16 | RA | 2015 | RL-D | 11.1 | FF | 66.7 | none | 5,900 | surplus, Lewiston Sand Docks |
| Brown Trout | Fort Niagara | 806 | 2-Jun-16 | RM | 2015 | RL-D | 18.2 | Ylg | 100.6 | none | 8,500 | surplus |
| Brown Trout | Fort Niagara | 806 | 3-Nov-16 | CH | 2016 | RL-D | 10.9 | FF | 42.0 | none | 12,400 | surplus |
| **Brown Trout Fall Fingerlings** | | | | | | | | | **56.9** | | **31,300** | |
| **Brown Trout Yearlings** | | | | | | | | | **108.6** | | **464,320** | |

***Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2016.***

| SPECIES | LOCATION | GD/KY | STK_DATE | HTCH | YCL | STRAIN | MOS | STAGE | WT(g) | MARK | NUMBERS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Brown Trout Total** | | | | | | | | | | **105.3** | **495,620** | |
| Chinook Salmon | Black River | O.19/OB-T0000 | 26-Apr-16 | SR | 2016 | SAL-W | 3.3 | SF | 4.1 | none | 159,000 | |
| Chinook Salmon | South Sandy Creek | O.45/LO-T0000 | 25-Apr-16 | SR | 2016 | SAL-W | 3.3 | SF | 4.0 | none | 100,000 | |
| Chinook Salmon | Salmon River | O.53/LO-T0000 | 17-May-16 | SR | 2016 | SAL-W | 4.0 | SF | 5.3 | none | 372,900 | |
| Chinook Salmon | Oswego River | O.65 | 6-May-16 | SR | 2016 | SAL-W | 3.6 | SF | 4.5 | none | 97,810 | |
| Chinook Salmon | Oswego River | O.65 | 12-May-16 | SR | 2016 | SAL-W | 3.8 | SF | 6.3 | none | 41,890 | In pens 4/20/16 @100/lb 50ºF |
| Chinook Salmon | Little Sodus Bay | O.74 | 14-May-16 | SR | 2016 | SAL-W | 3.9 | SF | 6.9 | none | 25,000 | In pens 04/19/15 @ 120/lb. 50ºF |
| Chinook Salmon | Sterling Creek | O.73 | 2-May-16 | SR | 2016 | SAL-W | 3.5 | SF | 4.2 | none | 87,200 | Old State Road |
| Chinook Salmon | Sodus Bay | O.84-P96 | 6-May-16 | SR | 2016 | SAL-W | 3.6 | SF | 4.5 | none | 60,000 | Sodus Point: Off West Pier |
| Chinook Salmon | Sodus Bay | O.84-P96 | 11-May-16 | SR | 2016 | SAL-W | 3.8 | SF | 7.3 | none | 50,000 | In pens 4/18/16 @120/lb 47ºF. |
| Chinook Salmon | Genesee River | O.117 | 13-May-16 | SR | 2016 | SAL-W | 3.8 | SF | 4.5 | none | 85,250 | |
| Chinook Salmon | Genesee River | O.117 | 5-May-16 | SR | 2016 | SAL-W | 3.6 | SF | 6.4 | none | 85,250 | In pens 4/15/16 @120/lb 41ºF |
| Chinook Salmon | Sandy Creek | O.130 | 29-Apr-16 | SR | 2016 | SAL-W | 3.4 | SF | 4.3 | none | 110,000 | No pens- all shore stocked. Pen site not available in 2016. |
| Chinook Salmon | Oak Orchard Creek | O.138 | 5-May-16 | SR | 2016 | SAL-W | 3.6 | SF | 4.5 | none | 63,940 | |
| Chinook Salmon | Oak Orchard Creek | O.138 | 10-May-16 | SR | 2016 | SAL-W | 3.7 | SF | 6.1 | none | 106,560 | In pens 4/12/16 @121/lb 43ºF |
| Chinook Salmon | Eighteenmile Creek | O.148 | 5-May-16 | SR | 2016 | SAL-W | 3.6 | SF | 4.5 | none | 67,100 | |
| Chinook Salmon | Eighteenmile Creek | O.148 | 3-May-16 | SR | 2016 | SAL-W | 3.5 | SF | 7.6 | none | 67,100 | In pens 4/13/2016 @ 116/lb. 44ºF |
| Chinook Salmon | lower Niagara River | O.158/EN-T0000 | 17-May-16 | SR | 2016 | SAL-W | 4.0 | SF | 6.5 | none | 75,000 | In pens 4/27/16@120/lb. 45ºF |
| Chinook Salmon | lower Niagara River | O.158/EN-T0000 | 9-May-16 | SR | 2016 | SAL-W | 3.7 | SF | 4.5 | none | 128,500 | |
| **Chinook Salmon Spring Fingerling Total** | | | | | | | | | **5.1** | | **1,882,500** | |
| Coho Salmon | Beaverdam Brook | O.53-8 | 11-May-16 | SR | 2015 | SAL-W | 15.5 | Ylg | 50.4 | none | 99,150 | transferred to smolt release pond 10/20/2015 |
| Coho Salmon | Beaverdam Brook | O.53-8 | 27-May-16 | SR | 2016 | SAL-W | 4.3 | SF | 5.7 | AD | 25,690 | surplus stocked behind hatchery at pumphouse |
| Coho Salmon | Sodus Bay | O.84 | 2-Nov-16 | SR | 2016 | SAL-W | 9.4 | FF | 16.0 | AD CWT | 13,798 | CWT#640865, smaller group |
| Coho Salmon | Sodus Bay | O.84 | 2-Nov-16 | SR | 2016 | SAL-W | 9.4 | FF | 20.0 | AD CWT | 11,592 | CWT#640866, larger group |
| Coho Salmon | Genesee River | O.117 | 2-Nov-16 | SR | 2016 | SAL-W | 9.4 | FF | 17.6 | AD CWT | 10,213 | CWT#640869, smaller group |
| Coho Salmon | Genesee River | O.117 | 2-Nov-16 | SR | 2016 | SAL-W | 9.4 | FF | 24.2 | AD CWT | 12,557 | CWT#640870, larger group |
| Coho Salmon | Sandy Creek | O.130 | 3-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 11.1 | AD CWT | 11,351 | CWT#640871, smaller group |
| Coho Salmon | Sandy Creek | O.130 | 3-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 19.6 | AD CWT | 12,480 | CWT#640872, larger group |
| Coho Salmon | Sandy Creek | O.130 | 3-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 19.6 | AD CWT | 3,619 | CWT#600150 or 600134, larger group |

***Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2016.***

| SPECIES | LOCATION | GD/KY | STK_DATE | HTCH | YCL | STRAIN | MOS | STAGE | WT(g) | MARK | NUMBERS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Coho Salmon | Oak Orchard Creek | O.138 | 3-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 18.8 | AD CWT | 12,385 | CWT#640867, larger group |
| Coho Salmon | Oak Orchard Creek | O.138 | 3-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 17.1 | AD CWT | 13,255 | CWT#640868, smaller group |
| Coho Salmon | Oak Orchard Creek | O.138 | 3-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 17.0 | AD | 500 | AD only added to fill out total at site |
| Coho Salmon | Eighteenmile Creek | O.148 | 4-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 10.4 | AD CWT | 11,531 | CWT#640875, smaller group |
| Coho Salmon | Eighteenmile Creek | O.148 | 4-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 17.4 | AD CWT | 12,816 | CWT#640876, larger group |
| Coho Salmon | Eighteenmile Creek | O.148 | 4-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 15.7 | AD CWT | 6,350 | CWT#600137, larger group |
| Coho Salmon | lower Niagara River | O.158 | 4-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 13.7 | AD CWT | 9,497 | Lewiston Sand Docks, CWT#640873, smaller grou |
| Coho Salmon | lower Niagara River | O.158 | 4-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 22.2 | AD CWT | 10,952 | Lewiston Sand Docks, CWT#640874, larger group |
| Coho Salmon | lower Niagara River | O.158 | 4-Nov-16 | SR | 2016 | SAL-W | 9.5 | FF | 18.8 | AD CWT | 5,191 | Lewiston Sand Docks, CWT#600146, larger group |
| Coho Salmon | lower Niagara River | O.158 | 31-May-16 | SR | 2016 | SAL-W | 4.4 | SF | 5.7 | AD | 33,520 | surplus, Lewiston Sand Docks |
| **Coho Salmon Fall Fingerlings** | | | | | | | | | **17.4** | | **158,087** | |
| **Coho Salmon Spring Fingerlings** | | | | | | | | | **5.7** | | **59,210** | |
| **Coho Salmon Yearlings** | | | | | | | | | **50.4** | | **99,150** | |
| **Coho Salmon Total** | | | | | | | | | **25.6** | | **316,447** | |
| Lake Trout | Stony Point | 422 | 10-May-16 | AL | 2015 | HPW | 15.3 | Ylg | 36.3 | AD CWT | 31,470 | Barge/LCM, CWT#640714 |
| Lake Trout | Stony Point | 422 | 10-May-16 | AL | 2015 | SEN-W | 14.1 | Ylg | 30.0 | AD CWT | 40,830 | Barge/LCM, CWT#640720 |
| Lake Trout | Oswego | 622 | 11-May-16 | AL | 2015 | SEN-W | 14.1 | Ylg | 28.0 | AD CWT | 40,840 | Barge/LCM, CWT#640716 |
| Lake Trout | Oswego | 623 | 11-May-16 | AL | 2015 | SKW | 16.0 | Ylg | 34.9 | AD CWT | 13,220 | Barge/LCM, CWT#640703 |
| Lake Trout | Oswego | 623 | 11-May-16 | AL | 2015 | SKW | 16.0 | Ylg | 34.9 | AD CWT | 5,270 | Barge/LCM, CWT#640704 |
| Lake Trout | Oswego | 622 | 12-May-16 | EI | 2015 | LCH-D | 15.1 | Ylg | 31.4 | AD CWT | 38,360 | Barge/LCM, CWT#640695 |
| Lake Trout | Sodus | 819 | 13-May-16 | AL | 2015 | SKW | 16.1 | Ylg | 42.0 | AD CWT | 36,300 | Barge/LCM, CWT#640702 |
| Lake Trout | Sodus | 819 | 13-May-16 | AL | 2015 | HPW | 15.4 | Ylg | 31.9 | AD CWT | 40,670 | Barge/LCM, CWT640713 |
| Lake Trout | Oak Orchard | 711 | 17-May-16 | EI | 2015 | LCH-D | 15.1 | Ylg | 31.3 | AD CWT | 40,650 | Barge/LCM, CWT#640696 |
| Lake Trout | Oak Orchard | 711 | 17-May-16 | EI | 2015 | LCH-D | 15.1 | Ylg | 33.1 | AD CWT | 40,800 | Barge/LCM, CWT#640697 |
| Lake Trout | Olcott | 708 | 20-May-16 | AL | 2015 | SEN | 14.4 | Ylg | 29.5 | AD CWT | 40,890 | Barge/LCM, CWT 640717 |
| Lake Trout | Olcott | 708 | 20-May-16 | AL | 2015 | HPW | 15.6 | Ylg | 37.2 | AD CWT | 14,950 | Barge/LCM, CWT#640715 |
| **Lake Trout Spring Yearlings** | | | | | | | | | **32.7** | | **384,250** | |
| **Lake Trout Total** | | | | | | | | | **32.7** | | **384,250** | |
| Rainbow Trout | Black River | 424 | 28-Apr-16 | SR | 2015 | WAS-W | 10.7 | Ylg | 16.2 | none | 36,000 | Sacketts Harbor |
| Rainbow Trout | Black River | O.19 | 28-Apr-16 | SR | 2015 | WAS-W | 10.7 | Ylg | 16.2 | none | 36,000 | below Dexter Falls |
| Rainbow Trout | Stony Creek | O.40 | 1-Apr-16 | SR | 2015 | WAS-W | 9.8 | Ylg | 16.8 | none | 20,700 | |
| Rainbow Trout | South Sandy Creek | O.45 | 1-Apr-16 | SR | 2015 | WAS-W | 9.8 | Ylg | 16.8 | none | 28,750 | |

***Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2016.***

| SPECIES | LOCATION | GD/KY | STK_DATE | HTCH | YCL | STRAIN | MOS | STAGE | WT(g) | MARK | NUMBERS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rainbow Trout | Beaverdam Brook | O.53-8 | 13-Apr-16 | SR | 2015 | WAS-W | 10.2 | Ylg | 23.2 | none | 129,630 | Some stocked 4/8/2016 |
| Rainbow Trout | Beaverdam Brook | O.53-8 | 11-May-16 | SR | 2015 | SKA-W | 11.1 | Ylg | 23.5 | AD | 75,190 | |
| Rainbow Trout | Grindstone Creek | O.54 | 8-Apr-16 | SR | 2015 | WAS-W | 10.1 | Ylg | 15.1 | none | 5,000 | |
| Rainbow Trout | Little Salmon River | O.58 | 12-May-16 | SR | 2015 | WAS-W | 11.2 | Ylg | 29.3 | none | 5,000 | In pens 4/19/2016 @ 28.2 /lb 53ºF |
| Rainbow Trout | Oswego River | O.66 | 8-Apr-16 | SR | 2015 | WAS-W | 10.1 | Ylg | 15.1 | none | 20,000 | |
| Rainbow Trout | Sterling Creek | O.73 | 1-Apr-16 | SR | 2015 | WAS-W | 9.8 | Ylg | 16.8 | none | 4,600 | |
| Rainbow Trout | Sterling Valley Ck | O.73-3 | 1-Apr-16 | SR | 2015 | WAS-W | 9.8 | Ylg | 16.8 | none | 4,600 | |
| Rainbow Trout | Little Sodus Bay | O.74 | 14-May-16 | SR | 2015 | WAS-W | 11.2 | Ylg | 32.4 | none | 6,000 | In pens 4/19/16@ 30/lb 50ºF |
| Rainbow Trout | Maxwell Creek | O.85 | 4-May-16 | SR | 2015 | WAS-W | 10.9 | Ylg | 18.9 | none | 19,950 | |
| Rainbow Trout | Irondequoit Creek | O.108 | 26-Apr-16 | SR | 2015 | WAS-W | 10.6 | Ylg | 17.4 | none | 27,500 | |
| Rainbow Trout | Genesee River | O.117 | 15-Apr-16 | SR | 2015 | WAS-W | 10.3 | Ylg | 16.8 | none | 12,100 | |
| Rainbow Trout | Genesee River | O.117 | 5-May-16 | SR | 2015 | WAS-W | 10.9 | Ylg | 30.9 | none | 10,000 | In pens 4/15/16@ 27/lb 41ºF |
| Rainbow Trout | Salmon Creek | O.93 | 28-Apr-16 | SR | 2015 | WAS-W | 10.7 | Ylg | 18.1 | none | 5,050 | |
| Rainbow Trout | Sandy Creek | O.130 | 29-Apr-16 | SR | 2015 | WAS-W | 10.7 | Ylg | 15.1 | none | 14,650 | No pens. All shore stocked |
| Rainbow Trout | Oak Orchard Creek | O.138 | 12-Apr-16 | SR | 2015 | WAS-W | 10.2 | Ylg | 17.9 | none | 7,000 | |
| Rainbow Trout | Oak Orchard Creek | O.138 | 10-May-16 | SR | 2015 | WAS-W | 11.1 | Ylg | 29.1 | none | 14,000 | In Pens 4/12/16 @25.3/lb 43ºF |
| Rainbow Trout | Marsh Creek | O.138-2 | 28-Apr-16 | SR | 2015 | WAS-W | 10.7 | Ylg | 18.1 | none | 7,100 | |
| Rainbow Trout | Johnson Creek | O.139 | 28-Apr-16 | SR | 2015 | WAS-W | 10.7 | Ylg | 18.1 | none | 6,700 | |
| Rainbow Trout | Eighteenmile Creek | O.148 | 13-Apr-16 | SR | 2015 | WAS-W | 10.2 | Ylg | 17.9 | none | 6,500 | |
| Rainbow Trout | Eighteenmile Creek | O.158 | 2-May-16 | SR | 2015 | WAS-W | 10.8 | Ylg | 28.6 | none | 3,500 | In pens 4/13/16@24.3/lb 44ºF |
| Rainbow Trout | Twelvemile Creek E Br | O.152 | 18-Apr-16 | SR | 2015 | WAS-W | 10.4 | Ylg | 18.1 | none | 10,500 | |
| Rainbow Trout | Twelvemile Creek | O.152A | 18-Apr-16 | SR | 2015 | WAS-W | 10.4 | Ylg | 18.1 | none | 12,000 | |
| Rainbow Trout | Twelvemile Creek (Wilson) | O.152 | 10-May-16 | SR | 2015 | WAS-W | 11.1 | Ylg | 45.4 | none | 7,500 | In pens 04/18/2016 @25/lb 55ºF |
| Rainbow Trout | lower Niagara River | O.158 | 27-Apr-16 | SR | 2015 | WAS-W | 10.7 | Ylg | 18.1 | none | 37,000 | |
| Rainbow Trout | lower Niagara River | O.158 | 17-May-16 | SR | 2015 | WAS-W | 11.3 | Ylg | 30.3 | none | 10,000 | In pens 4/27/2016 @25/lb 45ºF |
| Rainbow Trout | Irondequoit Creek | O.108 | 12-Apr-16 | PMP | 2015 | FL-W | 10.2 | Ylg | 34.9 | none | 7,200 | Powder Mill Pond release, No WAS strain after 2006 |
| Rainbow Trout | Sodus | 819 | 26-Apr-16 | CH | 2015 | RA-D | 16.1 | Ylg | 113.4 | none | 20,000 | 11,600 stocked on 4/25/16; 8,400 stocked on 4/26/16 |
| Rainbow Trout | Webster | 815 | 4-May-16 | CS | 2015 | RA-D | 16.8 | Ylg | 163.2 | none | 4,070 | Fish stocked at Irondequoit off Peter Franks |
| Rainbow Trout | Webster | 815 | 25-May-16 | VH | 2015 | RA-D | 17.0 | Ylg | 108.0 | none | 5,930 | Off Joe Abrahams |
| Rainbow Trout | Hamlin | 713 | 25-Apr-16 | CH | 2015 | RA-D | 16.0 | Ylg | 114.0 | none | 17,450 | 5,850 stocked on 4/25/16; 11,600 stocked 5/12/16 |
| Rainbow Trout | Hamlin | 713 | 21-Apr-16 | CS | 2015 | RA-D | 15.9 | Ylg | 116.9 | none | 2,550 | |
| Rainbow Trout | Olcott | 708 | 28-Apr-16 | CS | 2015 | RA-D | 16.1 | Ylg | 145.4 | none | 12,500 | |
| Rainbow Trout | Wilson | 707 | 2-May-16 | CS | 2015 | RA-D | 16.3 | Ylg | 144.0 | none | 12,500 | |

***Table 3. Trout, salmon and other species stocked in New York waters of Lake Ontario and the Upper St. Lawrence River in 2016.***

| SPECIES | LOCATION | GD/KY | STK_DATE | HTCH | YCL | STRAIN | MOS | STAGE | WT(g) | MARK | NUMBERS | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Washington Steelhead Yearlings** | | | | | | | | | **20.3** | | **507,330** | |
| **Skamania Steelhead Yearlings** | | | | | | | | | **23.5** | | **75,190** | |
| **Rainbow Trout Yearlings (Randolph strain)** | | | | | | | | | **126.3** | | **75,000** | |
| **Rainbow Trout Yearlings (Finger Lakes W strain)** | | | | | | | | | **34.9** | | **7,200** | |
| **Rainbow Trout Total** | | | | | | | | | **32.8** | | **664,720** | |
| Walleye | lower Niagara River | EN-P0000 | 9-Jun-16 | CQ | 2016 | ONL-W | 0.3 | PF | 0.2 | none | 23,200 | |
| Walleye | Sodus Bay | O-P0096 | 13-Jun-16 | CQ | 2016 | ONL-W | 0.4 | PF | 0.3 | none | 45,050 | |
| **Walleye Fingerling Total** | | | | | | | | | **0.3** | | **68,250** | |
| Bloater | Oswego | 621 | 3-Nov-16 | TUN | 2016 | LM | 6.8 | FF | 3.2 | ALZ | 149,353 | Stocked off Oswego at 100m contour by USGS RV/Kaho. Single ALZ red mark |
| Cisco | Sodus Bay | 815 | 25-Oct-16 | TUN | 2016 | LO | 8.6 | FF | 8.4 | CAL | 22,109 | Stocked by boat. Single CAL mark. |
| **Coregonine Total** | | | | | | | | | **3.8** | | **171,462** | |
| Lake Sturgeon | Genesee River | O.117 | 7-Oct-16 | GEN | 2016 | SLR | 3.9 | FF | 20.7 | CWT-VIE-SCU | 500 | CWT (#055197) in 1st scute on right side of fish. |
| **Lake Sturgeon Total** | | | | | | | | | **20.7** | | **500** | |
| **Salmonine Total** | | | | | | | | | | | **3,899,894** | |
| **Total All Species** | | | | | | | | | | | **4,140,106** | |

# 2016 Lake Ontario Fishing Boat Survey

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Lake Ontario provides anglers with a diverse world-class trout and salmon fishery and ample fishing opportunities for a variety of warm- and cool-water species (e.g., smallmouth bass, walleye, yellow perch). Each year from 1985-2016 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. Data presented and discussed in this report are 5½ month estimates for each survey year (1985-2016). This report focuses on 2016 results and on comparisons of 2016 with data collected during previous years. Appended tables and figures provide additional data (e.g., annual estimates of effort, catch, harvest and biological data) collected each year 2007-2016 and a 22-year average for 1985-2006.

## Methods

<u>Sampling Design and Data Collection</u>

Methods and procedures have changed little throughout the 32 years surveyed. For 20 of the 32 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 changed to 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 (29 channels in 2016). 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 period from two hours after sunrise (1.5 hours after sunrise during April and September only) and

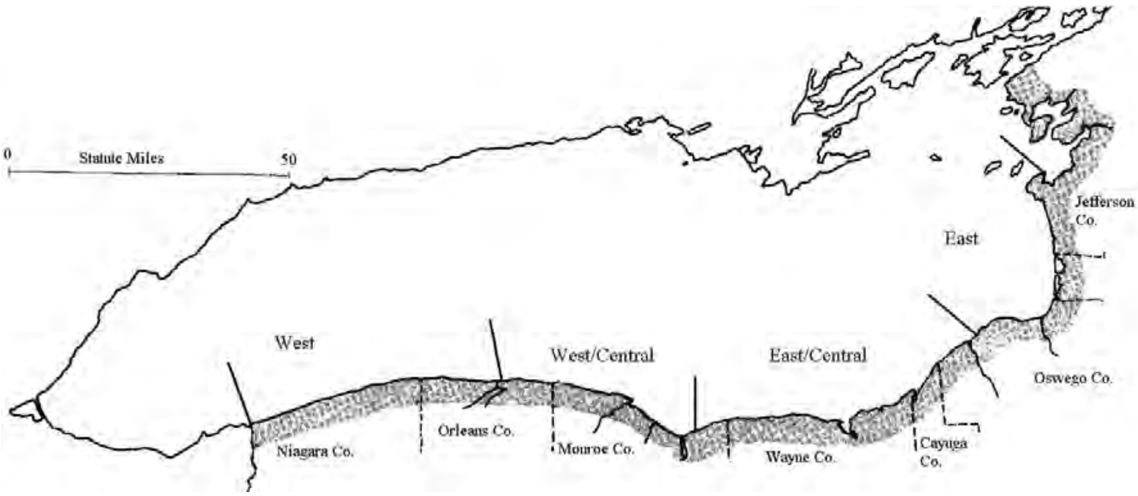


***Figure 1. Lake Ontario's New York shoreline (shaded in gray), the seven New York counties that border the lake, and the four geographic areas used in analysis of the survey data.***

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 2010-2016*

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 5.5-month 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 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 (see Lantry and Eckert 2013 for detailed methods).

*Geographic Area Comparisons*
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). 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 general trends, typically observed each year, are reiterated here. For this report we compare 2016 5½ month regional results with general trends observed in previous years of the survey 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 9.3, SAS Institute 2011, 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

<u>Fishing and Boating Effort</u>
The estimated number of all 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. Effort remained relatively stable until the early 2000s. Since then fishing effort specifically targeting trout and salmon remained relatively stable, while total fishing effort declined (Figure 2). This was attributed to a decline in effort targeting smallmouth bass (see *Smallmouth Bass Targeted Effort* in this section). In 2016, however, the record low total fishing effort (46,339 boat trips [±14.8%], a decline of about 6,800 boat trips from 2015) is attributed to reduced effort directed at trout and salmon (38,776 boat trips, a decrease of about 7,400 boat trips from 2015 and a 24% decrease compared to the previous 10-year average; Figure 2, Table A2). Fishing effort targeting trout and salmon was the lowest observed and may be partly attributed to undesirable weather patterns and reduced fishing quality for some species.

Total fishing effort in 2016, as measured by angler trips and angler hours, was 138,434 and 787,588, respectively (Table A2). The average number of anglers per boat trip ranged from 2.5 (1985) to 3.0 (2016 was highest in data series), and averaged 2.9 with an increasing trend during the last 10 years (Table A2). The increased number of anglers per boat trip is largely influenced by the increase in trout and salmon fishing effort relative to effort targeting smallmouth bass (i.e., boats targeting trout and salmon typically have more anglers onboard than bass trips). The 2016 average trip length of 5.7 hours per boat trip was comparable to previous 5-year (+3.2%) and 10-year averages (+6.3%).

We evaluated the contribution to total fishing effort for each month April through September (Table A2). The greatest amount of fishing effort occurred during the second half of the open lake fishing season (2007-2016 10-year averages: April 15-30: 4.5%, May: 15.8%, June: 11.9%, July: 21.0%, August: 29.4%, and September: 17.4%). In 2016, total fishing effort estimates for May, July, and August were the lowest in the 32-years surveyed and well below respective previous 10-year averages (range: -34.7% to -22.9%). Estimates of effort in June and September were the second lowest on record (-30.9% and -29.2% decreases, respectively, as compared to the previous 10-year averages).

*Geographic Area Fishing Effort*
We evaluated regional contributions to total 5.5-month fishing effort (Table A2). The greatest

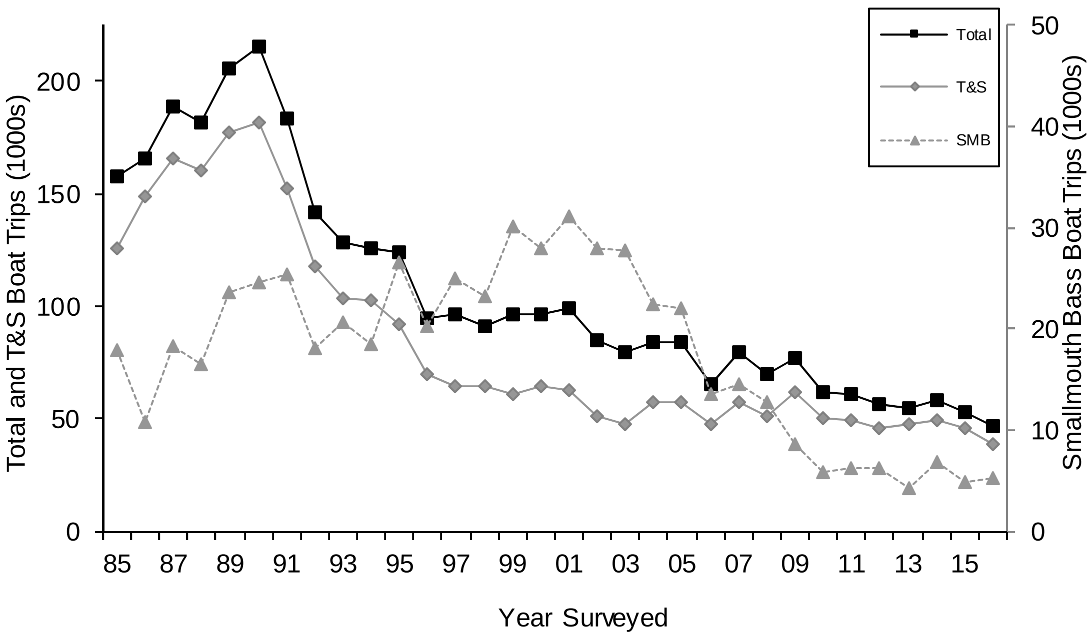


***Figure 2. Estimated number of total fishing boat trips, trips targeting trout and salmon (T&S; April 15-September 30), and trips targeting smallmouth bass (SMB) during the traditional open season (3rd Saturday in June-September 30 when the survey ended), 1985-2016.***

amount of fishing effort occurred in the east/central area for 28 of the last 32 years (Table A2). In 2016, fishing effort declined in each of the four areas. The greatest effort occurred in the east/central area (17,508 boat trips, the fourth lowest for that area, 37.8% of all fishing effort) and east area (12,622 boat trips, the lowest for that area, and 27.2% of all effort). Effort in the west was estimated at 11,649 boat trips (the lowest for that area). For each of the 32 years surveyed, the lowest fishing effort occurred in the west/central area (4,561 boat trips in 2016 and 9.8% of total fishing effort).

*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 46,747 vessel excursions and 30.0% of the total vessel traffic in 2016 (Table A2). Non-fishing power boats were estimated at 96,268 excursions in 2016 (61.8% of the total vessel traffic). Non-fishing power boat traffic peaked and declined similar to that described for fishing boats over the 32-year survey period.

Sailboats, the smallest component of vessel traffic, showed a downward trend through much of the time series (1985-2006; highest in 1987 [48,272 trips], lowest in 2006 [12,186 trips]), increased in recent years to 20,703-23,914 trips during 2009-2013, but most recently declined. In 2016, sailboats accounted for 12,789 excursions and represented 8.2% of vessel traffic. This is similar to (-1.2%) the record lows observed from 2004-2006 (average = 13,043 sailboat trips; Table A2).

*Trout and Salmon Targeted Effort*

Trout and salmon were the primary target of boat anglers interviewed each year since 1985 (1985-2016 average = 77.1%; range: 59.7% [2003] to 90.0% [1986]; Figure 2, Table A2), and trends in total fishing effort were largely attributed to trout and salmon anglers from 1985 through the late 1990s. Although there was no significant trend in effort directed at trout and salmon over the last 15 years, effort declined in 2016 to a record low level (38,776 [±15.2%] boat trips) that was 15.8% below the previous record low (46,059 boat trips in 2012; Table A2). In 2016, trout and salmon anglers accounted for 83.7% of total fishing boat trips, 88.0% of angler trips, and 93.4% of angler hours (Table A2).

Estimated monthly fishing effort targeting trout and salmon in 2016 was above the previous 5-year averages in April (+15.3%), but was below the previous 5-year averages May through September (range: -30.8% [August] to -10.2% [July]; Table A2). Trout and salmon fishing effort estimates for May, June, August and September were the lowest or second lowest in the 32-years surveyed, and coincided with reduced fishing quality for Chinook salmon, coho salmon, rainbow trout, and brown trout during at least some of these months. The majority of anglers interviewed each year since 2005 were specifically targeting Chinook salmon (2005-2015 average=47.9%). During 2016, 45.9% of salmonine anglers interviewed were specifically targeting Chinook salmon, 41.4% were targeting a mix of two or more species, and 10.1% were specifically targeting brown trout.

*Smallmouth Bass Targeted Effort*

Pre-Season Catch and Release Period:

Fishing effort targeting smallmouth bass before the traditional open lake season (i.e., beginning the third Saturday of June) has remained low since it became legal to do so. An October 1, 2006 regulation change established a catch and release bass season 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 fishing effort (Table A2). In 2006, prior to the new pre-season catch and release regulation taking 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: 164 boat trips [2015] – 644 trips [2009]) and a minor component of total bass effort occurring from April 15 - September 30 (range: 2.8% [2008] to 7.7% [2012]). Pre-season effort targeting smallmouth bass in 2016 was an estimated 356 boat trips (6.3% of total bass effort; Table A2).

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 Lake Ontario anglers not seeking trout or salmon (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 2016, smallmouth bass anglers fishing during the traditional open season accounted for 11.4% of all fishing boat trips (April 15 – September 30), 8.6% of angler trips, and 4.7% of angler hours. The total number of angler hours spent targeting bass on Lake Ontario in 2016 was comparable to (-4.9%) the previous 5-year average. In 2016, the average number of anglers per bass boat trip (2.3 anglers) was the highest since 2007 but was comparable to (+6.4%) the previous 5-year average. The number of hours per boat trip (3.1 hours) was also average (-3%).

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 ($P < 0.05$; Figure 2, Table A2). These trends in fishing effort coincide with a similar declining trend in fishing quality through 2010 (see section "Smallmouth Bass *Fishing Quality*" of this report). Since 2010, effort remained low and at a level 81.9% below the 2001 peak (2011-2016 average = 5,629 boat trips). In 2016, smallmouth bass fishing effort during the traditional open season (June 18 to September 30) was an estimated 5,295 (±38.3%) boats trips, comparable to (-7.0%) the previous 5-year average (Figure 2, Table A2). Fishing effort for smallmouth bass was below the previous 5-year average during June (-18.4%) and July (-29.2%), above average in August (+24.0%), and was comparable to the previous 5-year average in September (+5.1%; Table A2). Effort was well below recent averages in the west area (-67.5%) and west/central area (-79.3%), was above average in the east/central (+35.8%), and comparable to the previous 5-year average in the east (-3.0%) area (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 2016, however, trips targeting these species only represented 1.7% of the total fishing boat trips on Lake Ontario (Table A2). The "all others" category, which represented 2.3% of 2016 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 2016, charter boats accounted for 18.7% of the total number of fishing boat trips (Figure 3). With more anglers on board and longer trips, charter boats accounted for 32.9% and 39.9% of the angler trips and angler hours, respectively (captains and mates counted as anglers; Table A2). Although charter boats accounted for only 18.7% of total fishing boat effort, they accounted for 47.6% of the total salmonine catch in 2016. 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.

The highest charter fishing effort occurred 1988-1991, then declined and has remained relatively stable for over ten years (Figure 3, Table A2). The 2016 estimated charter boat effort was 8,653 (±24.3%) trips, comparable to the previous 5-year (-3.5%) and 10-year (-4.8%) averages. Estimated monthly charter fishing effort in 2016 was below the previous 5-year averages for May (-29.9%) and August (-36.1%), and above average the other months (range: +16.2% [June] to +54.9% [April]; Table A2).

Angler Residency

Lake Ontario’s world-class sportfishery has attracted anglers from all 50 states (32 in 2016) and many different countries (6 in 2016) over the last 32 years. 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 interviewed, respectively (Figure 4). There was no trend in the percentage of anglers residing in NYS for the period 1987-2016. Over the last 10 years, an average of 60.6% of Lake Ontario anglers resided in NYS (58.9% in 2016; Table A4).

Contribution of nonresident anglers increased after 1985 when 20.2% of Lake Ontario open lake anglers were not NYS residents. This increase was likely due to increasing awareness of the Lake Ontario trout and salmon sport fishery (Figure 4). Since the early 1990s the percentage of anglers who reside outside of NYS ranged from 35.2% (2003) to 45.6% (1992). In 2016, non-NYS residents comprised 41.1% of the boat anglers interviewed, comparable to previous 5-year and 10-year averages (+4.2% and +4.5%, respectively; Figure 4; Table A2, Table A4). Pennsylvania represented the largest component of nonresident anglers for each of the 32 years surveyed (21.2% of the all anglers in 2016). The highest percentage of Pennsylvania anglers occurred in 2012 (21.9%) and the lowest (8.5%) occurred in 1985 (Table A4). Other major sources of non-NYS anglers in 2016 were Ohio (4.3%), Massachusetts (3.3%), New Jersey (2.7%), Vermont (1.5%), New Hampshire (1.4%), and Maine (1.3; Table A4).

Throughout the 32-year survey period, 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). The percentage of NYS residents residing in the border counties declined in recent years, with the lowest levels recorded 2014-2016 (57.1% in 2016). As

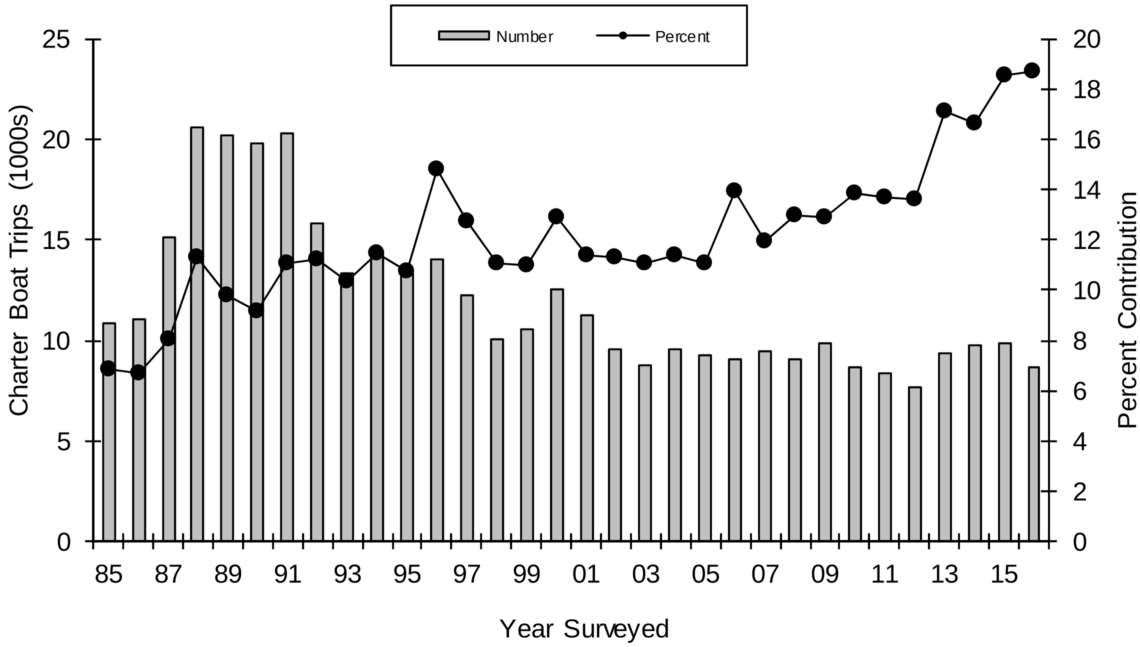


***Figure 3. Estimated number of charter fishing boat trips and their percent contribution to total fishing boat trips, April 15- September 30, 1985-2016.***

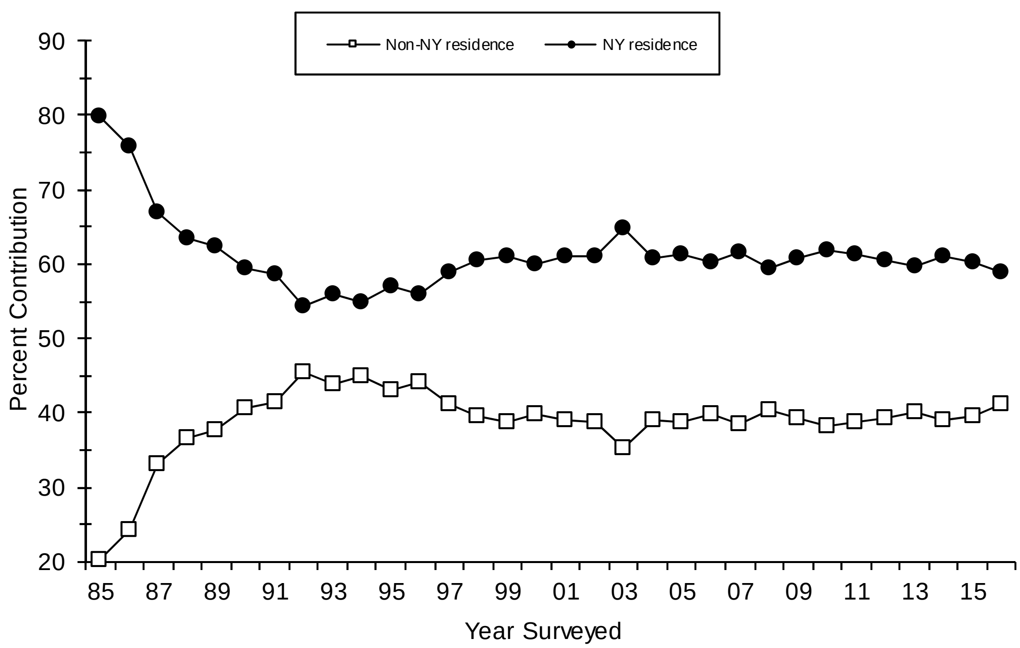


***Figure 4. Percent contribution of anglers with and without New York state residency, 1985-2016.***

was observed each year of the survey, Monroe County remained the most important source of residents in the boat fishery, representing 16.0% of all NYS anglers interviewed in 2016 (Table A4). Other counties representing important components of the open lake boat fishery in 2016 were Oswego (12.8%), Wayne (9.5%), Niagara (6.5%), Onondaga (6.0%), Orleans (5.2%), and Erie

(4.7%; Table A4).

Total Salmonines: Catch, Harvest and Fishing Quality

*Catch and Harvest*

Trout and salmon are the most sought after fish in Lake Ontario. The six species provide anglers with a diverse trout and salmon fishery throughout the open lake season and along the entire NY shoreline. This variety gives anglers the opportunity to target another species when their preferred target is not available. Total catch of all trout and salmon species was estimated at 138,231 (±19.8%) fish, the lowest estimated since 2008 (Figure 5, Table 1, Table A5a). In 2016, anglers harvested 57.4% of the catch, comparable to the long-term average (60.9%). Estimated salmonine harvest was 79,334 (±21.4%) fish, a 21.1% decrease comparable to the 2011-2015 average (Figure 5, Table 1, Table A5a).

Each year since 2003, Chinook salmon dominated the trout and salmon catch (2016: 60,435 [±26.9%] fish, 44% of total catch) and harvest (2016: 34,405 [±28.7%] fish, 43% of total harvest). In most recent years, brown trout or rainbow trout represented the second most commonly caught and harvested species, and lake trout represented a relatively minor component of the fishery. In 2015 and 2016, however, lake trout represented the second most commonly caught and harvested species (2016: 36,336 [±31.7%] and 18,426 [±33.2%] fish, respectively) representing 26% of catch and 23% of angler harvest (the highest percentages since 2002). Brown trout was the third most commonly caught species, although the estimated catch (20,871 [±37.3%] fish) was the second lowest observed. Rainbow trout represented 12% of angler trout and salmon catch (16,639 [±42.7%] fish, the lowest estimate since 2005). Coho salmon and Atlantic salmon each represented relatively small components of the fishery (2.3% and 0.5% of total, respectively).

*Fishing Quality*

Each year trout and salmon catch rates vary by month and region and similar trends tend to occur each year. Fishing quality is influenced by many factors including, angler experience (e.g., best lure, fishing depths), water temperature patterns, recent wind patterns, distance from shore, fish distribution, and species targeted. Quality experienced also varies with when (e.g., specific day, week, month, year) and where anglers are fishing (e.g., west, west/central, east/central, east). During 2016, there were periods and locations of

***Table 1. Harvest and catch estimates for April 15 – September 30, 2016 from the NYSDEC Lake Ontario fishing boat survey.***

| | Number Harvested | Number Caught |
|---|---|---|
| Coho salmon | 2,173 | 3,219 |
| Chinook salmon | 34,405 | 60,435 |
| Rainbow trout | 9,487 | 16,639 |
| Atlantic salmon | 236 | 704 |
| Brown trout | 14,608 | 20,871 |
| Lake trout | 18,426 | 36,336 |
| Smallmouth bass (includes pre-season) | 3,701 | 26,719 |
| Yellow perch | 10,483 | 18,176 |
| Walleye | 349 | 671 |
| Round goby | 5,015 | 12,982 |
| Other fish | 207 | 1,862 |

excellent fishing quality and periods and locations of poor fishing quality. With the variety of trout and salmon species present in Lake Ontario, anglers were able to target another species when catch rates for their preferred target declined. This resulted in a good catch rate for all trout and salmon combined (3.6 fish per boat trip) in 2016; however, this relatively high rate is partly attributed to the high catch rate of lake trout (e.g., 0.9 lake trout per boat trip and the fourth highest in the entire data series) which is viewed by many as a less desirable target. Species-specific rates are discussed in greater detail in the species-specific sections of this report.

The quality of trout and salmon fishing in Lake Ontario, as measured by catch rate of all species combined, was variable but relatively stable from 1985-2002; however, increased substantially in 2003 and remained at a higher variable level since (Figure 5). Anglers experienced eight consecutive years (2009-2016) of record high trout and salmon catch rates. The catch per boat trip in 2016 was the fifth highest estimated in the survey (3.6 fish caught per boat trip) and was only a slight decrease (-9.5%) compared to the previous 5-year average (Figure 5, Table A5b). Eleven of the twelve highest catch rates occurred between 2003 and 2016. During this time period anglers experienced high species-specific catch rates (Chinook salmon 2003-2016; coho salmon 2006-2007 and 2009-2012; rainbow trout 2008-2014; brown trout 2007, 2011-2012, and 2014; and lake trout 2013-2016). The 2016 total trout and salmon harvest rate for all boats targeting trout and salmon was 2.0 fish per boat trip, comparable to (-2.6%) the 2011-2015 average harvest rate (Figure 5, Table A5b). Catch and harvest rate data (fish per boat trip) were also evaluated by month. In 2016, catch rates were comparable to respective previous 5-year averages during June, July and September (range: -4.2% to +6.4%). Rates were below average during the other months (range: -27.6% [May] to -16.4% [April]; Table A5b).

In 2016, charter boats targeting trout and salmon accounted for 47.6% and 61.8% of all salmonines caught and harvested, respectively, but represented only 22.0% of trout and salmon fishing boat effort, 36.8% of angler trips and 42.1% of angler hours directed at trout and salmon. Charter boat total trout and salmon catch rate (7.7 fish per boat trip) and harvest rate (5.7 fish per boat trip) were slight increases compared to long-term averages (+10.9% and +13.2%, respectively) and comparable to the previous 10-years averages (-0.4% and +0.4%, respectively; Table A5b). Charter catch rate per angler hour was 0.21 salmonines, an 11.4% increase compared to the long-term average and comparable to (-4.1%) the previous 10-year average (Figure 5c; Table A5b).

Noncharter fishing boats caught an average of 2.4 salmonines per boat trip (0.17 fish caught per angler hour) in 2016, comparable to (-9.0%) the previous 10-year average (Table A5b). Among

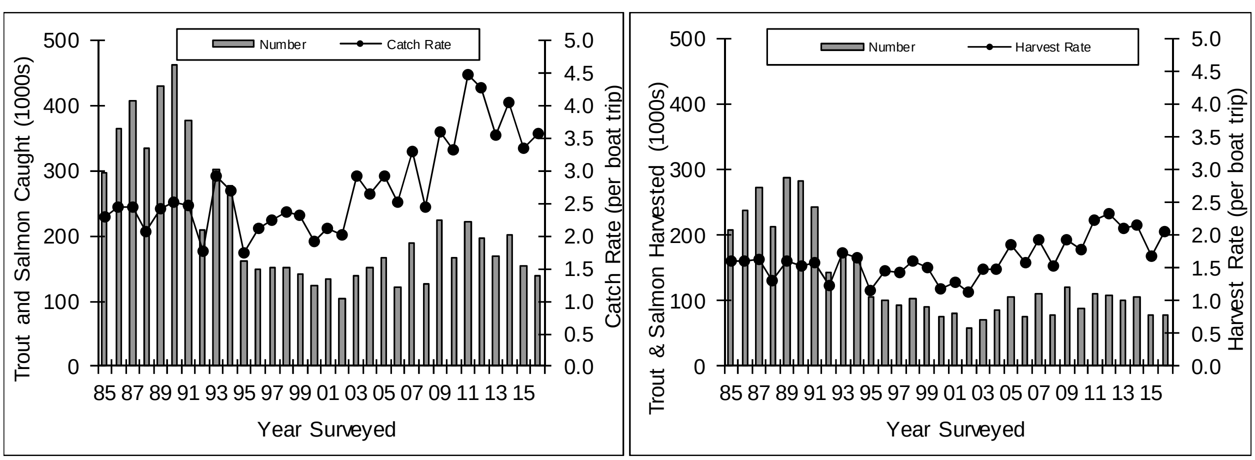


***Figure 5. Total trout and salmon catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985 - 2016.***

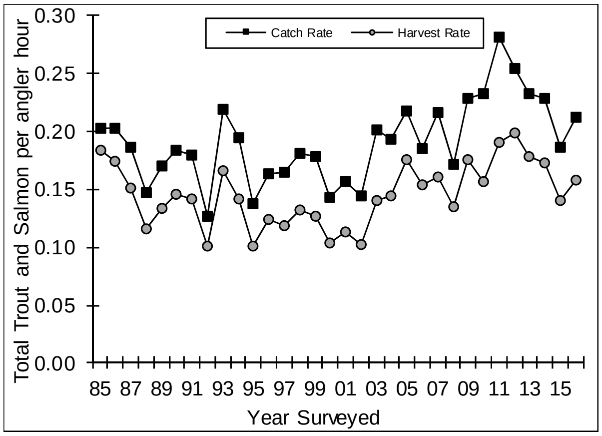


***Figure 5c. Charter boat catch rate and harvest rate per angler hour for total trout and salmon, April 15 – September 30, 1985 - 2016.***

noncharter boats fishing for trout and salmon, the 2016 lake-wide harvest rate was 1.0 salmonine per boat trip, comparable to (+2.7%) the previous 10-year average (Table A5b).

Additional metrics reflect angling quality, such as percentage of boats with zero catch (indicator of poor angling quality), and percentage of boats that harvested the maximum daily limit (indicator of good angling quality; Table A6). These variables 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 catch or harvest at least one fish, and vice versa). From 1985-2012, the proportion of boats targeting trout and salmon 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). In 2016, 31.4% of boats targeting trout and salmon caught zero salmonines, 7.3% higher than the previous 5-year average indicating a worse quality of fishing compared to the previous 5 years. The ten years with the lowest proportions of boats with zero trout and salmon catch occurred since 2003. This indicates that, fishing quality has generally been good relative to the years prior to 2003.

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 three fish of coho salmon, Chinook salmon, rainbow trout or brown trout in combination; and no more than one Atlantic salmon (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).

Some variables examined did indicate that angling quality was lower in 2016 relative to recent years. In 2016, 9.5% of charter boats targeting trout and salmon harvested the maximum daily limit of the three in any combination species for their customers (i.e., coho salmon, Chinook salmon, rainbow trout, and/or brown trout; Table A6). This was the second lowest percentage since 2002 (2015 was the lower) and a 43.8% decrease compared to the previous 10-year average. Charter boat catch rate of these four species was also the second lowest since 2002 (2015 was lower) and a 23.8% decrease compared to the record high levels during 2003-2014. The highest percentage of charters with the maximum daily limit occurred in 2009, when 24.2% of all charter boats interviewed harvested the three in combination limit for their customers (i.e., indicating excellent fishing quality). In 2016, of the charter boats that harvested the three in any combination limit for their customers, 54.0% went on to harvest additional fish on the captain and mate licenses, and 1.3% harvested the three in any combination limit for all anglers (i.e. fishing licenses) on the boat. Among noncharter boats fishing for trout and salmon in 2016, 1.3% harvested the maximum daily limit of three coho salmon, Chinook salmon,

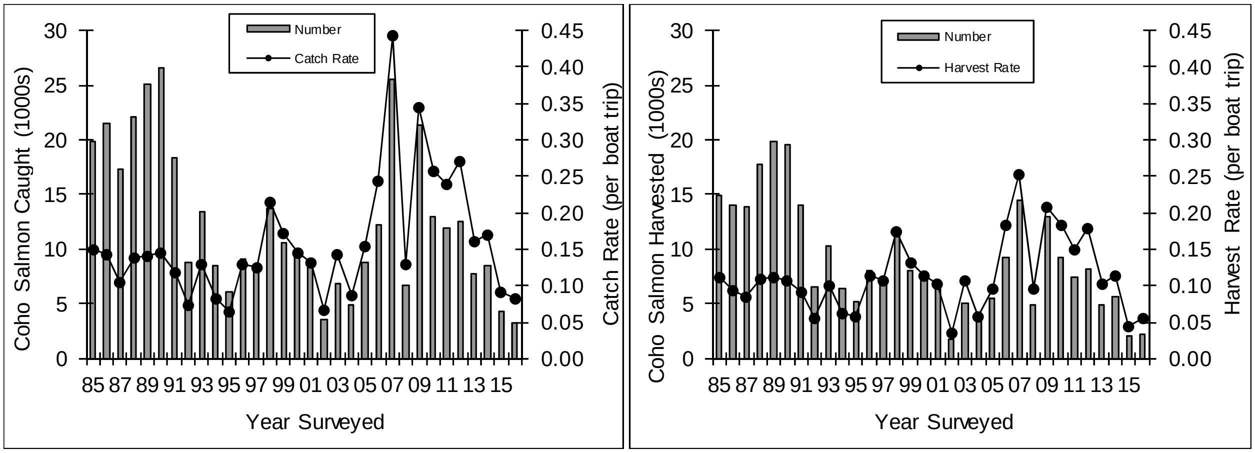


***Figure 6. Total coho salmon catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985-2016.***

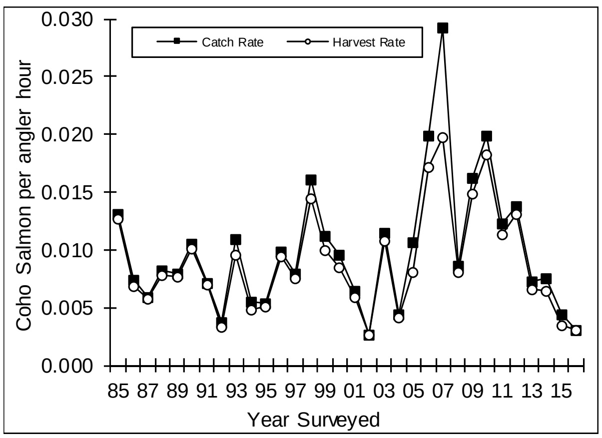


***Figure 6b. Charter boat catch rate and harvest rate per angler hour for coho salmon, April 15 – September 30, 1985-2016.***

rainbow trout, or brown trout in combination, a 26.4% decrease compared to the previous 10-year average.

Limits of lake trout were consistently less common than aggregate limits for the other four species through 2012 (2007-2012 average = 2.5%). From 2013-2015, 8.5%-11.8% of charter boats harvested the limit of lake trout for their party. In 2016, this increased to 13.5% of charter boats harvested the limit of lake trout for the party (Table A6). Of the charter boats that harvested the legal limit of lake trout for their customers, 43.1% went on to harvest additional lake trout on the captain and mate licenses, and 2.6% of charter boats harvested the limit for all anglers. Among noncharter boats, 0.3% harvested the maximum daily limit of lake trout in 2016.

In 2012 and 2013, some charter boat trips harvested the limit of lake trout and the three fish in any combination for each angler in the charter party (147 and 234 trips, respectively), none did so in 2014, but 14 boats did in 2015. In 2016, 147 charter boat trips harvested the limit of lake trout and three fish in any combination. No boats interviewed during 1997-2016 harvested the maximum aggregate limit of lake trout, Atlantic salmon and the three fish in any combination, including charter boats when counting only the charter party as potential anglers (i.e. excluding captains and mates).

Coho Salmon

*Catch and Harvest*

In 2016, coho salmon was the fifth most commonly caught and harvested salmonine in the boat fishery (2.3% and 2.7% of total catch and harvest, respectively; Table 1, Table A7a). Estimated coho salmon catch (3,219 [±35.8%] fish) in 2016 was a 74.7% decrease compared to the long-term average (1985-2015; Figure 6). Approximately 68% of coho salmon caught were harvested. Coho salmon harvest was an estimated 2,173 (±37.3%) fish and a 76.4% decrease compared to the long-term average (Figure 6, Table A7a). During 2016, estimated catch of coho salmon was below the long-term average each month April through September (range: -96.4% [April] to -28.3% [July];

Table A7a).

*Fishing Quality*

During the last decade, coho salmon catch rates and harvest rates were at or near record levels in six years (2006-2007, 2009-2012; Table A7b, Figure 6, Figure 6b). In 2015 and 2016, however, catch rates were among the lowest in the 32-years surveyed. The 2016 catch rate (0.08 fish per boat trip) was the fifth lowest and a 48.7% decrease compared to the long-term average (Figure 6, Table A7b). Harvest rate (0.06 fish per boat trip) was also a decrease compared to (-50.9%) the long-term average. In 2016, charter boats targeting trout and salmon caught 29.8% of the coho salmon caught by trout and salmon fishing boats. Among charter boats, coho salmon catch and harvest rates were both 0.003 fish per angler hour, and well below long-term averages (-69.6% and -65.8%, respectively; Figure 6b, Table A7b). Among noncharter boats, the 2016 catch and harvest rates were 0.005 and 0.003 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; Figures 6c and 6d). For the nineteenth consecutive year, the west area experienced the highest coho salmon catch rate among all regions (0.14 fish per boat trip), however, catch rates were below long-term averages in all areas surveyed (range: -64.1% [west/central] to -35.6% [east/central]; Figure 6d). The lowest coho salmon catch rate occurred in the east area (0.05 fish per boat trip, a 45.4% decrease compared to the long-term average; Figure 6d). Unlike most years when catch rate in April is relatively high, April 2016 catch rate was the lowest of the season (0.03 fish per boat trip) and the lowest April catch rate in the 32-years surveyed. The highest catch rate occurred in May (0.13 fish per boat trip), however, it was the lowest May catch rate since 2004 (Figure 6c). Coho salmon catch rates per boat trip were well below respective long-term averages each month April – June and September (range: -91.8% [April] to -40.1% [September]), and were average during July (-1.4%) and August (-7.9%; Table A7b).

*Biological Data*

Biological data analysis presented below includes fish processed during April 15 - September 30 (length: 1985-2016, weight: 1988-2016, scale samples for age determination: 2000-2016). Coho salmon scale samples for aging were not collected regularly until 2000. To determine percent contribution by age for 1985-1999, we assigned age to fish of unknown age (i.e., fish processed 1985-1999) using monthly length frequency distributions from fish of unknown age, and age and length data from fish of known age (i.e., those sampled after 1999). Ages of coho salmon for which no scale samples were collected during 2000-2016, were determined using monthly length frequency distributions, and age and length data derived from fish aged by scales collected in the respective year.

Each year, the majority (>73.8%) of coho salmon harvested in the open lake were age 2 (32-year average = 95.7% of those harvested were age 2; Table A8). In 2016, 100.0% of coho salmon sampled were age 2. No age-1 coho were sampled during 2010-2016. This was the eighth occurrence of zero age-1s observed during this survey. Harvest of age 1s is influenced by harvest regulations (i.e., 15 inch minimum harvestable size and angler desire to keep small coho salmon). Most anglers prefer to release the smaller age-1 fish even when they are longer than 15 inches. The contribution of age-3 coho salmon in angler harvest is small and represented ≤2.0% of harvest for 27 out of 32 years surveyed. In 2016, none of the coho salmon sampled were age 3.

Condition indices for coho salmon in 2016, as determined from predicted weights of standard length fish, were below previous 28-year averages for each inch group evaluated from 18 in to 28 in (1988-2015; range: -9.9% [18-in] to -0.9% [28-in]), but were slightly above average for the larger sized fish (+0.5% [30-in]; Table A8). Mean length of age-2 coho salmon sampled in April 2016 was 18.9 inches, the fifth lowest April mean length in the data series. The mean length of age-2 in September 2016 was 27.6 in, 0.3 inches shorter than the long-term average (Table A8). Two consecutive long, cold winters (2013/2014 and

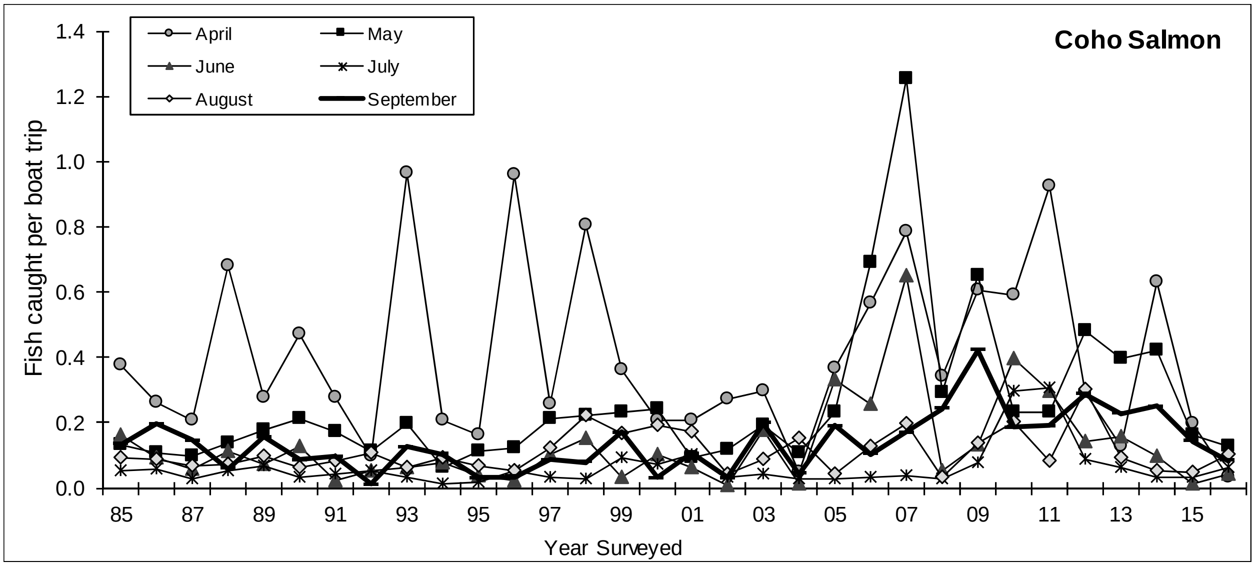


***Figure 6c. Coho salmon caught per boat trip April through September, 1985-2016. Note: Catch rate varied by region within each month surveyed.***

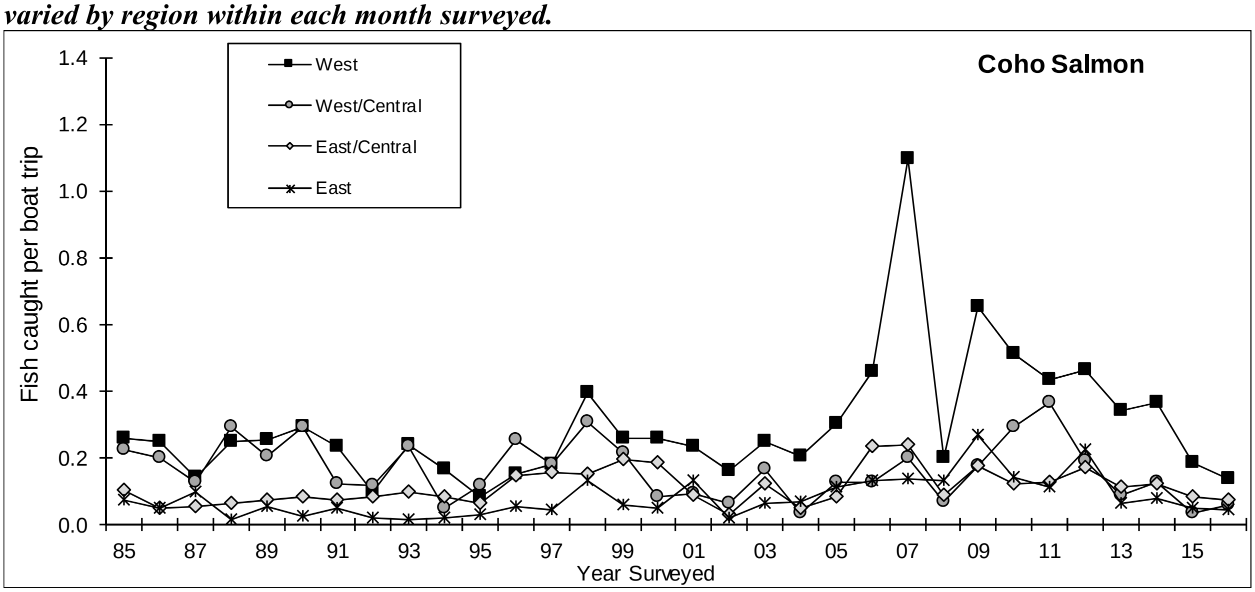


***Figure 6d. Coho salmon caught per boat trip in the west, west/central, east/central and east areas surveyed, April 15 – September 30, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

2014/2015) followed by below average water temperatures during summers of 2014 and 2015 likely contributed to reduced metabolism and growth of coho salmon, resulting in shorter fish and lower condition as compared to previous years.

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 21 of the 32 years surveyed. From 1985-2002 Chinook salmon represented an average of 28.3% of the total salmonid catch among trout and salmon boats. From 2003-2015, 45.4% of all salmonines caught were Chinook salmon. In 2016, Chinook salmon catch was an estimated 60,435 fish (±26.9%), representing 43.7% of the total salmonine catch (Figure 7, Table 1, Table A9a).

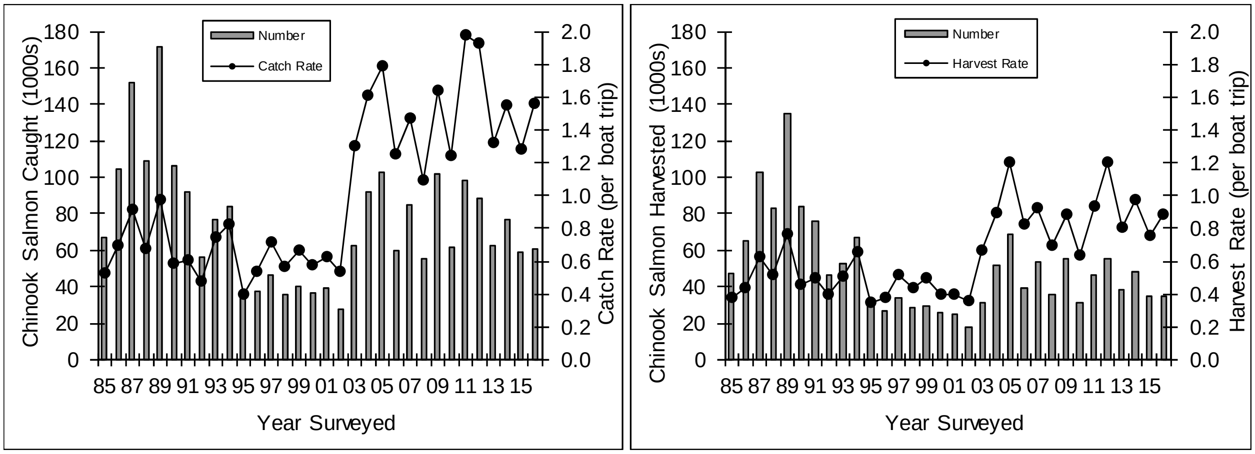


***Figure 7. Total Chinook Salmon catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 - September 30, 1985-2016.***

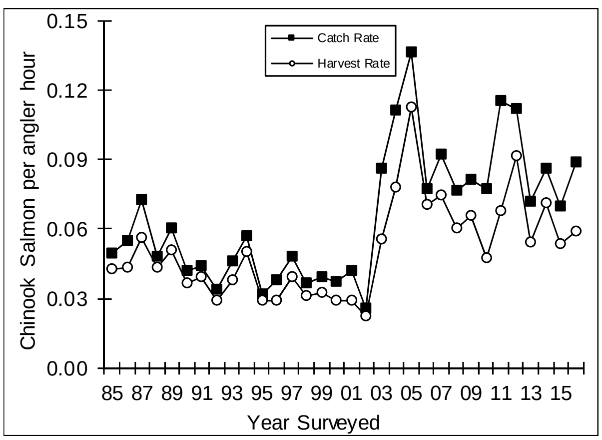


***Figure 7b. Charter boat catch rate and harvest rate per angler hour for Chinook salmon, April 15 – September 30, 1985-2016.***

Of Chinook salmon caught in 2016, 56.9% 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 quality on Lake Ontario and the percentage of Chinook salmon harvested (2003-2016 average percent harvest=58.7%) was 20.6% 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 2016 was estimated at 34,405 Chinook salmon (±28.7%), which represented 43.4% of the total salmonine harvest (Figure 7, Table 1, Table A9a).

Typically, the majority of the Chinook salmon catch and harvest occurs during August (Table A9a), however, in 2015 and 2016 the highest estimated catch occurred in May (18,854 caught in 2015) and July (25,456 in 2016; an 89.7% increase compared to the long-term average). Estimated catch in August 2016 (13,432 fish) was the lowest recorded and 51.2% below the long-term average. In 2016, catch estimates were also below respective monthly averages in April (-96.5%), May (-41.0%), and September (-44.9). The highest regional contribution of Chinook salmon catch typically occurs in the west area (28 of 31 years 1985-2015). In 2016, estimated catch was again highest in the west area (30,833 fish, 51.0% of all Chinook salmon caught), however, the estimate for that area was an 11.2% decrease compared to the long-term average. Catch estimates were below average in the west/central (-70.2%, lowest since 2002) and east (-52.7%) areas, but was above average in the east/central area (+18.2%; Table A9a).

*Fishing Quality*

The highest Chinook salmon fishing quality occurred the last 14 consecutive years (2003-2016; Figure 7, Figure 7b, Table A9b). From 1985-2002 catch rate of Chinook salmon per boat trip for all trout and salmon boats was variable and without trend, but beginning in 2003 lake-wide catch rates averaged more than 2.3-fold higher than those observed in years prior to 2003. It is important to note that Chinook salmon fishing quality in 2016 was highly dependent on where and when anglers were fishing. While anglers have experienced good to excellent fishing quality in recent years, Chinook salmon catch rates declined in most months and lake areas during 2016. The 5.5 month average catch rate was positively influenced by relatively good fishing in the west area during May through August, and during July for all regions. The 2016 lake-wide catch rate among all boats fishing for trout and salmon was 1.6 Chinook salmon per boat trip, comparable to (+5.9%) the previous 10-year average, and 55.7% above the long-term average (Figure 7, Table A9b).

In 2016, charter boats targeting trout and salmon caught 45.6% of the Chinook salmon caught by all trout and salmon anglers. Among charter boats, the 2016 Chinook salmon catch rate was 3.2 fish per boat trip, comparable to (+8.2%) the previous 10-year average and a 41.0% increase compared to the long-term average (Table A9b). Chinook salmon 5.5-month lake-wide catch rates (charter boat catch per angler hour) were at the highest levels during 2003-2016 (average = 0.09; Fig. 4). The 2016 catch rate (0.09) was comparable to (-3.3%) the 2003-2015 average (Figure 7b). Among noncharter boats, the 2016 catch rates were 1.1 Chinook salmon per boat trip and 0.08 per angler hour, which were comparable to (-5.3% and –7.0%, respectively) previous 10-year averages (Table A9b).

Similar to catch rates, the highest Chinook salmon harvest rates occurred during 2003-2016 (i.e., an average of 84.6% higher than those prior to 2003; 1985-2002 average = 0.48 fish per boat trip, 2003-2016 average = 0.88; Figure 7, Figure 7b, Table A9b). The 2016 lake-wide harvest rate among boats seeking trout and salmon was 0.9 Chinook salmon per boat trip, comparable to (+2.8%) the previous 10-year average (Figure 7, Table A9b). Among charter boats, the 2016 harvest rate (2.1 Chinook salmon per boat trip) was comparable to (-6.2%) the previous 10-year average (Figure 7b, Table A9b). Charter boats harvested 0.06 Chinook salmon per angler hour in 2016 (Figure 7b). Among noncharter boats, the harvest rate was 0.5 Chinook salmon per boat trip, a slight decrease (-10.4%) compared to the previous 10-year average (Table A9b).

As with other salmonids, Chinook salmon catch rates vary by region and season. Typically, April-June catch rates of Chinook salmon in the western half of the lake are relatively higher than those

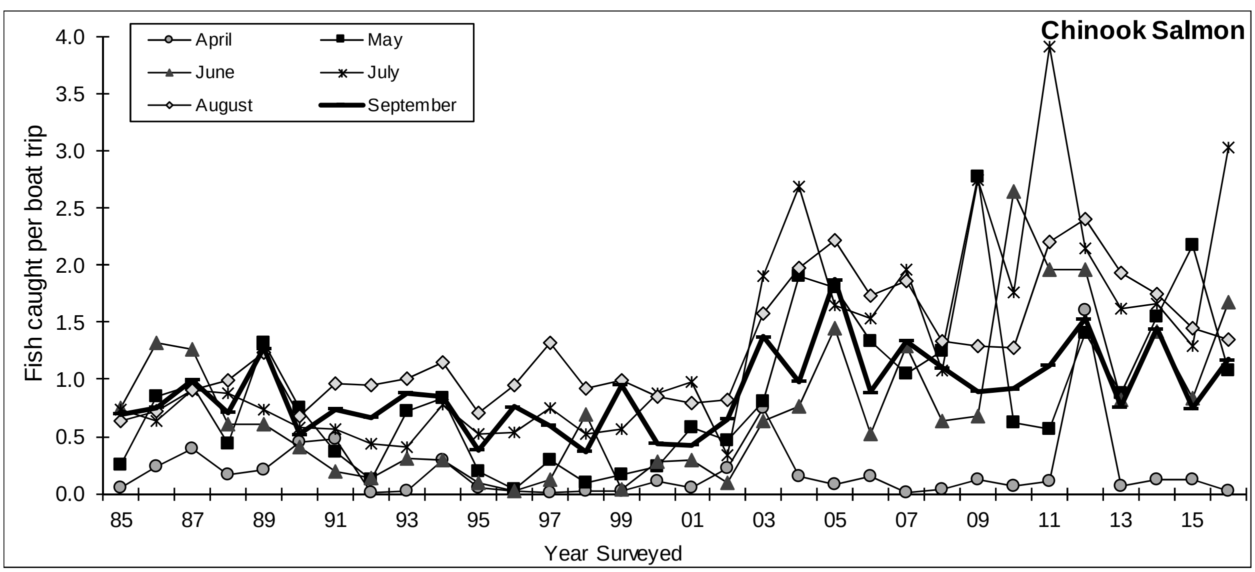


***Figure 7c. Chinook salmon caught per boat trip April through September, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

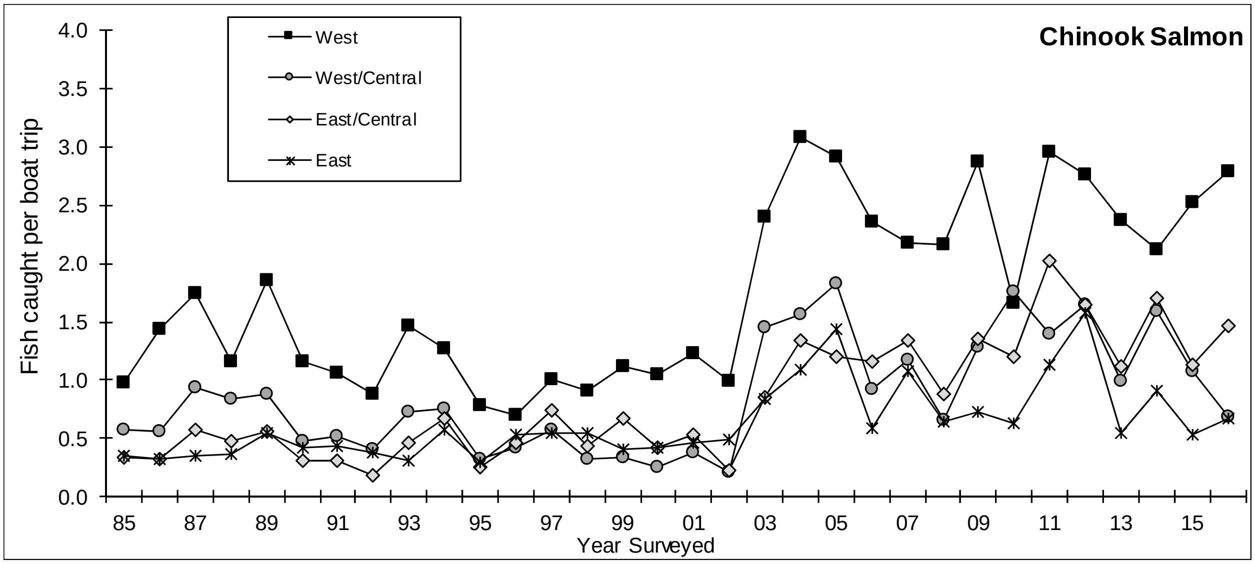


***Figure 7d. Chinook salmon caught per boat trip in the west, west/central, east/central and east areas surveyed, April 15 – September 30, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

toward the eastern half (Lantry and Eckert 2011; Figures 7c and 7d). For the rest of year and in all areas, Chinook salmon catch rates are typically higher than in the spring. These higher rates last into early September in some years. In 2016, the 5.5 month average catch rate was positively influenced by relatively good fishing in the west area during May through August, and during July for all regions. The July 2016 catch rate was the second highest monthly rate among all months survey from 1985 through 2016. For only the eighth time in the 32 years surveyed, the highest Chinook salmon catch rate occurred in July (3.0 Chinook salmon caught per boat trip), when the rate was a 53.8% increase compared to the previous 10-year average and 149.2% higher that the long-term average (Figure 7c). Monthly catch rates were well below respective previous 10-year averages in April (-90.8%), May (-20.5%) and August (-22.0), and were above average in June (+31.8%) and July (+53.8%; Table A9b, Figure 7c).

The 2016, Chinook salmon catch rate in the west area was a 16.4% increase compared to the previous 10-year average (Figure 7d). Catch rates were below previous 10-year averages in the west/central (-45.3%) and east (-19.5%) areas. Catch rate was comparable to the previous 10-year average in the east/central area (+7.9%).

*Biological Data*

Biological data analysis presented here includes fish processed during April 15 - September 30 (length: 1985-2016, weight: 1988-2016, scale samples for age determination: 1991-2016). Chinook salmon scale samples for aging were not collected regularly until 1991. To determine percent contribution by age for fish processed 1985-1990, we assigned age to fish of unknown age (i.e., Chinook salmon processed 1985-1990) using monthly length frequency distributions from fish of unknown age, and age and length data from fish of known age (i.e., those sampled in the early 1990s). Ages of Chinook salmon for which no scale samples were collected during 1991-2016, were determined using monthly length frequency distributions, and age and length data derived from fish aged by scales collected in the respective year.

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. For 29 of the 32 years surveyed, Chinook salmon sampled from angler harvest were dominated by age-2 and age-3 fish (1985-2016 averages: age 2 = 38.8%, age 3 = 47.0% of fish sampled; Table A10). In

2016, angler harvest consisted of 43.0% age-2 fish and 46.9% age-3 fish. Ages 1 and 4 typically represent small components of angler harvest. In 2016, 9.1% of Chinook salmon processed were age 1, nearly 19% below the long-term average. The oldest Chinook salmon sampled in Lake Ontario are age-4 and comprised a small percentage of the total Chinook salmon sampled in 2016 (1.0% of all Chinooks processed; Table A10). Scale growth patterns suggest that the fastest growing individuals of any year class are more likely to mature and spawn at age 2 or 3, thereby removing themselves from the lake population, and that many of the age-4 fish are among the slower growing members of their cohort.

To evaluate Chinook salmon growth, we determined mean length-at-age by month for samples collected July through September (data collected from 1991-2016; Figure A1, Table A11). Growth was good to excellent in 2010-2013, however, mean lengths were among the lowest recorded for a second consecutive year in 2016. Age-1 Chinook salmon were well below average length and among the shortest recorded during July and August (low sample size prevented determination in September). The 2016 August mean length of age-1 fish improved from the record low in 2015 (17.3 in) to 19.0 inches, however, remained 0.6 inches shorter than the long-term (1991-2015) mean. Of all age-1 fish processed during July-September 2016, the largest was just 23.6 inches long (5.5 lbs). The shorter than average length of age-1s in 2016 likely contributed to the low contribution of that age in angler harvest (i.e., fewer Chinook may have been of minimum harvestable size during a portion of the year).

The longest average lengths of age-2 Chinook salmon during August occurred each year 2010-2012 (average = 32.6 in). Average length of age 2s in August declined each year since, falling to 29.3 inches in 2016 and 1.1 inches shorter than the long-term average (Figure A1, Table A11). Mean length of age 3s was also below average in 2016 (August mean 36.2 in, 0.6 in shorter than the long-term mean). The shorter length of Chinook salmon in 2016 is partly attributed to the two consecutive long and cold winters (2013-2014 and 2014-2015) followed by below average temperatures the following summers.

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 1988-2016 (Table A10) and showed no statistically significant trends over the 29-year survey period. Predicted weights of Chinook salmon in 2016 were among the heaviest in the data series for Chinook salmon 20 in and larger, particularly for the 28 in (4th highest), 32 in (3rd highest), 36 in (2nd highest), and 40 in (2nd highest) size groups. Estimates for the smallest length (1.40 lb) was comparable to long-term average of 1.41 lb (Table A10). These results indicate that the recent long, cold winters may have negatively impacted growth in length, however, the good condition of Chinook salmon >28 inches indicates that alewife (the primary forage of Chinook salmon; Lantry 2001) abundance was sufficient to maintain Chinook weight.

*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 and Forestry (OMNRF) initiated a Chinook salmon mass marking program beginning with the 2008 stockings (Connerton et al. 2011). 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 2008-2011 and 2013 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.

Each year Connerton et al. (e.g., 2011, 2017) report results of the Chinook salmon mass-marking program as determined from data collected during the Lake Ontario Fishing Boat Survey and additional sampling efforts conducted in New York and Ontario waters. Connerton et al. (2016) completed determination of the contribution of wild Chinook salmon to the fishery in 2015. Among the year classes studied (2008-2011), wild Chinook were an important component of the Lake Ontario fishery averaging 47% of the age-2 and -3 Chinooks harvested in the lake from 2010-2014. Preliminary results of pen-reared vs. traditional shore stocking evaluations indicated that the 2010, 2011, and 2013 Chinook salmon year classes stocked into pens had relatively higher contributions to the lake harvest than their shore-stocked counterparts (about 2:1). More detailed discussions of the mass marking program, methods, and 2010-2016 results of open lake and tributary collections are reported in Connerton et al. (2017).

*Stocking Level Verses Relative Harvest*

To permit between year comparisons of harvest-at-age data, we calculated age-specific harvest rates, hereafter termed relative harvest (age-specific numbers of Chinook salmon harvested per 50,000 boat trips April 15 - September 30; Table A12). Relative harvest is now calculated as the age-specific number of Chinook salmon harvest per 50,000 boat trips (i.e., as compared to adjustments of harvest to 150,000 boat trips reported previously; e.g., Eckert 2007, Lantry and Eckert 2015) because estimated fishing effort was near approximately 50,000 boat trips for more than a decade, and is not expected to increase to the relatively high levels observed in earlier surveys (Figure 2). Determination of percent contribution by age of Chinook salmon harvested during 1985-2016 was described above.

Chinook salmon relative harvest (harvest per 50,000 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 (1984-2012 year classes) varied from a high of 74,929 fish for the 2010 year class (harvested at ages 1 to 4 from 2011 to 2014, respectively) to a low of 6,832 fish for the 1994 year class (harvested at ages 1 to 4 from 1995 to 1998, respectively), a 10.9 fold difference (Table A12). By comparison, survey year-specific total relative harvest (1985-2016 survey years) varied from the high of 59,952 fish in 2005 to a low of 17,371 fish in 1995, only a 3.5 fold difference. The ten highest total relative harvest estimates occurred since 2004 (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 2009-2013. These year classes contributed to the some of the highest relative harvests of age-2 and age-3 Chinook salmon among the years surveyed, despite the intermediate stocking level of each of these year classes (1,700,374 [2003 year class] – 2,075,169 [2005 year class] fish stocked; Table A12, Table A13). Stocking levels varied from 862,840 (1981 year class) and 3,368,296 (1987 year class) fingerling equivalents. The 2016 relative harvest (44,364 fish) was the seventh highest in the 32-year data series (Table A12). To date, returns of age-1 to age-4 fish from the 2010 year class was the highest on record (74,929 fish) and was 10.9%

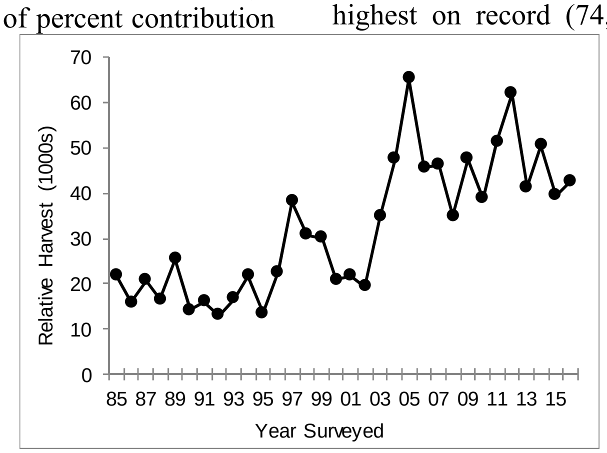


***Figure 8. Relative harvest of Chinook salmon per 50,000 boat trips targeting trout and salmon, per 2,000,000 fingerling equivalents stocked.***

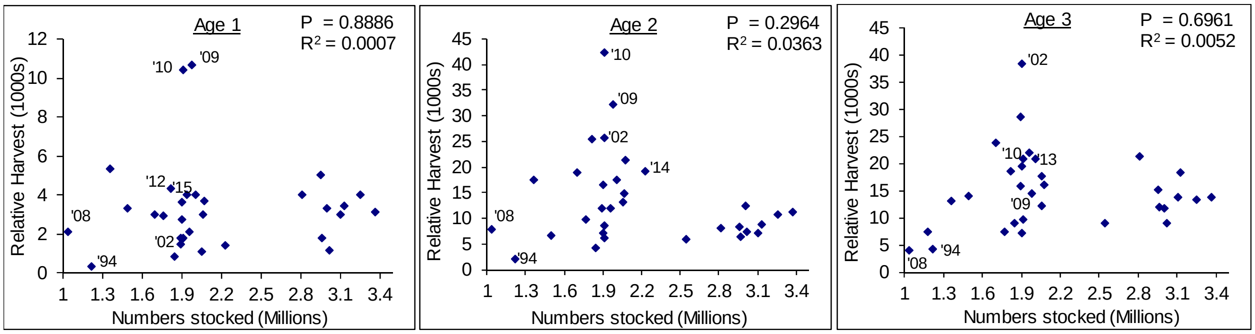


***Figure 9. Number of fingerling equivalents stocked and relative harvest of age-1 (1984-2015 year classes), age-2 (1983-2014 year classes), and age-3 (1982-2013 year classes) Chinook salmon.***

higher than returns of the 2002 year class (67,570 fish and the previous record high; Table A12).

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 1985-2016 data resulted in a significant (P<0.0001) 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 (e.g., improved survival of pen-reared fish; Connerton et al. 2017) 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, 2009-2010, and 2012 year classes), and age 3s (2002-2004, 2006, 2010 and 2012-2013 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 relative harvest at age 1 (P=0.8886 and $R^2$=0.0007), age 2 (P=0.2964 and $R^2$=0.0363), or age 3 (P=0.6961 and $R^2$=0.0052; 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 1993-2015 year classes (1.04-2.23 million fingerling equivalents stocked; Figure 9, Table A13). The lowest and highest age-1 (1994 and 2010 year classes, respectively) and age-2 (1994 and 2010 year classes, respectively) relative harvest estimates occurred after the 1993 stocking cuts. For age-3s the lowest relative harvest occurred before stocking cuts (1989 year class) but the highest (2002 year class) occurred after the 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 of the 2008 year class (4,041 fish) was the lowest in the data series and relative harvest at age 4 (99 fish) was the fourth lowest. The 2008 year class were among the fastest growing fish in the data series as indicated by mean size at age 2 (2010) and age 3 (2011; Figure A1).

Based on relative harvest, the 2009 and 2010 year classes were two of the strongest produced (Figure 9, Table A12). Relative harvest estimates for the 2009 year class at age 1 (10,663 fish) was the highest in the data series, and at age 2 (32,236 fish) was the second highest in the data series. Relative harvest of the 2009 year class at age 3 (14,404 fish) was the fourteenth highest.

The 2010 year class performed similar to the 2009 year class, in that relative harvest estimate at age 1 (10,398 fish) was the second highest in the data series, and the age 2 estimate (42,386 fish) was the highest for that age. Relative harvest of the 2010 year class at age 3 (20,939 fish) was the sixth highest. The Salmon River wild young-of-year Chinook salmon seining program indicated possible production of a strong 2010 year class. The 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 (shore stocked and/or pen reared fish; Connerton et al. 2017), 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 ten were significant (p-values≤0.0330). The $R^2$ values for these relationships ranged between 0.2123 and 0.5348, indicating that although some of the variation could be accounted for, approximately 47%-79% 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 allows us to estimate relative survival of stocked fish (e.g., shore stocked vs. pen reared fish) and the contribution of wild fish to the population and the fishery (see Connerton et al. 2017). This information is needed to better manage Lake Ontario's fishery.

Rainbow Trout

*Catch and Harvest*

Rainbow trout was the fourth most commonly caught and harvested salmonine in 2016, and represented 12.0% 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 the early 2000s, then improved. Rainbow trout catch in 2016 was an estimated 16,639 (±42.7%) fish, a 51.6% decrease compared to the long-term average. Anglers harvested 9,487 (±46.7%) rainbow trout (57.0% of those caught), a slight decrease (-10.1%) compared to the long-term average. This was the second consecutive year of the lowest catch and harvest estimates since prior to the October 1, 2006 regulation change that increased the minimum harvestable size from 15 in to 21 in. Reduced

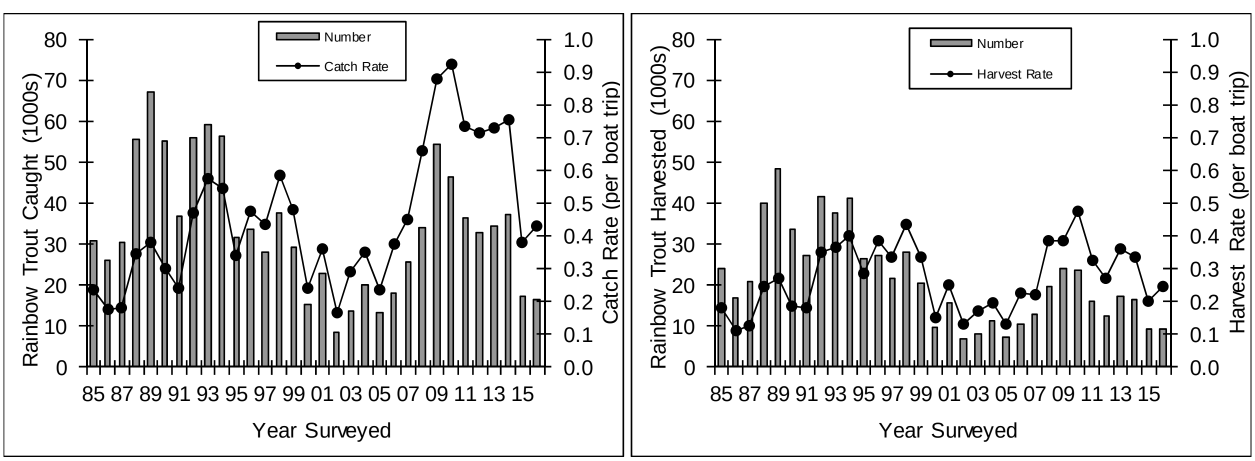


***Figure 10. Total rainbow trout catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 - September 30, 1985-2016.***

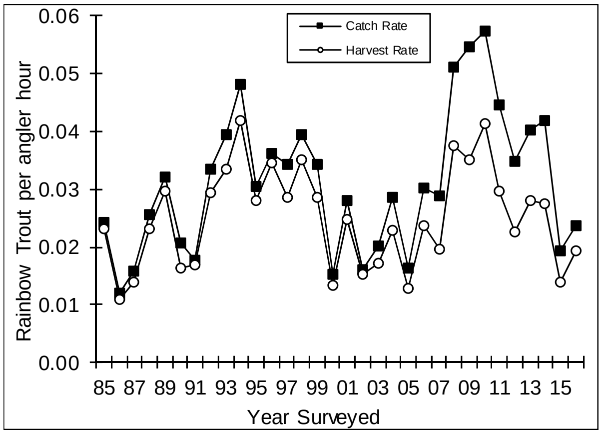


***Figure 10b. Charter boat catch rate and harvest rate per angler hour for rainbow trout, April 15 – September 30, 1985-2016.***

catches of rainbow trout may have been due to a due to a reduced population size in the lake during the 2015 and 2016 open lake seasons. A prolonged rainbow trout mortality event attributed to thiamine deficiency occurred in the Salmon River, NY from fall 2014 and into winter 2015. This event and possibly additional mortality in the lake may have reduced the numbers of rainbow trout in the lake during the 2015 and 2016 fishing seasons. Another indication of a reduced population is the size of the run at the Ganaraska River. The rainbow trout run at the Ganaraska Fishway in Ontario has traditionally been used as an index of abundance, which was markedly lower in spring 2014 and 2015 (ONMRF 2016). Run size declined further in spring 2016 to the lowest level since 2009 (ONMRF 2017).

For 31 consecutive years (1986-2016), the majority of rainbow trout caught and harvested were in the west area (Lantry and Eckert 2011, Table 14a). In 2016, 76.9% of all rainbow trout caught and 81.8% of those harvested were from the west area. The majority of rainbow trout catch (42.1%) and harvest (43.2%) occurred during July (Table A14a).

*Fishing Quality*

For seven consecutive years, from 2008 to 2014, anglers experienced the highest rainbow trout catch per boat trip in the history of the survey. The 2015 and 2016 catch rates (0.38 and 0.43 fish per boat trip), however, declined to the lowest since 2006. The 2016 catch rate was a 44.4% decrease compared to the 2008-2014 time period (i.e., years of the highest rates on record), but comparable to (-5.1%) to the long-term average (Figure 10, Table A14b). In 2016, charter boats caught 44.1% of all rainbow trout caught by trout and salmon boats. Charter boats caught 0.86 rainbow trout per boat trip, a 24.0% decrease compared to the long-term

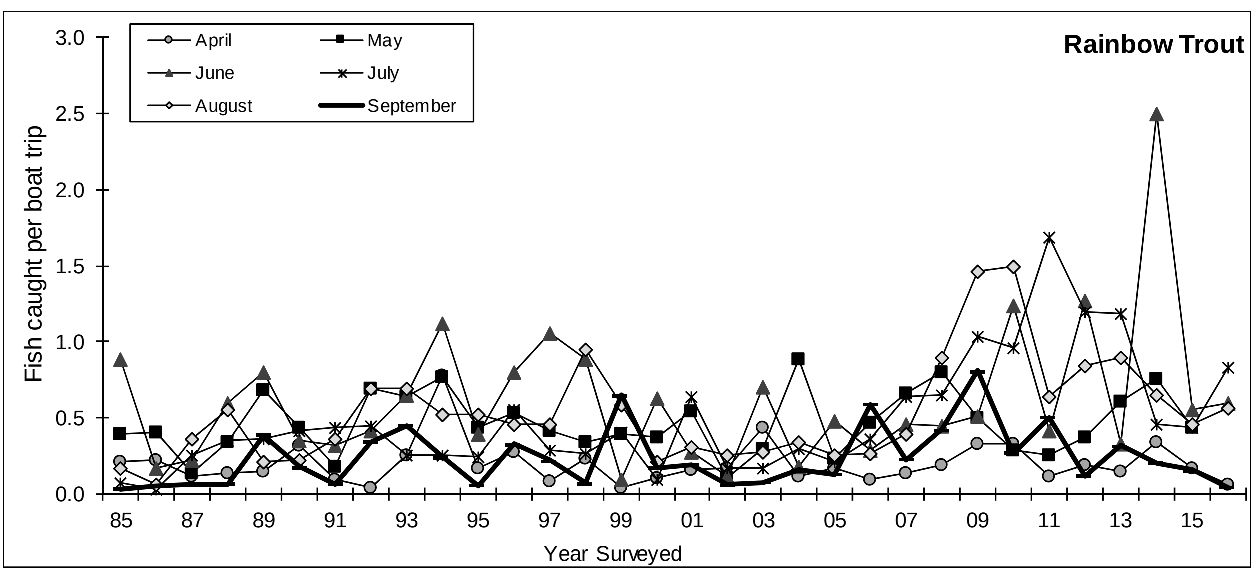


***Figure 10c. Rainbow trout caught per boat trip April through September, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

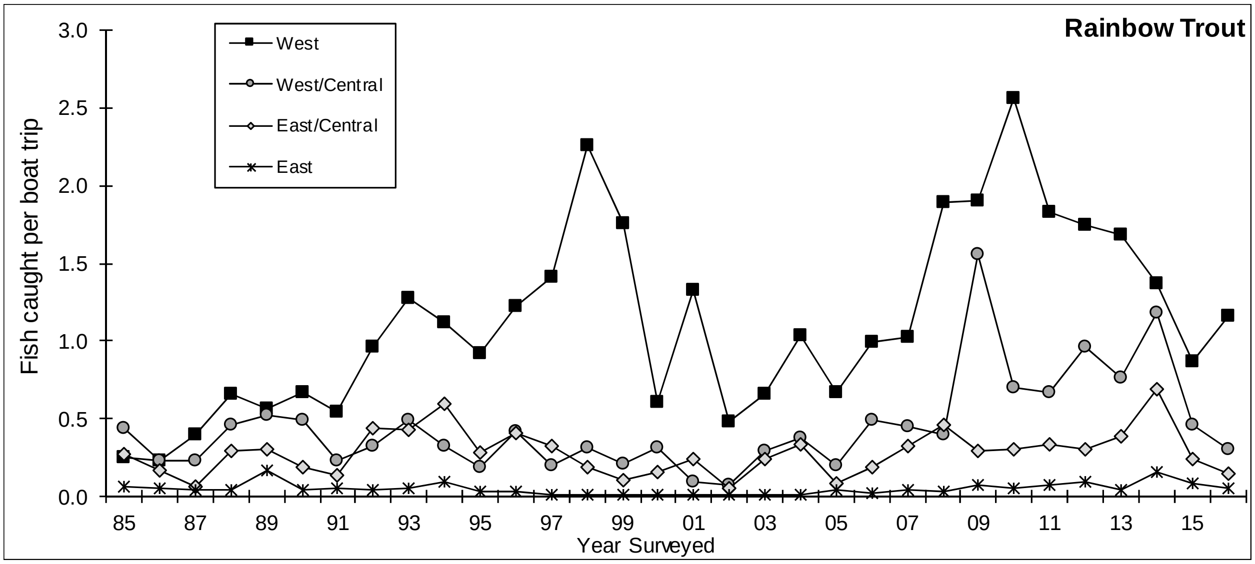


***Figure 10d. Rainbow trout caught per boat trip in the west, west/central, east/central and east areas surveyed, April 15 – September 30, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

average (Figure 10b). Charter boat catch per angler hour (0.02 fish per hour) was a 49.0% decrease compared to 2008-2014, and a 24.5% decrease compared to the long-term average. Catch rates also declined among noncharter boats to the lowest levels since 2006 (0.3 rainbow trout per boat trip and 0.02 fish per angler hour in both 2015 and 2016; Table A14b).

The 2016 lake-wide harvest rate among all boats fishing for trout and salmon (0.2 rainbow trout per boat trip) was a 10.2% decrease compared to the long-term average (Figure 10, Table A14b). Among charter boats fishing for trout and salmon, the harvest rate was 0.70 rainbow trout per boat trip (Table A14b). Charter boats harvested 0.01 rainbow trout per angler hour (Figure 10b), a 25.5% decrease compared to the long-term average. Among noncharter boats fishing for trout and salmon, the harvest rate was 0.12 rainbow trout per boat trip (0.01 fish per angler hour) which was 27.3% below the long-term average (Table A14b). Rainbow trout monthly and geographical catch rate and harvest rate trends for most years showed monthly rates highest during the summer, and geographical rates highest in the west area and lowest in the east area (Lantry and Eckert 2011; Table A14b; Figures 10c and 10d). As compared to the previous 5-year averages, the 2016 rainbow trout catch rate was above average in July (+73.9%), average in June (-4.1%) and August (+6.7%), but well below average during the other months (April [-67.4%], May [-62.2%], and September [-81.9%]; Table A14b). Regional catch rates were average in the west (+2.7%) and east (+5.6%), but below average in the west/central (-32.2%) and east/central (-47.3%; Figure 10d).

*Biological Data*

Biological data analysis presented here includes fish processed during April 15 - September 30 (length: 1985-2016, weight: 1988-2016). Scale samples were collected from rainbow trout processed for biological data each year 1996-2016; however, they are not yet aged. 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 2016 open lake season was the tenth affected by the increased minimum harvestable length of rainbow trout from 15 in to 21 in. The average percent contribution of fish <21.0 in for the ten years since the regulation (2007-2016) was 10.6%, and significantly lower than the previous nine years (1997-2006) when 17.7% of rainbow trout processed were <21.0 in (Chi-square analysis: $X^2 = 47.323 > \chi^2_{[1](.005)} = 7.879$). During 2016, 13.1%

of harvested rainbow trout were below the legal 21 in minimum harvestable size.

Weight data were collected each year from 1988-2016 and rainbow trout condition was calculated as 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 generally declined to record and near record lows. In more recent years, rainbow trout condition of fish in the 26-in and smaller length groups was variable at a lower level. Condition of the three largest inch groups examined (i.e., 28-in, 30-in, and 32-in) was at and near record low levels for each of the last three years. These larger fish would likely be those who survived both the fall/winter 2014/2015 mortality event observed in the Salmon River and the two consecutive long, cold winters followed by summers with below average temperatures (2013/2014 and 2014/2015). Both factors likely contributed to reduced condition.

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 salmon stockings in the Black River with an equivalent number of brown trout. Each year 2009-2016, and in addition to the NYSDEC stockings, the USGS Tunison Laboratory of Aquatic Sciences reared and conducted experimental stockings of Atlantic salmon (Connerton 2010, 2017).

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 80 fish per year and catch estimates of less than 250 fish per year (Figure 11, Table A16; Lantry and Eckert 2010). Beginning in 2009, and before initiation of the creel survey, anecdotal reports indicated that anglers were catching Atlantic salmon in greater frequency than in the previous decade. For three consecutive years (2009-2011),

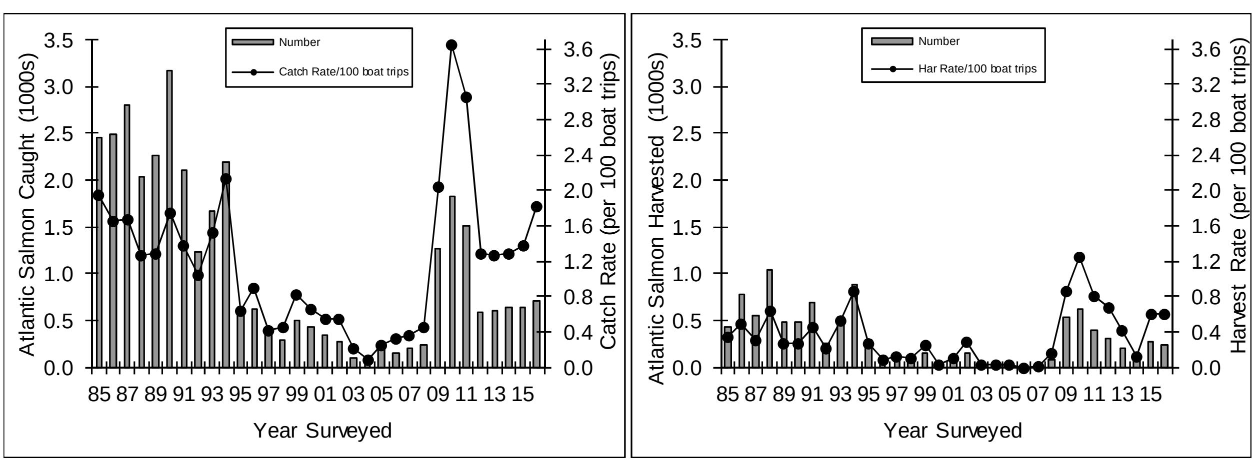


***Figure 11. Total Atlantic salmon catch and catch rate, and harvest and harvest rate per 100 boat trips for boats seeking trout and salmon, April 15 – September 30, 1985-2016.***

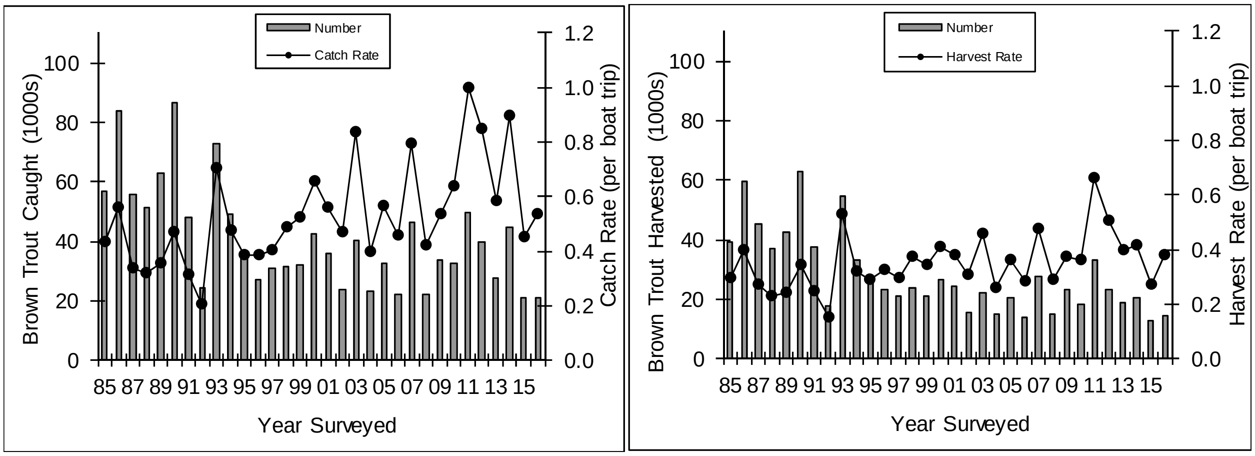


***Figure 12. Total brown trout catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985-2016.***

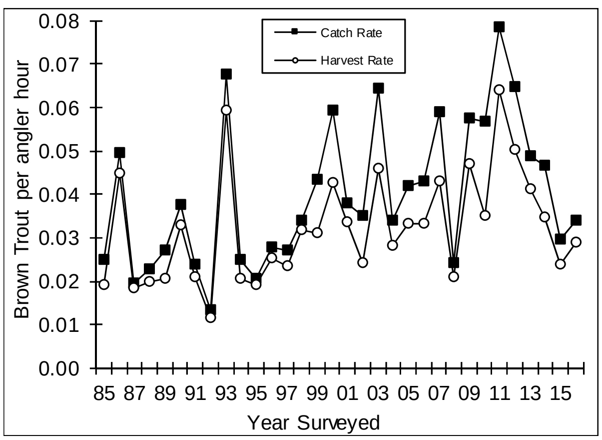


***Figure 12b. Charter boat catch rate and harvest rate per angler hour for brown trout, April 15 – September 30, 1985-2016.***

estimated lake-wide catch and harvest were the highest since 1994 (Figure 11, Table A16). Since then, fewer Atlantic salmon were caught and harvested, however, estimates remained well above 1995-2008 levels. During 2016, estimated catch (704 ±50.3%) was a 118.3% increase compared to the 1995-2008 time period when estimated catch was the lowest on record (Figure 11, Table 1, Table A16). Anglers harvested an estimated 236 [±71.2%] Atlantic salmon in 2016. The 2016 Atlantic salmon catch rate (1.8 fish per 100 boat trips seeking trout and salmon) was comparable to levels observed during the late 1980s-early 1990s and was more than 3.7-fold higher than the 1995-2008 average rate (average = 0.48 per 100 boat trips). Harvest rate in 2016 (0.61 fish per 100 boat trips seeking trout and salmon) was 5.5-fold higher than the 1995-2008 average (0.11 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, young-of-year Atlantic salmon were captured in the Salmon River each year 2009-2011, 2013 and 2016 (none were captured in 2012, 2014 or 2015; 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 OMNRF to restore self-sustaining populations of Atlantic salmon in several Lake Ontario tributaries included increased stocking levels beginning in 2006. To date, the contribution of the enhanced stocking by OMNRF to the sport fishery is unknown. Genetic analysis of tissue samples collected from New York anglers 2009-2016 indicated that, 86.5% were from NYSDEC stockings, 4.3% were from OMNRF stockings and 9.2% were undetermined (Chris Wilson, OMNRF, personal communication).

<u>Brown Trout</u>

*Catch and Harvest*

Brown trout was the third most commonly caught and harvested salmonine in 2016, accounting for

15.1% and 18.4% of the total 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 2016, estimated catch (20,871 fish [±32.5%]) was similar to the 2015 record low (20,780 fish; +0.4%) and a 49.7% decrease compared to the long-term average. Estimated harvest (14,608 fish [±37.3%]) was a 48.3% decrease compared to the long-term average (Figure 12, Table 1, Table A17a). In 2016, 70.0% of brown trout caught were harvested, 16.5% and 13.6% increases compared to the previous 5-year and 10-year averages, respectively.

Typically, the majority of brown trout are caught during April and May, and in the east/central area. Over 56% of the 2016 brown trout catch occurred during April and May (Table A17a). Nearly 46% were caught in the east/central area. In 2008 and 2012 the highest proportion of brown trout catch and harvest occurred in the east area (60.6% and 37.2% of total catch, respectively) where brown trout fishing was good throughout much of the open lake fishing season (Lantry and Eckert 2011).

*Fishing Quality*

Brown trout catch rates (lake-wide, charter and noncharter) were variable over the 32-year data series with no trend (Figure 12, Figure 12b, Table A17b). In 2016, among trout and salmon fishing boats, brown trout catch rate (0.54 fish per boat trip) was comparable to the long-term average (+1.1%), but an 18.9% decrease compared to the previous 10-year average. Charter boats targeting trout and salmon caught 50.4% of all brown trout in 2016. Catch rate among charter boats was 1.2 brown trout per boat trip in 2016, a 13.7% decrease compared to the long-term average (Figure 12b, Table A17b). The charter boat catch rate per angler hour was 0.03, a 15.5% decrease compared to the long-term average (Figure 12b). Noncharter boats caught an estimated 0.34 brown trout per boat trip (0.02 per angler hour), comparable to the long-term average (-6.0%; Table 17b).

Brown trout harvest rates in 2016 (lake-wide, charter and noncharter) were also variable and showed no trends over time (Figure 12, Figure 12b, Table A17b). Among all boats seeking trout and salmon, the 2016 lake-wide harvest rate was 0.38 brown trout per boat trip, comparable to the long-term average (+7.6%; Figure 12, Table A17b). Among charter boats fishing for trout and salmon, the 2016 harvest rate was 1.05 brown trout per boat trip (0.03 fish per angler hour; Figure 12b, Table A17b). Among noncharter boats fishing for trout and salmon, the 2016 harvest rates were 0.19 brown trout per boat trip and 0.01 fish per angler hour.

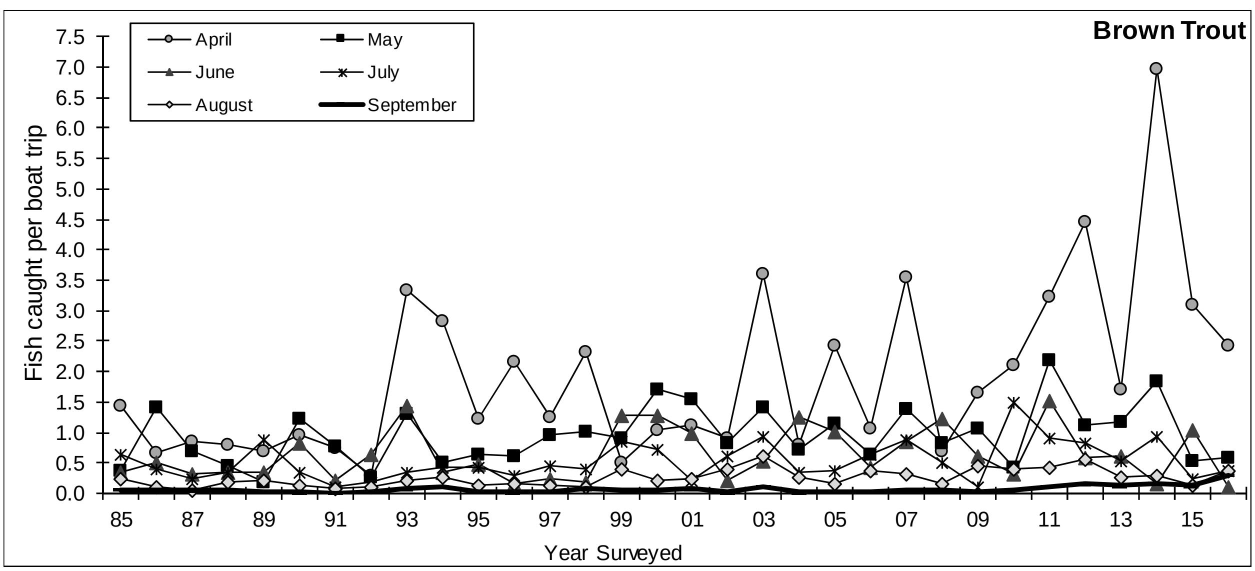


***Figure 12c. Brown trout caught per boat trip April through September, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

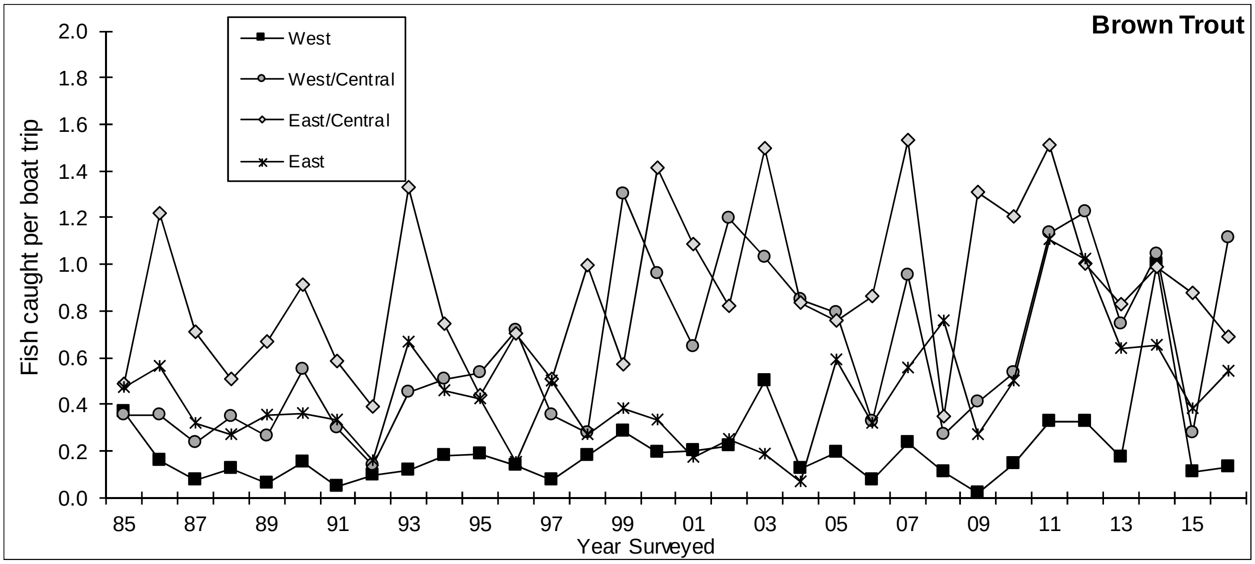


***Figure 12d. Brown trout caught per boat trip in the west, west/central, east/central and east areas surveyed, April 15 – September 30, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

Brown trout monthly and geographical catch and harvest rate trends for most years showed rates highest in April and May and lower and/or declining through September, and highest in the east/central area (Lantry and Eckert 2011; Table A17b, Figures 12c and 12d). During 2016, brown trout catch rates were highest in April (2.4 per boat trip) and May (0.6 fish per boat trip); however, the May catch rate (0.6 fish per boat trip) was the third lowest recorded for that month in over two decades (39.4% decrease compared to the long-term average). The June 2016 catch rate was the lowest recorded in the 32-year time series and an 82.0% decrease compared to the long-term average (Figure 12c; Table A17). Catch rates remained below average in July (-32.1%) but were above the long-term average in August (+43.7%) and September (+378.0%; Figure 12c; Table A17). Similar to estimated catch, the highest catch rate typically occurs in the east/central area. In 2016, however, despite the east/central area having the highest estimated catch it did not have the highest catch rate. The highest 2016 catch rate occurred in the west/central area (1.12 fish per boat trip, an 81.2% increase compared to the long-term average, and the fifth highest for that area in the 32-years surveyed). The second highest catch rate occurred in the east/central area (0.69 fish per boat trip), however, this was the lowest catch rate experienced in that area since 2008 and was a 22.7% decrease compared to the long-term average (Table A17b; Figure 12d). The lowest 2016 catch rates occurred in the west and east areas (0.14 and 0.55 fish per boat trip, respectively; Table A17b; Figure 12d).

*Biological Data*

Biological data analysis presented here includes fish processed during April 15 - September 30 (length: 1985-2016, weight: 1988-2016). Scales were collected from nearly all brown trout processed by creel agents during 1993-2016 (i.e., 24 years). Each year very few brown trout sampled are age 1 (0.0%-3.3%) due to their small size (under 15 inch minimum length limit) and angling strategies (e.g. species targeted, lure type). Each year 2011-2016, none of the brown trout sampled were age-1 (Table A18); the majority were age 2. During 1993-2012, 66.0% (2004) to 88.8% (1993) of all brown trout harvested were age-2 fish. Each year 2013-2015, age-2 brown trout dominated angler harvest, however, age 2s represented the lowest percentages observed from 1993-2015 (range: 58.3%-62.6% were age 2 2013-2015). The lowest percentage in the data series occurred in 2015 (58.3%). Conversely, the 2013-2015 contributions of age-3 brown trout (range: 28.8%-34.6%) were the highest observed from 1993-2015. In 2016, 73.8% of brown trout harvested were age-

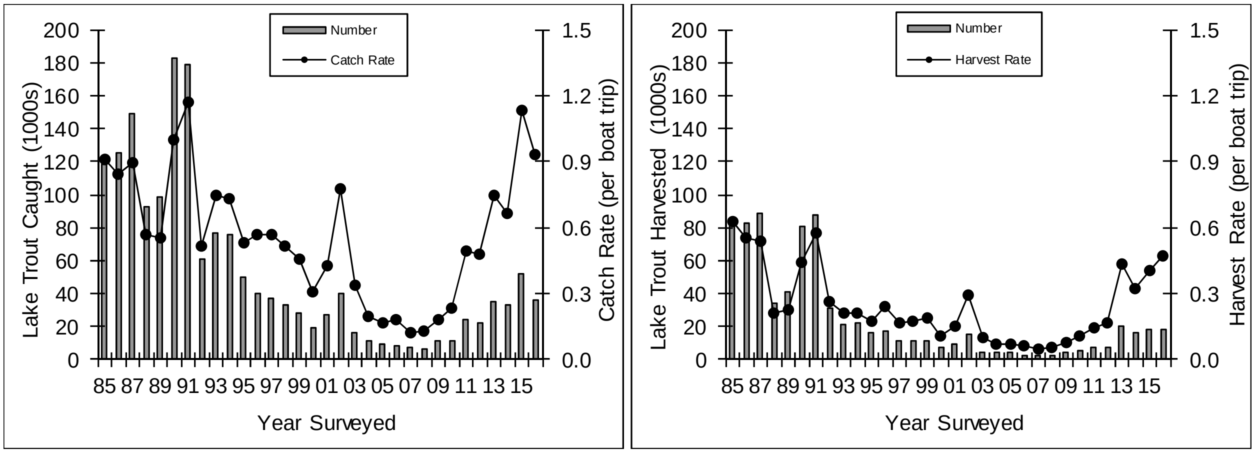


***Figure 13. Total lake trout catch and catch rate, and harvest and harvest rate per boat trip for boats seeking trout and salmon, April 15 – September 30, 1985-2016.***

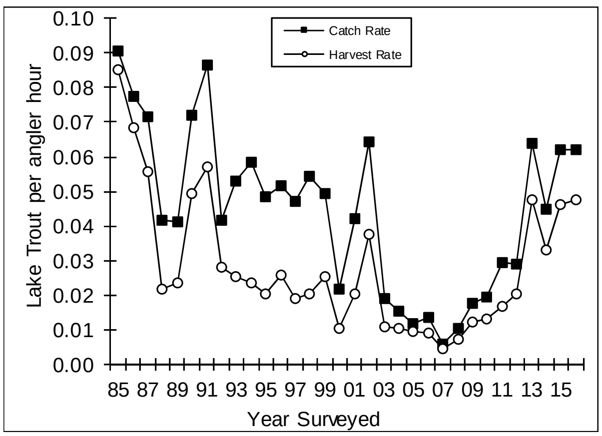


***Figure 13b. Charter boat catch rate and harvest rate per angler hour for lake trout, April 15 – September 30, 1985-2016.***

2 fish, comparable to (-2.0%) the long-term average. We saw a more typical contribution of age-3 fish to angler harvest in 2016 with 19.2% of the harvested brown trout being age 3. For nearly all years, <4% of brown trout harvested were age-4 fish; however, in 2014 and 2015 the percentages of brown trout that were age 4 were the highest recorded (7.8% and 9.2%, respectively). In 2016, 5.8% of the brown trout were age-4 fish. From 1993-2016, age-5 or older brown trout comprised an average of 0.8% (1.2% in 2016; Table A18). Few brown trout age 6 or older were observed, and in the 24 years that scale samples were aged, only thirteen age-6 and one age-7 brown trout were observed.

Each year we determine the mean length of brown trout sampled April 15-30. In 2016, average length of an age-2 brown trout in April was 17.3 in, the fourth shortest recorded since we began collecting length data in 1993 (Table A18). Mean length of age-3 brown trout in 2016 was 22.1 in.

We evaluated brown trout condition by determining predicted weights of seven standard length groups (16-28 in, by 2-in length increments; Table A18). In 2015, predicted weights for the 16-24 inch groups were at record low values and condition of 26 and 28-inch brown trout were near record low values. Brown trout condition improved slightly in 2016 but remained near record low values for all sizes examined.

<u>Lake Trout</u>

*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 2016, lake trout was the second most commonly caught and harvested trout or salmon species, contributing 26.3% and 23.2% of the total salmonine catch and harvest, respectively (Table 1, Table A19a). In 2016, estimated lake trout catch (36,336 [±31.7%] fish) and harvest (18,426 [±33.2%]) were 70.6% and 107.8% increases compared to previous 10-year averages, respectively (Figure 13, Table 1, Table A19a). Catch was the second highest estimated since the mid-1990s. Relatively low catch and catch rates of lake trout through much of the 2000s were attributed, in part, to both the excellent fishing quality for other salmonine species (i.e., possibly less effort specifically directed at lake trout) and relatively low lake trout abundance during the mid-2000s (Lantry and Lantry 2017). Increased lake trout catch, which began in 2011, is most likely attributed to increased lake trout abundance in recent years (Lantry and Lantry 2017). Additionally, some anglers reported specifically targeting lake trout when fishing quality for other species (e.g., brown trout and Chinook salmon) was considered low during 2013-2016.

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). Since 2001, the majority of lake trout were caught in the west or west/central areas (13 of the 15 years 2001-2015). In 2016, the majority of lake trout were caught in the west area (10,329 fish, 28.4% of all lake trout; Table A19a). The 2016 monthly catch and harvest estimates were above previous 10-year averages each month April-September except during August when estimates were below average (-8.5% and -30.8%, respectively; Table A19a).

*Fishing Quality*

Low lake trout abundance during the mid-2000s (Lantry and Lantry 2017) and excellent fishing quality for other salmonine species beginning in 2003 contributed to declining lake trout catch and harvest rates from 2003 to 2007 (2003-2007 average catch rate = 0.2 per boat trip; Figures 13 and 13b, Table A19b). Since then, catch rates increased reaching 1.1 per boat trip in 2015 (second highest on record) and remained high in 2016 (0.9 per boat trip, fourth highest on record; Figure 13, Table A19b). This increase coincided with an increased population of adult lake trout in recent years as well as a likely increase in angler effort targeting lake trout during periods of relatively lower catch rates for other species (2014-2016). In 2016, 53.1% of all lake trout caught by trout and salmon anglers were caught by charters. Among charter boats fishing for trout and salmon, the lake-wide catch rates per boat trip (2.3) and per angler hour (0.06) were 43.1% and 42.2% increases compared to long-term averages, respectively; Table A19b, Figure 13b). Catch rate among noncharter boats fishing for trout and salmon was 0.6 lake trout per boat trip and 0.04 fish per angler hour (Table A19b).

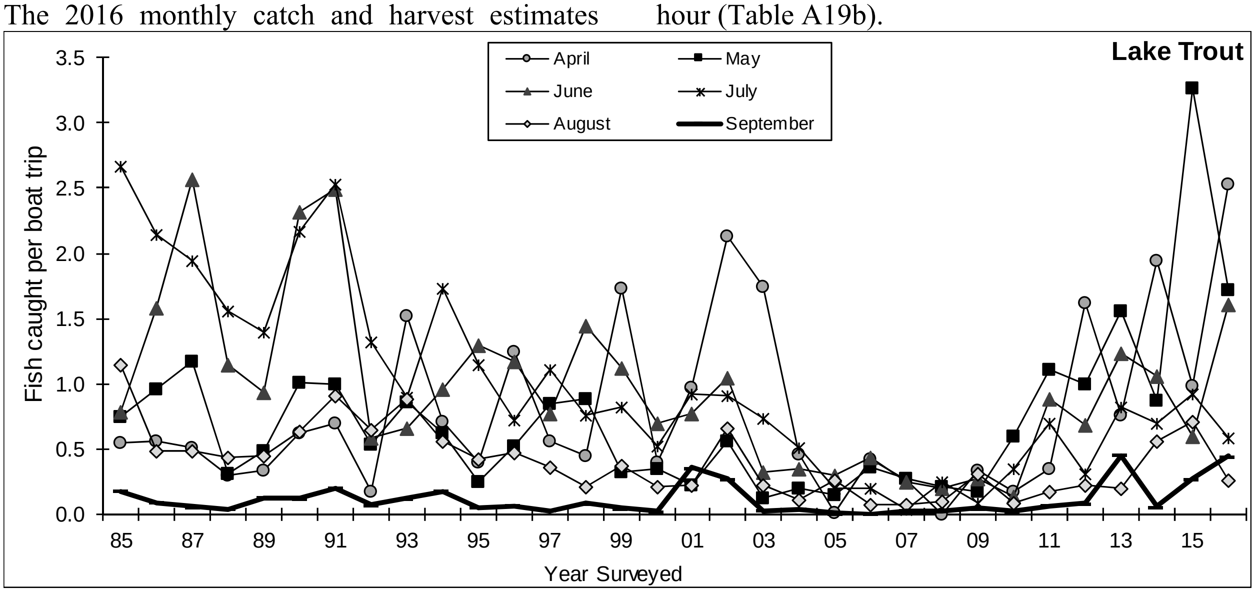


***Figure 13c. Lake trout caught per boat trip April through September, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

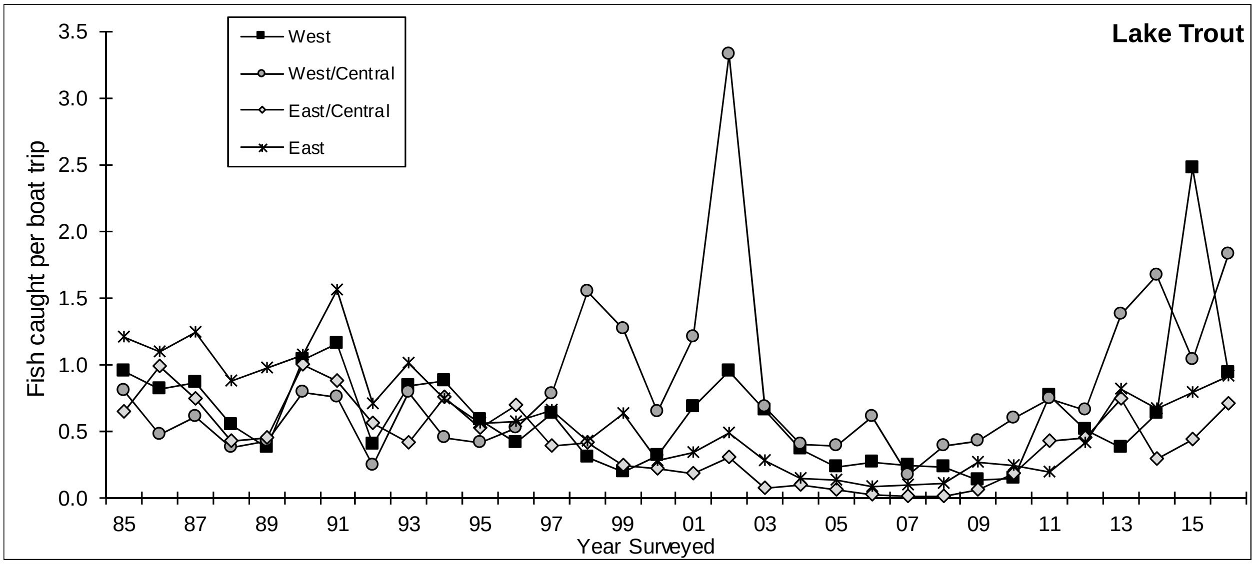


***Figure 13d. Lake trout caught per boat trip in the west, west/central, east/central and east areas surveyed, April 15 – September 30, 1985-2016. Note: Catch rate varied by month within each area surveyed.***

The 2016 lake-wide harvest rate among boats seeking trout and salmon was 0.5 lake trout per boat trip, the fifth highest in the data series (Figure 13, Table A19b). Among charter boats fishing for trout and salmon, the 2016 harvest rate was 1.7 lake trout per boat trip (0.05 per angler hour; Figure 13b, Table A19b). Among noncharter boats fishing for trout and salmon, the harvest rate was 0.1 lake trout per boat trip (0.01 per angler hour; Table A19b).

Comparisons by month showed that catch rates were well above their respective long-term averages during April-June and September (range: +71.2% [June] to +329.2% [September]; Table A19b), and were below average in July (-41.7%) and August (-36.8%; Figure 13c). Catch rates of lake trout have improved in all areas of the lake in recent years. Each year from 1997 to 2014 and in 2016, the west/central area experienced the highest lake trout catch rate (Table A19b, Figure 13d). In 2016, anglers fishing the west/central area caught 1.8 lake trout per boat trip, the highest recorded for that area in the 32-year data series. The highest harvest rate also occurred in the west/central area (1.0 per boat trip; Table A19b). Anglers fishing the west area experienced a catch rate of 0.9 lake trout per boat trip, a 52.8% increase compared to the long-term average. East/central area catch rate (0.7 per boat trip) was a 71.7% increase compared to the long-term average. Lake trout catch rate in the east area (0.9 fish per boat trip) was also well above average (+51.8%, highest since 1993).

*Biological Data*

Biological data analysis presented here includes fish processed during April 15 - September 30 (length: 1985-2016, weight: 1988-2016). The 2016 fishing season was the tenth season affected by the October 2006 regulation change permitting each angler to keep two lake trout per day with no more than one between 25 and 30 inches. From 1993-2006, 9.8% (1998) to 26.6% (1993; 1993-2006 average = 17.0%) 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%), the most recent five years prior to the regulation change (Table A20). From 2012 through 2015, over 50% of lake trout harvested were within the slot limit (2012-2015 average=54.9%). In 2016, 46.3% of all lake trout harvested were within the 25-30 inch slot.

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. A regulation change effective October 1, 2006 established a pre-season catch and release period for 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 17, 2016 was the tenth pre-season catch and release period covered by this survey. During that period, there were an estimated 356 (±84.6%) fishing boat trips targeting smallmouth bass with effort occurring during May (99 boat trips) and June 1-17 (257 boat trips; Table A2).

Among all fish species, smallmouth bass was the most commonly caught species each year 1985 and 1987-2006. Fishing effort targeting smallmouth bass began declining in the early 2000s and, since 2010, has remained relatively stable at the lowest levels recorded (Figure 2). 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). From 2009-2015, catch of smallmouth bass remained low and this species was the fifth or sixth most commonly captured Lake Ontario fish species. In 2016, smallmouth bass was again the third most commonly caught species with an estimated catch of 26,719 fish (±46.0%; April 15 - September 30), preceeded only by Chinook salmon (60,435 fish) and lake trout (36,336 fish; Table 1, Table A21a). During the traditional open fishing season, 21,014 smallmouth bass were caught and 17.0% of those were harvested (3,578 fish; Figure 14, Table A21a).

*Fishing Quality*

Fishing quality was relatively stable from 1985 through the early 1990s (1985-1994 average catch per boat trip = 8.3 bass; average catch per angler hour = 1.0 bass), increased to its highest level in 2002 (14.1 per boat trip and 2.02 per angler hour; Figure 14, Table A21b; Eckert 2005), then declined to the lowest level recorded in 2010 (1.9 per boat trip and 0.35 per angler hour; Figure 14). Fishing quality in 2016 remained among the lowest rates observed (4.0 and 0.7 bass caught and harvested per bass boat trip, respectively; Figure 14, Table A21b). Smallmouth bass catch rate per angler hour in 2016 was 0.57, slightly higher than (+11.0%) the previous 10-year average but 71.9% below the 2002 record high (Figure 14b, Table A21b).

Comparisons of 2016 month- and area-specific catch and harvest rates with their respective 2011-2015 averages (Table A21b) showed above average fishing quality during June (+77.3%) and

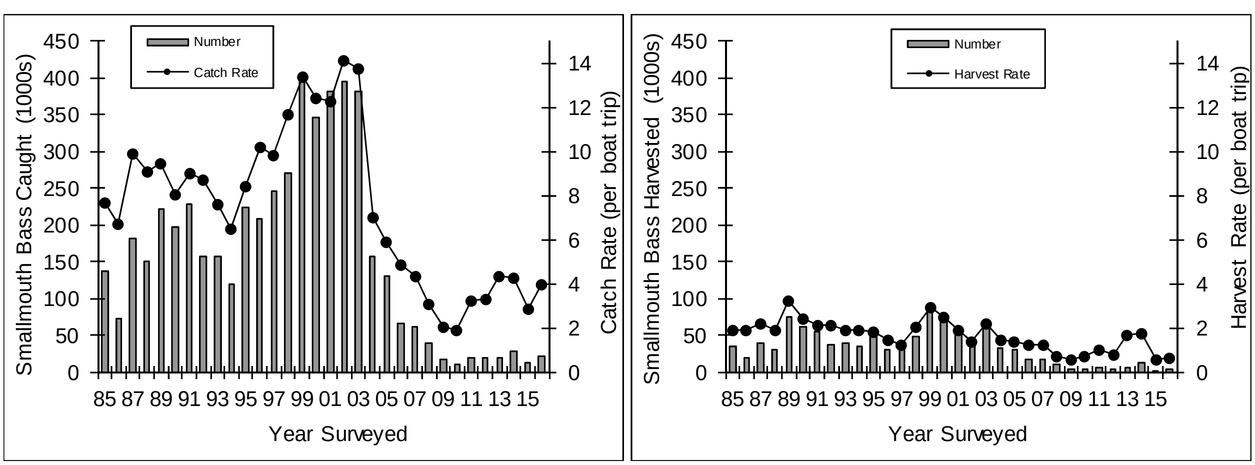


***Figure 14. Total smallmouth bass catch and catch rate, and harvest and harvest rate per boat trip for boats seeking smallmouth bass during the traditional open season, 1985-2016.***

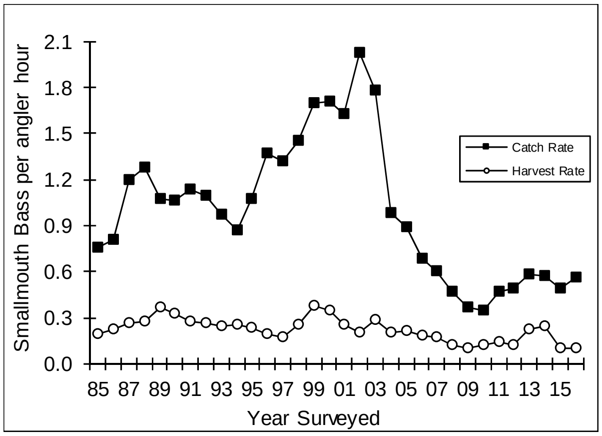


***Figure 14b. Smallmouth bass catch rate and harvest rate per angler hour among anglers targeting bass during the traditional open season, 1985-2016.***

September (+48.8%), comparable to average quality in August (-6.2%), and rates below the previous 5-year average in July (-19.1%). The 2016 catch rate was below previous 5-year averages in the west (-77.8%) and east (-23.8%) areas, and was above average in the west/central (+185.4%) and east/central (+72.4%) areas (Table A21b).

Additional measures of fishing quality were evaluated. In 2016, 43.7% of boats specifically targeting smallmouth bass during the traditional open season failed to catch at least one bass, which is slightly better than most recent years but remaining well above levels observed prior to 2006 (Table A6, Part B), indicating continued poor fishing quality (Table A6). Each year a relatively low percentage of bass 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 (2004-2016 average=2.5%). In 2016, for the first year in the 32-year data series, none of the boats specifically targeting bass harvested the daily creel limit of five bass per angler (Table A6). This metric 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).

Fishing quality along Lake Ontario's south shore since the mid-2000s may have been influenced by several factors including, round goby, Viral Hemorrhagic Septicemia virus [VHSv], *Hemimysis*, *Cladaphora* (i.e., commonly called witch's hair), and nutrient and water clarity changes. Many of these factors also affect populations in Lake Ontario's Eastern Outlet Basin, the St. Lawrence River and Lake Erie bass populations. Unlike the southern shore, however, these regions have generally continued to provide acceptable bass catch rates.

A Lake Ontario bass angler diary program, conducted 2010-2013, surveyed bass anglers fishing Lake Ontario and its embayments and tributaries. Catch rates experienced by diarists (0.39-0.63 bass per angler hour) were similar to rates reported in this survey for the same time period (0.35-0.59 bass per angler hour; Table A21b; Sanderson and Lantry 2014). The angler diary program was discontinued following the 2013 season due to low participation (Sanderson and Lantry 2014).

Yellow Perch

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 2016 estimated catch (18,176 [±128.3%] fish) and harvest (10,483 [±163.9%] fish) were below long-term (1985-2015) averages (-36.9% and -16.7%, respectively), but were the highest since 2012 (Figure 15, Table 1, Table A22). Reduced angler catch reported in this survey the last three years coincided with reduced catch in the Eastern Basin gillnetting assessment (Lantry 2017) and anecdotal angler reports of lower catches in areas not covered by this survey, suggesting that perch populations in recent years were likely lower than those during 2007-2012. At that time angler catches of yellow perch in this survey were among the highest in the 32-years surveyed (Figure 15), anecdotal angler reports indicated good fishing quality, and gillnet catches in the Eastern Basin were the highest since the late 1980s – all indicating increased population size (e.g., Lantry 2017). Yellow perch are distributed along much of

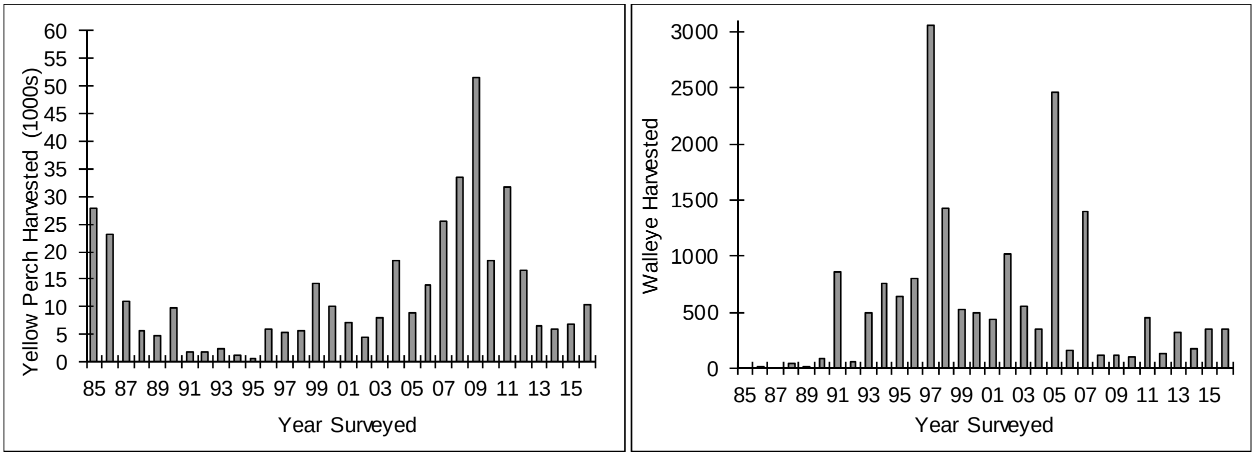


***Figure 15. Total yellow perch and walleye harvested by all fishing boats, April 15-September 30 1985-2016.***

the Lake Ontario shoreline, however, each year 1996-2016 the greatest proportion of catch occurred in the east/central area by relatively few fishing boats targeting perch (67.7% of total catch in 2016; Table A22).

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 2017). 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 2016, there were an estimated 671 walleye caught and 349 harvested in Lake Ontario (±198.5% and ±149.6%, respectively; Figure 15, Table A23). Fisheries assessment data (Lantry 2017) and anecdotal angler reports suggest that walleye populations and fisheries are greatly underestimated by this survey and estimated catch and harvest of them are of limited value.

"Other Fish"

The "other fish" category includes a variety of species, including unidentified fish. In 2016, 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 2016 were: northern pike (84 caught, 84 harvested) and largemouth bass (160 caught, 0 harvested). Lake sturgeon were reported in angler catch during only two of the 32 years surveyed, 2001 (44 fish) and 2012 (27 fish). Chain pickerel were only recently reported in angler catch (caught each year 2008-2010, and in 2013) but none were reported 2014-2016. Cisco (a.k.a lake herring; 84 caught, 15 harvested) were reported in angler creel for the seventh consecutive year (2010-2016). 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 (Table A3). 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, Weidel et al. 2013). Round goby catches were first reported in the NYSDEC Fishing Boat Survey in 2001 (965 fish caught). As round goby increased in abundance and distribution in Lake Ontario (Weidel et al. 2013), its occurrence in angler creel increased dramatically. 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. Since then estimated catch of goby has declined. In 2016, round goby was the seventh most commonly caught species (12,982 ±66.4% caught; 5,015 ±65.0% harvested; Table 1, Table A3).

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 2016, there were an estimated 1,680 (±34.6%) lampreys observed in this survey, a 50.2% decrease compared to the previous 5-year average and a 80.1% decrease compared to the 2007 record high (Figure16, 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 (Lantry and Lantry 2017). Lamprey attack rate decreased from the 2007 peak and, in 2016, there were an estimated 12.2 lamprey per 1,000 trout or salmon caught (Figure 16, Table A24). This rate was the lowest estimated since 2002, however, was still over 2-fold higher than the 1986-1995 average rate.

For 13 of the last 16 years (2001-2016) the majority of lamprey observations occurred on Chinook salmon (2001-2016 average=58.5%), which was due, in part, to the large number of Chinook salmon caught by anglers (e.g., 2001-2016 average=43.1% of total trout and salmon catch; Table A5a, Table A9a). In 2016, 60.7% of lamprey observed by anglers were on Chinook salmon (Table A5a, Table A17a, Table A24). Other host salmonines in 2016 were brown trout (19.0% of observations), lake trout (11.9% of observations), rainbow trout (7.1% of observations), and Atlantic salmon (1.2%; Table

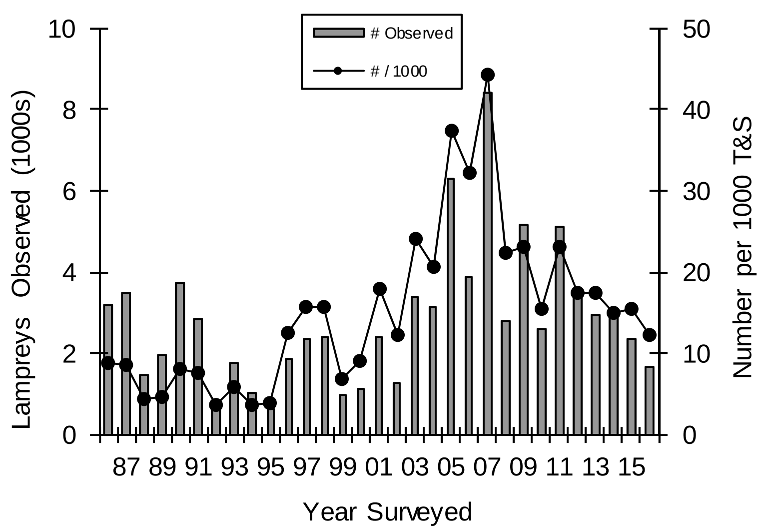


***Figure 16. Total lamprey observed, and lampreys observed per 1,000 trout and salmon caught, April 15-September 30, 1985-2016.***

A24). There were three reports of lamprey observed on fishing gear in 2016. Among the 31 years of lamprey observation data, there were a total of 40 lampreys reported on fishing gear.

Host-specific attack rate on Lake Ontario's trout and salmon (e.g., the proportion of brown trout caught by anglers with a lamprey attached; Table A24) was determined each year. 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 the "other" salmonines. On average, during 1996-2016, lampreys were observed on a much higher percentage of angler catch (range: 1.0% [coho salmon] to 5.6% [Atlantic salmon]). The increase in attack rate on these salmonine species coincided with a decrease in abundance of the preferred lamprey prey (i.e., lake trout $\geq$17 inches; Lantry and Lantry 2017). The lower attack rates since 2007 (Figure 16) coincide 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 an increased lake trout population (Lantry and Lantry 2017).

## Acknowledgments

We would like to acknowledge the help and cooperation of staff from the U.S. Geological Survey's Oswego Station and the NY State Department of Transportation at Spencerport and Braddock Bay, who provided field headquarters from which the creel agents operated. NYSDEC fisheries staff in Regions 6-9 provided additional logistical support. Special thanks to the 2016 creel agents, Ryan Smith, Joseph Xamountry, Jeffrey Meyer, and Benjamin Little; and to Vicki Southwell who assisted with data entry.

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## 2016 Lake Ontario Fishing Boat Survey

### Appendix Tables and Figures

***Table A1. The four geographic areas (Roman numerals) used in analysis of the 1985-2016 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 1985-2016 NYSDEC fishing boat surveys.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Part A: Effort for all fishing boats. | | | | | | | | | | | |
| Seasonal (5½ month) estimates of fishing effort for all fishing boats: | | | | | | | | | | | |
| Fishing Boat Trips | 126,890 | 79,167 | 69,687 | 76,838 | 62,104 | 60,943 | 56,182 | 54,605 | 58,554 | 53,154 | 46,339 |
| Boat Angler Trips | 350,098 | 219,647 | 194,658 | 221,925 | 175,820 | 171,519 | 160,363 | 161,620 | 174,079 | 157,151 | 138,434 |
| Boat Angler Hours | 1,893,144 | 1,113,767 | 985,898 | 1,229,977 | 905,357 | 898,339 | 848,905 | 937,822 | 980,409 | 879,681 | 787,588 |
| Anglers/Boat Trip | 2.75 | 2.77 | 2.79 | 2.89 | 2.83 | 2.81 | 2.85 | 2.96 | 2.97 | 2.96 | 2.99 |
| Hours/ Boat Trip | 5.32 | 5.07 | 5.06 | 5.54 | 5.15 | 5.24 | 5.29 | 5.80 | 5.63 | 5.60 | 5.69 |
| Monthly estimates of boat trips for all fishing boats: | | | | | | | | | | | |
| April | 10,907 | 3,014 | 3,131 | 3,230 | 2,680 | 2,529 | 2,409 | 2,672 | 1,935 | 2,251 | 3,257 |
| May | 19,112 | 11,796 | 7,784 | 15,360 | 11,111 | 8,605 | 9,540 | 8,368 | 8,652 | 9,147 | 7,299 |
| June | 15,303 | 11,174 | 8,650 | 8,351 | 5,489 | 6,183 | 8,128 | 7,608 | 8,002 | 5,190 | 5,231 |
| July | 22,938 | 16,316 | 15,507 | 12,735 | 12,703 | 15,024 | 12,024 | 11,950 | 11,234 | 10,904 | 10,305 |
| August | 35,278 | 23,131 | 21,147 | 19,815 | 21,764 | 17,315 | 15,096 | 17,404 | 19,666 | 14,085 | 12,284 |
| September | 23,353 | 13,736 | 13,468 | 17,346 | 8,356 | 11,286 | 8,986 | 6,603 | 9,061 | 11,577 | 7,963 |
| Seasonal estimates of boat trips among four geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 29,611 | 18,543 | 14,276 | 20,404 | 16,269 | 16,248 | 14,145 | 14,602 | 13,674 | 12,543 | 11,649 |
| West/Central | 18,578 | 11,461 | 7,722 | 10,746 | 7,011 | 6,890 | 7,412 | 7,648 | 7,210 | 7,407 | 4,561 |
| East/Central | 41,597 | 25,300 | 25,094 | 25,448 | 22,318 | 19,926 | 17,410 | 17,368 | 18,455 | 16,964 | 17,508 |
| East | 37,104 | 23,863 | 22,594 | 20,239 | 16,506 | 17,879 | 17,215 | 14,988 | 19,215 | 16,240 | 12,622 |
| Part B: Seasonal estimates of total boat excursions (traffic). | | | | | | | | | | | |
| Power Boats: | | | | | | | | | | | |
| Fishing Boats | 130,719 | 80,405 | 70,525 | 77,410 | 62,435 | 61,383 | 56,979 | 55,116 | 59,149 | 53,812 | 46,747 |
| Nonfishing Boats | 111,641 | 76,672 | 80,479 | 86,372 | 84,587 | 69,943 | 71,318 | 89,530 | 70,311 | 97,066 | 96,268 |
| Sail Boats | 28,711 | 18,126 | 19,750 | 22,224 | 23,914 | 23,782 | 20,703 | 21,432 | 19,104 | 13,905 | 12,789 |
| Part C: Seasonal estimates of boat angler trips by residence. | | | | | | | | | | | |
| NY Resident | 216,733 | 135,400 | 115,936 | 134,954 | 108,712 | 105,145 | 97,153 | 96,610 | 106,088 | 94,785 | 81,559 |
| Nonresident | 133,365 | 84,247 | 78,722 | 86,971 | 67,108 | 66,374 | 63,210 | 65,010 | 67,991 | 62,366 | 56,875 |
| % NY Resident | 61.5% | 61.6% | 59.6% | 60.8% | 61.8% | 61.3% | 60.6% | 59.8% | 60.9% | 60.3% | 58.9% |
| 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 | 98,963 | 57,620 | 51,229 | 62,028 | 50,059 | 49,548 | 46,059 | 47,520 | 49,434 | 46,142 | 38,776 |
| Boat Angler Trips | 286,115 | 172,001 | 152,905 | 189,796 | 151,747 | 147,775 | 138,687 | 146,900 | 155,656 | 142,816 | 121,828 |
| Boat Angler Hours | 1,677,243 | 968,752 | 868,237 | 1,143,095 | 843,037 | 831,675 | 785,271 | 889,719 | 917,662 | 838,730 | 735,716 |
| Anglers/Boat Trip | 2.90 | 2.99 | 2.98 | 3.06 | 3.03 | 2.98 | 3.01 | 3.09 | 3.15 | 3.10 | 3.14 |
| Hours/ Boat Trip | 5.84 | 5.63 | 5.68 | 6.02 | 5.56 | 5.63 | 5.66 | 6.06 | 5.90 | 5.87 | 6.04 |
| Monthly estimates of boat trips for boats seeking trout and salmon: | | | | | | | | | | | |
| April | 10,768 | 2,998 | 2,874 | 3,610 | 2,610 | 2,518 | 2,366 | 2,575 | 1,920 | 2,251 | 3,198 |
| May | 18,211 | 11,009 | 7,262 | 14,731 | 9,401 | 8,050 | 8,388 | 7,911 | 8,417 | 8,656 | 6,770 |
| June | 9,680 | 5,862 | 4,760 | 5,201 | 3,878 | 4,313 | 5,138 | 6,333 | 5,489 | 4,322 | 3,785 |
| July | 13,714 | 10,212 | 9,261 | 8,743 | 9,233 | 10,903 | 9,255 | 9,651 | 8,827 | 8,140 | 8,403 |
| August | 27,396 | 16,674 | 16,485 | 15,192 | 18,080 | 14,123 | 12,910 | 15,910 | 16,917 | 12,340 | 9,997 |
| September | 19,194 | 10,864 | 10,586 | 14,552 | 6,858 | 9,642 | 8,002 | 5,141 | 7,864 | 10,433 | 6,622 |
| Seasonal estimates of boat trips among four geographic areas for boats seeking trout and salmon: | | | | | | | | | | | |
| West | 25,641 | 16,119 | 12,440 | 18,562 | 14,258 | 14,715 | 12,671 | 13,674 | 12,092 | 11,350 | 11,061 |
| West/Central | 13,676 | 6,962 | 4,293 | 7,725 | 5,574 | 5,047 | 5,584 | 6,634 | 6,251 | 6,447 | 3,914 |
| East/Central | 29,454 | 16,507 | 17,094 | 19,173 | 16,740 | 15,137 | 13,596 | 15,259 | 15,852 | 13,937 | 13,830 |
| East | 30,193 | 18,031 | 17,403 | 16,568 | 13,487 | 14,649 | 14,208 | 11,954 | 15,239 | 14,408 | 9,972 |
| Percent of total seasonal fishing effort by boats seeking trout and salmon: | | | | | | | | | | | |
| Fishing Boat Trips | 75.1% | 72.8% | 73.5% | 80.7% | 80.6% | 81.3% | 82.0% | 87.0% | 84.4% | 86.8% | 83.7% |
| Boat Angler Trips | 79.2% | 78.3% | 78.6% | 85.5% | 86.3% | 86.2% | 86.5% | 90.9% | 89.4% | 90.9% | 88.0% |
| Boat Angler Hours | 86.7% | 87.0% | 88.1% | 92.9% | 93.1% | 92.6% | 92.5% | 94.9% | 93.6% | 95.3% | 93.4% |

## *Table A2 (continued). Summary of effort statistics.*

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **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 | 22,354 | 14,509 | 12,786 | 8,666 | 5,855 | 6,257 | 6,203 | 4,273 | 6,878 | 4,868 | 5,295 |
| Boat Angler Trips | 51,218 | 33,135 | 28,548 | 18,885 | 12,106 | 13,758 | 13,505 | 9,082 | 14,223 | 9,900 | 11,944 |
| Boat Angler Hours | 172,417 | 103,494 | 83,434 | 48,847 | 32,603 | 42,718 | 41,972 | 31,569 | 51,006 | 28,115 | 37,167 |
| Anglers/Boat Trip | 2.29 | 2.28 | 2.23 | 2.18 | 2.07 | 2.20 | 2.18 | 2.13 | 2.07 | 2.03 | 2.26 |
| Hours/ Boat Trip | 3.37 | 3.12 | 2.92 | 2.59 | 2.69 | 3.10 | 3.11 | 3.48 | 3.59 | 2.84 | 3.11 |
| Monthly estimates of boat trips for boats seeking smallmouth bass during the traditional open season: | | | | | | | | | | | |
| April & May | - | - | - | - | - | - | - | - | - | - | - |
| June | 3,945 | 2,879 | 2,325 | 1,284 | 634 | 935 | 1,525 | 637 | 1,900 | 543 | 904 |
| July | 7,903 | 4,738 | 4,979 | 2,517 | 2,212 | 2,704 | 2,303 | 1,403 | 1,786 | 2,376 | 1,498 |
| August | 6,978 | 4,778 | 3,579 | 2,878 | 2,139 | 1,724 | 1,646 | 959 | 2,312 | 1,148 | 1,931 |
| September | 3,528 | 2,114 | 1,903 | 1,987 | 870 | 894 | 728 | 1,275 | 880 | 801 | 962 |
| Seasonal estimates of boat trips among four geographic areas for boats seeking smallmouth bass during the traditional open season: | | | | | | | | | | | |
| West | 2,530 | 1,561 | 1,001 | 1,370 | 1,051 | 815 | 984 | 352 | 1,101 | 793 | 263 |
| West/Central | 3,663 | 2,621 | 2,426 | 1,453 | 642 | 784 | 1,006 | 564 | 609 | 370 | 138 |
| East/Central | 10,418 | 6,649 | 5,451 | 3,638 | 2,768 | 2,809 | 2,289 | 1,174 | 1,801 | 2,233 | 2,800 |
| East | 5,744 | 3,677 | 3,908 | 2,204 | 1,394 | 1,849 | 1,924 | 2,183 | 3,367 | 1,473 | 2,094 |
| Percent of total seasonal fishing effort by boats seeking smallmouth bass during the traditional open season: | | | | | | | | | | | |
| Fishing Boat Trips | 20.2% | 18.3% | 18.3% | 11.3% | 9.4% | 10.3% | 11.0% | 7.8% | 11.7% | 9.2% | 11.4% |
| Boat Angler Trips | 16.8% | 15.1% | 14.7% | 8.5% | 6.9% | 8.0% | 8.4% | 5.6% | 8.2% | 6.3% | 8.6% |
| Boat Angler Hours | 10.8% | 9.3% | 8.5% | 4.0% | 3.6% | 4.8% | 4.9% | 3.4% | 5.2% | 3.2% | 4.7% |
| **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 | 91 | 224 | 0 | 0 | 78 | 46 | 29 | 78 | 22 | 0 | 49 |
| SMB pre-opener | 219 | 496 | 367 | 644 | 292 | 239 | 521 | 191 | 295 | 164 | 356 |
| Largemouth Bass | 25 | 52 | 16 | 0 | 0 | 13 | 13 | 197 | 62 | 29 | 0 |
| Yellow Perch | 882 | 1,203 | 1,914 | 1,800 | 1,901 | 1,794 | 1,556 | 779 | 712 | 623 | 422 |
| Walleye | 451 | 1,210 | 373 | 270 | 470 | 384 | 233 | 249 | 137 | 348 | 368 |
| All Other | 3,869 | 3,853 | 3,003 | 3,863 | 3,449 | 2,662 | 1,568 | 1,319 | 1,015 | 980 | 1,073 |
| % Northern Pike | 0.08% | 0.28% | | | 0.13% | 0.08% | 0.05% | 0.14% | 0.04% | 0.00% | 0.11% |
| % SMB pre-opener | 0.23% | 0.63% | 0.53% | 0.84% | 0.47% | 0.39% | 0.93% | 0.35% | 0.50% | 0.31% | 0.77% |
| % Largemouth Bass | 0.01% | 0.07% | 0.02% | | | 0.02% | 0.02% | 0.36% | 0.11% | 0.05% | 0.00% |
| % Yellow Perch | 0.61% | 1.52% | 2.75% | 2.34% | 3.06% | 2.94% | 2.77% | 1.43% | 1.22% | 1.17% | 0.91% |
| % Walleye | 0.58% | 1.53% | 0.54% | 0.35% | 0.76% | 0.63% | 0.41% | 0.46% | 0.23% | 0.65% | 0.79% |
| % All Other | 3.11% | 4.87% | 4.31% | 5.03% | 5.55% | 4.37% | 2.79% | 2.42% | 1.73% | 1.84% | 2.32% |
| **Part G: Charter fishing boats.** | | | | | | | | | | | |
| Seasonal (5½ month) estimates of fishing effort for charter boats: | | | | | | | | | | | |
| Fishing Boat Trips | 13,259 | 9,448 | 9,012 | 9,885 | 8,612 | 8,332 | 7,632 | 9,343 | 9,718 | 9,831 | 8,653 |
| Boat Angler Trips | 66,826 | 48,726 | 47,015 | 50,142 | 44,773 | 43,124 | 38,880 | 48,694 | 51,351 | 51,311 | 45,496 |
| Boat Angler Hours | 489,651 | 340,751 | 322,072 | 347,188 | 288,231 | 275,652 | 256,420 | 338,688 | 345,925 | 334,663 | 314,553 |
| Anglers/Boat Trip | 5.00 | 5.16 | 5.22 | 5.07 | 5.20 | 5.18 | 5.09 | 5.21 | 5.28 | 5.22 | 5.26 |
| Hours/ Boat Trip | 7.27 | 6.99 | 6.85 | 6.92 | 6.44 | 6.39 | 6.60 | 6.96 | 6.74 | 6.52 | 6.91 |
| Monthly estimates of boat trips for charter boats: | | | | | | | | | | | |
| April | 808 | 401 | 210 | 331 | 428 | 300 | 599 | 426 | 281 | 353 | 607 |
| May | 2,310 | 1,299 | 1,227 | 1,712 | 1,425 | 1,119 | 733 | 1,607 | 1,401 | 1,941 | 954 |
| June | 1,477 | 1,221 | 930 | 974 | 657 | 873 | 648 | 965 | 1,028 | 707 | 981 |
| July | 2,073 | 2,237 | 1,455 | 1,917 | 2,112 | 2,174 | 1,826 | 2,252 | 2,141 | 1,724 | 2,431 |
| August | 4,342 | 2,732 | 3,588 | 2,949 | 3,259 | 2,513 | 2,622 | 3,060 | 3,620 | 3,407 | 1,946 |
| September | 2,250 | 1,559 | 1,602 | 2,002 | 731 | 1,353 | 1,203 | 1,032 | 1,247 | 1,700 | 1,735 |
| Seasonal estimates of boat trips among four geographic areas for charter boats: | | | | | | | | | | | |
| West | 3,493 | 2,810 | 2,371 | 2,624 | 2,837 | 2,658 | 2,060 | 2,572 | 2,234 | 2,401 | 2,426 |
| West/Central | 1,454 | 1,387 | 472 | 1,056 | 933 | 842 | 813 | 1,120 | 1,321 | 1,283 | 922 |
| East/Central | 4,768 | 3,292 | 3,854 | 4,235 | 3,512 | 3,263 | 2,879 | 3,935 | 4,254 | 3,732 | 3,411 |
| East | 3,545 | 1,960 | 2,315 | 1,971 | 1,329 | 1,570 | 1,880 | 1,715 | 1,910 | 2,415 | 1,894 |
| Percent of total seasonal fishing effort by charter boats: | | | | | | | | | | | |
| Fishing Boat Trips | 10.9% | 11.9% | 12.9% | 12.9% | 13.9% | 13.7% | 13.6% | 17.1% | 16.6% | 18.5% | 18.7% |
| Boat Angler Trips | 19.8% | 22.2% | 24.2% | 22.6% | 25.5% | 25.1% | 24.2% | 30.1% | 29.5% | 32.7% | 32.9% |
| Boat Angler Hours | 27.3% | 30.6% | 32.7% | 28.2% | 31.8% | 30.7% | 30.2% | 36.1% | 35.3% | 38.0% | 39.9% |

***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, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of fish harvested: | | | | | | | | | | | |
| Unidentified Fish | 4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bowfin | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| American Eel | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Alewife | 31 | 0 | 0 | 0 | 365 | 0 | 14 | 72 | 0 | 20 | 53 |
| Gizzard Shad | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Cisco | 24 | 0 | 0 | 0 | 76 | 187 | 247 | 221 | 270 | 48 | 15 |
| Lake Whitefish | 0 | 0 | 0 | 0 | 11 | 13 | 0 | 0 | 0 | 0 | 0 |
| Pink Salmon | 3 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Salmonine | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Northern Pike | 84 | 0 | 40 | 0 | 0 | 14 | 132 | 0 | 35 | 0 | 84 |
| Chain Pickerel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 67 | 0 | 0 | 0 |
| Common carp | 4 | 0 | 0 | 0 | 0 | 0 | 45 | 0 | 0 | 0 | 0 |
| Unidentified Redhorse | 0 | 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yellow Bullhead | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brown Bullhead | 104 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 53 | 0 | 30 |
| Channel Catfish | 63 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Threespine Stickleback | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Perch | 1,664 | 0 | 0 | 0 | 20 | 0 | 0 | 0 | 115 | 0 | 0 |
| White Bass | 293 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 22 | 0 | 0 |
| Rock Bass | 2,946 | 363 | 1,115 | 526 | 131 | 135 | 688 | 134 | 478 | 12 | 25 |
| Pumpkinseed | 482 | 0 | 95 | 29 | 20 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bluegill | 117 | 29 | 79 | 87 | 140 | 329 | 0 | 0 | 368 | 13 | 0 |
| Largemouth Bass | 98 | 108 | 149 | 88 | 32 | 0 | 132 | 22 | 26 | 0 | 0 |
| Black Crappie | 88 | 0 | 0 | 0 | 0 | 0 | 26 | 0 | 151 | 0 | 0 |
| Freshwater Drum | 464 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 151 | 0 | 0 |
| Round Goby | 1,667 | 28,974 | 39,611 | 36,003 | 13,138 | 12,770 | 9,182 | 7,546 | 4,222 | 4,683 | 5,015 |
| Seasonal (5½ month) estimates of fish caught: | | | | | | | | | | | |
| Unidentified Fish | 34 | 48 | 250 | 213 | 0 | 19 | 24 | 23 | 0 | 41 | 0 |
| Lake Sturgeon | 2 | 0 | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 0 | 0 |
| Longnose Gar | 2 | 0 | 0 | 72 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Bowfin | 21 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 24 | 0 |
| American Eel | 81 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Alewife | 396 | 0 | 45 | 43 | 736 | 220 | 27 | 403 | 163 | 127 | 223 |
| Gizzard Shad | 11 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 13 | 0 |
| Cisco | 33 | 0 | 0 | 0 | 181 | 229 | 375 | 221 | 297 | 120 | 84 |
| Lake Whitefish | 0 | 0 | 0 | 0 | 11 | 13 | 0 | 0 | 0 | 0 | 0 |
| Pink salmon | 3 | 23 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Unidentified Salmonine | 291 | 31 | 281 | 14 | 106 | 113 | 0 | 0 | 0 | 60 | 26 |
| Rainbow Smelt | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Northern Pike | 326 | 2,191 | 235 | 1,370 | 900 | 62 | 204 | 130 | 255 | 36 | 84 |
| Muskellunge | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Chain Pickerel | 0 | 0 | 690 | 422 | 32 | 0 | 0 | 290 | 0 | 0 | 0 |
| Common Carp | 92 | 19 | 114 | 38 | 62 | 26 | 72 | 70 | 0 | 0 | 0 |
| White Sucker | 26 | 14 | 14 | 0 | 36 | 13 | 0 | 0 | 26 | 0 | 0 |
| Unidentified Redhorse | 11 | 45 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Yellow Bullhead | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brown Bullhead | 141 | 0 | 0 | 0 | 0 | 0 | 0 | 25 | 53 | 0 | 30 |
| Channel Catfish | 147 | 0 | 198 | 0 | 15 | 0 | 19 | 0 | 0 | 0 | 0 |
| Threespine Stickleback | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White perch | 4,386 | 30 | 606 | 0 | 83 | 101 | 0 | 12 | 115 | 0 | 40 |
| White Bass | 1,308 | 72 | 14 | 257 | 20 | 25 | 2,533 | 0 | 49 | 0 | 0 |
| Rock Bass | 14,786 | 4,608 | 4,495 | 2,546 | 991 | 818 | 1,840 | 1,088 | 5,371 | 596 | 555 |
| Pumpkinseed | 1,603 | 1,369 | 2,774 | 577 | 222 | 28 | 36 | 322 | 436 | 0 | 267 |
| Bluegill | 333 | 306 | 284 | 146 | 349 | 1,257 | 77 | 225 | 869 | 25 | 0 |
| Largemouth Bass | 548 | 1,177 | 1,313 | 594 | 190 | 227 | 516 | 456 | 106 | 425 | 160 |
| Black Crappie | 136 | 18 | 0 | 0 | 0 | 0 | 26 | 0 | 0 | 0 | 0 |
| Freshwater Drum | 7,753 | 686 | 360 | 266 | 701 | 240 | 525 | 256 | 388 | 163 | 393 |
| Round Goby | 3,331 | 62,615 | 63,407 | 58,310 | 21,033 | 25,290 | 13,484 | 12,659 | 6,704 | 6,297 | 12,982 |

***Table A4. Residency for boat anglers interviewed April 15 – September 30, 1985-2016. Shown are percent contributions of the most common states or provinces, and for the most common counties among New York resident anglers.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **State or Province of Residence** | | | | | | | | | | | |
| Connecticut | 2.0 | 2.4 | 1.6 | 1.7 | 1.6 | 1.3 | 1.5 | 1.3 | 0.8 | 1.2 | 0.9 |
| Florida | 0.3 | 0.5 | 0.4 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 | 0.5 | 0.4 | 0.4 |
| Maine | 0.8 | 1.0 | 0.9 | 0.9 | 0.8 | 0.7 | 0.7 | 1.0 | 0.5 | 0.7 | 1.3 |
| Maryland | 0.3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.3 | 0.8 | 0.4 | 0.5 | 0.8 |
| Massachusetts | 3.9 | 2.9 | 3.3 | 3.3 | 3.0 | 2.7 | 2.6 | 2.6 | 2.8 | 2.5 | 3.3 |
| Michigan | 0.3 | 1.2 | 0.3 | 0.3 | 0.4 | 0.6 | 0.2 | 0.6 | 0.5 | 0.3 | 0.4 |
| New Hampshire | 1.2 | 1.3 | 1.2 | 1.2 | 1.1 | 0.8 | 0.9 | 1.0 | 1.3 | 0.9 | 1.4 |
| New Jersey | 4.4 | 3.8 | 3.3 | 3.8 | 3.0 | 3.0 | 2.6 | 2.2 | 2.9 | 3.5 | 2.7 |
| New York | 61.5 | 61.6 | 59.6 | 60.8 | 61.8 | 61.3 | 60.6 | 59.8 | 60.9 | 60.3 | 58.9 |
| Ohio | 4.3 | 2.8 | 4.5 | 3.5 | 2.6 | 4.0 | 3.9 | 4.7 | 3.6 | 4.6 | 4.3 |
| Pennsylvania | 16.8 | 17.6 | 19.8 | 18.9 | 20.4 | 20.4 | 21.9 | 20.8 | 21.0 | 20.6 | 21.2 |
| Province of Ontario | 0.2 | 0.4 | 0.1 | 0.4 | 0.3 | 0.3 | 0.1 | 0.2 | 0.2 | 0.1 | 0.3 |
| Province of Quebec | 0.2 | 0.0 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.3 | 0.2 | 0.3 |
| Vermont | 2.2 | 2.8 | 2.0 | 2.8 | 2.3 | 2.1 | 2.5 | 2.2 | 2.3 | 2.1 | 1.5 |
| Virginia | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.1 | 0.3 | 0.1 | 0.3 | 0.4 |
| West Virginia | 0.4 | 0.3 | 0.7 | 0.4 | 0.3 | 0.4 | 0.5 | 0.4 | 0.3 | 0.4 | 0.3 |
| Total of all Listed States & Provinces: | 99.0 | 98.7 | 98.5 | 98.7 | 98.4 | 98.4 | 98.9 | 98.5 | 98.4 | 98.7 | 98.5 |
| **County of Residence Among NY Anglers** | | | | | | | | | | | |
| County Bordering Lake Ontario: | | | | | | | | | | | |
| Cayuga | 2.4 | 2.9 | 4.2 | 3.0 | 3.3 | 2.6 | 2.2 | 2.2 | 2.6 | 3.1 | 4.4 |
| Jefferson | 2.5 | 2.3 | 2.4 | 2.2 | 1.6 | 1.5 | 3.2 | 3.6 | 3.3 | 2.5 | 2.7 |
| Monroe | 24.5 | 21.9 | 18.8 | 20.0 | 18.7 | 16.5 | 16.2 | 16.5 | 15.7 | 15.7 | 16.0 |
| Niagara | 8.7 | 9.5 | 6.6 | 7.3 | 7.8 | 10.9 | 9.4 | 9.7 | 8.6 | 9.1 | 6.5 |
| Orleans | 3.7 | 2.9 | 4.0 | 3.8 | 4.9 | 4.2 | 4.1 | 4.8 | 5.3 | 4.7 | 5.2 |
| Oswego | 10.6 | 11.3 | 12.8 | 13.0 | 13.1 | 13.6 | 12.5 | 12.8 | 12.8 | 13.1 | 12.8 |
| Wayne | 10.9 | 11.4 | 11.5 | 9.5 | 9.5 | 9.6 | 10.3 | 8.7 | 7.7 | 9.4 | 9.5 |
| Border Co. Total | 63.2 | 62.3 | 60.4 | 58.8 | 58.8 | 59.0 | 57.9 | 58.4 | 56.0 | 57.7 | 57.1 |
| Other NY Counties: | | | | | | | | | | | |
| Albany | 1.3 | 2.0 | 1.2 | 1.0 | 1.1 | 1.0 | 1.0 | 0.8 | 1.9 | 1.2 | 1.4 |
| Broome | 1.9 | 1.6 | 1.4 | 2.1 | 2.5 | 1.9 | 1.8 | 1.5 | 1.8 | 1.8 | 2.0 |
| Dutchess | 1.0 | 0.7 | 0.5 | 0.6 | 0.6 | 0.3 | 0.3 | 0.7 | 0.7 | 0.8 | 0.7 |
| Erie | 4.2 | 4.1 | 3.4 | 3.4 | 3.8 | 5.8 | 5.2 | 4.9 | 4.1 | 4.0 | 4.7 |
| Genesee | 1.5 | 1.1 | 1.2 | 1.9 | 2.1 | 1.6 | 2.5 | 1.8 | 2.3 | 0.9 | 1.5 |
| Livingston | 0.8 | 0.7 | 0.8 | 0.7 | 0.6 | 0.6 | 1.0 | 0.7 | 0.8 | 0.7 | 0.7 |
| Oneida | 2.0 | 1.9 | 1.9 | 1.8 | 1.8 | 2.1 | 1.4 | 2.0 | 2.0 | 2.2 | 2.1 |
| Onondaga | 5.8 | 5.6 | 6.9 | 5.4 | 6.0 | 6.4 | 6.4 | 5.7 | 5.9 | 5.9 | 6.0 |
| Ontario | 1.5 | 1.5 | 1.1 | 1.5 | 1.7 | 1.6 | 1.7 | 2.0 | 1.8 | 1.7 | 1.5 |
| Orange | 0.9 | 1.1 | 1.7 | 1.3 | 1.2 | 0.5 | 0.8 | 0.9 | 1.2 | 1.4 | 1.3 |
| Saratoga | 1.0 | 0.7 | 0.6 | 1.0 | 0.8 | 0.7 | 0.6 | 0.9 | 0.9 | 1.1 | 1.4 |
| Total of all Listed Counties: | 85.1 | 83.1 | 81.1 | 79.5 | 80.9 | 81.5 | 80.7 | 80.3 | 79.4 | 79.4 | 80.6 |

***Table A5a. Trout and salmon catch and harvest data collected April 15 – September 30, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 149,539 | 111,200 | 78,060 | 120,477 | 89,092 | 110,196 | 107,456 | 100,047 | 106,880 | 77,887 | 79,334 |
| Catch | 234,025 | 189,916 | 125,686 | 223,316 | 167,405 | 221,977 | 196,625 | 168,837 | 200,763 | 154,411 | 138,231 |
| % Harvested | 63.2 | 58.6 | 62.1 | 53.9 | 53.2 | 49.6 | 54.7 | 59.3 | 53.2 | 50.4 | 57.4 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 16,686 | 8,197 | 2,432 | 6,635 | 5,939 | 5,050 | 10,045 | 4,580 | 6,329 | 4,151 | 7,502 |
| May | 32,060 | 22,638 | 12,493 | 29,432 | 11,638 | 16,139 | 16,015 | 22,142 | 20,118 | 20,314 | 12,618 |
| June | 16,359 | 12,419 | 6,896 | 5,050 | 8,025 | 10,387 | 10,135 | 11,467 | 11,777 | 6,361 | 7,968 |
| July | 23,591 | 22,507 | 12,851 | 24,171 | 21,904 | 36,207 | 22,706 | 21,311 | 22,955 | 13,148 | 24,090 |
| August | 41,648 | 30,604 | 28,919 | 32,685 | 34,636 | 29,189 | 34,770 | 33,670 | 33,092 | 23,111 | 16,992 |
| September | 19,195 | 14,835 | 14,471 | 22,504 | 6,950 | 13,225 | 13,785 | 6,878 | 12,609 | 10,800 | 10,165 |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 49,695 | 39,131 | 32,750 | 49,310 | 37,266 | 33,864 | 32,631 | 34,524 | 31,103 | 24,548 | 28,763 |
| West/Central | 16,594 | 9,618 | 2,901 | 8,174 | 6,523 | 8,356 | 9,216 | 11,694 | 13,696 | 9,191 | 7,982 |
| East/Central | 45,170 | 37,160 | 20,158 | 40,795 | 29,674 | 39,819 | 31,076 | 34,445 | 37,861 | 25,431 | 26,296 |
| East | 38,081 | 25,291 | 22,250 | 22,197 | 15,629 | 28,157 | 34,535 | 19,382 | 24,217 | 18,715 | 16,295 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 25,999 | 14,246 | 3,709 | 11,261 | 8,804 | 12,236 | 19,347 | 7,328 | 19,368 | 10,395 | 16,341 |
| May | 50,278 | 51,039 | 24,727 | 76,635 | 20,573 | 35,558 | 37,204 | 36,786 | 46,026 | 57,178 | 25,076 |
| June | 29,324 | 20,947 | 12,552 | 11,836 | 18,745 | 22,222 | 24,230 | 20,076 | 28,848 | 13,203 | 15,382 |
| July | 42,472 | 36,489 | 23,301 | 35,487 | 46,270 | 82,252 | 42,491 | 41,130 | 33,587 | 23,984 | 41,384 |
| August | 61,444 | 47,626 | 41,721 | 55,836 | 62,916 | 50,484 | 55,996 | 53,802 | 56,224 | 34,527 | 26,494 |
| September | 24,507 | 19,567 | 19,676 | 32,261 | 10,096 | 19,225 | 17,357 | 9,715 | 16,710 | 15,123 | 13,553 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 82,846 | 77,192 | 57,467 | 103,965 | 72,072 | 93,566 | 73,727 | 67,993 | 66,682 | 70,100 | 57,104 |
| West/Central | 31,981 | 20,602 | 7,754 | 30,121 | 22,128 | 22,100 | 26,231 | 26,378 | 35,306 | 18,565 | 15,641 |
| East/Central | 65,127 | 57,450 | 31,072 | 62,190 | 51,736 | 67,426 | 49,058 | 49,025 | 60,635 | 39,116 | 43,077 |
| East | 54,070 | 34,674 | 29,398 | 27,040 | 21,471 | 38,885 | 47,609 | 25,440 | 38,141 | 26,630 | 22,408 |
| Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 99.5 | 99.6 | 99.8 | 99.9 | 99.8 | 99.9 | 100.0 | 100.0 | 99.9 | 100.0 | 100.0 |
| % Catch | 99.3 | 99.7 | 99.6 | 99.8 | 99.6 | 99.8 | 99.7 | 99.9 | 99.9 | 100.0 | 100.0 |
| Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 47.2 | 47.9 | 53.7 | 50.5 | 50.3 | 47.3 | 47.5 | 59.4 | 56.0 | 60.2 | 61.8 |
| % Catch | 39.0 | 37.5 | 42.6 | 35.5 | 39.9 | 34.8 | 33.3 | 46.0 | 39.2 | 40.1 | 47.6 |

***Table A5b. Trout and salmon catch and harvest rate data collected April 15 – September 30, 1985-2016. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 1.484 | 1.922 | 1.520 | 1.940 | 1.776 | 2.222 | 2.332 | 2.104 | 2.159 | 1.688 | 2.046 |
| Catch/Boat Trip | 2.355 | 3.286 | 2.444 | 3.593 | 3.329 | 4.473 | 4.258 | 3.549 | 4.056 | 3.345 | 3.563 |
| Harv/Angler Trip | 0.513 | 0.644 | 0.509 | 0.634 | 0.586 | 0.745 | 0.774 | 0.681 | 0.686 | 0.545 | 0.651 |
| Catch/Angler Trip | 0.813 | 1.101 | 0.819 | 1.174 | 1.098 | 1.500 | 1.414 | 1.148 | 1.288 | 1.081 | 1.134 |
| Harv/Angler Hour | 0.088 | 0.114 | 0.090 | 0.105 | 0.105 | 0.132 | 0.137 | 0.112 | 0.116 | 0.093 | 0.108 |
| Catch/Angler Hr. | 0.140 | 0.195 | 0.144 | 0.195 | 0.198 | 0.266 | 0.250 | 0.190 | 0.219 | 0.184 | 0.188 |
| Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 1.750 | 2.734 | 0.847 | 1.838 | 2.275 | 2.006 | 4.246 | 1.779 | 3.296 | 1.844 | 2.346 |
| May | 1.713 | 2.056 | 1.720 | 1.998 | 1.238 | 2.005 | 1.909 | 2.799 | 2.390 | 2.347 | 1.864 |
| June | 1.566 | 2.083 | 1.418 | 0.949 | 2.052 | 2.396 | 1.973 | 1.811 | 2.131 | 1.472 | 2.105 |
| July | 1.645 | 2.195 | 1.386 | 2.765 | 2.363 | 3.321 | 2.448 | 2.203 | 2.595 | 1.614 | 2.867 |
| August | 1.534 | 1.828 | 1.752 | 2.150 | 1.971 | 2.065 | 2.693 | 2.116 | 1.956 | 1.873 | 1.700 |
| September | 0.970 | 1.366 | 1.367 | 1.546 | 1.006 | 1.372 | 1.723 | 1.338 | 1.603 | 1.035 | 1.535 |
| Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 1.977 | 2.428 | 2.630 | 2.657 | 2.614 | 2.300 | 2.575 | 2.523 | 2.572 | 2.163 | 2.600 |
| West/Central | 1.206 | 1.377 | 0.676 | 1.059 | 1.170 | 1.656 | 1.650 | 1.763 | 2.191 | 1.426 | 2.039 |
| East/Central | 1.526 | 2.233 | 1.171 | 2.128 | 1.765 | 2.631 | 2.282 | 2.256 | 2.385 | 1.825 | 1.901 |
| East | 1.194 | 1.397 | 1.277 | 1.331 | 1.154 | 1.919 | 2.431 | 1.621 | 1.584 | 1.298 | 1.634 |
| Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 2.947 | 4.752 | 1.291 | 3.119 | 3.373 | 4.859 | 8.177 | 2.837 | 10.088 | 4.618 | 5.110 |
| May | 2.751 | 4.636 | 3.397 | 5.201 | 2.188 | 4.400 | 4.435 | 4.650 | 5.458 | 6.606 | 3.702 |
| June | 2.817 | 3.527 | 2.568 | 2.227 | 4.809 | 5.117 | 4.644 | 3.166 | 5.241 | 3.044 | 4.064 |
| July | 2.932 | 3.564 | 2.511 | 4.059 | 4.948 | 7.544 | 4.581 | 4.252 | 3.799 | 2.945 | 4.925 |
| August | 2.292 | 2.845 | 2.528 | 3.668 | 3.480 | 3.569 | 4.335 | 3.382 | 3.322 | 2.798 | 2.645 |
| September | 1.270 | 1.800 | 1.859 | 2.210 | 1.464 | 1.994 | 2.169 | 1.885 | 2.123 | 1.450 | 2.047 |
| Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 3.375 | 4.789 | 4.617 | 5.601 | 5.055 | 6.344 | 5.818 | 4.967 | 5.506 | 6.176 | 5.163 |
| West/Central | 2.558 | 2.950 | 1.800 | 3.898 | 3.969 | 4.379 | 4.697 | 3.976 | 5.644 | 2.880 | 3.996 |
| East/Central | 2.216 | 3.456 | 1.801 | 3.227 | 3.051 | 4.448 | 3.587 | 3.208 | 3.822 | 2.803 | 3.111 |
| East | 1.675 | 1.918 | 1.682 | 1.624 | 1.586 | 2.650 | 3.337 | 2.126 | 2.498 | 1.847 | 2.246 |
| Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 4.915 | 5.816 | 4.800 | 6.170 | 5.245 | 6.319 | 6.690 | 6.417 | 6.162 | 4.792 | 5.742 |
| Catch/Boat Trip | 6.398 | 7.787 | 6.136 | 8.044 | 7.826 | 9.359 | 8.583 | 8.385 | 8.115 | 6.321 | 7.719 |
| Harv/Angler Trip | 0.985 | 1.131 | 0.921 | 1.216 | 1.006 | 1.211 | 1.313 | 1.233 | 1.167 | 0.919 | 1.093 |
| Catch/Angler Trip | 1.279 | 1.514 | 1.177 | 1.585 | 1.500 | 1.794 | 1.685 | 1.611 | 1.536 | 1.212 | 1.469 |
| Harv/Angler Hour | 0.136 | 0.161 | 0.134 | 0.175 | 0.156 | 0.190 | 0.198 | 0.178 | 0.173 | 0.141 | 0.158 |
| Catch/Angler Hr. | 0.176 | 0.216 | 0.172 | 0.229 | 0.233 | 0.282 | 0.254 | 0.232 | 0.228 | 0.186 | 0.212 |
| Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.913 | 1.187 | 0.846 | 1.140 | 1.062 | 1.404 | 1.466 | 1.060 | 1.182 | 0.852 | 1.003 |
| Catch/Boat Trip | 1.672 | 2.436 | 1.686 | 2.750 | 2.404 | 3.497 | 3.399 | 2.378 | 3.064 | 2.544 | 2.391 |
| Harv/Angler Trip | 0.359 | 0.461 | 0.335 | 0.426 | 0.411 | 0.554 | 0.565 | 0.411 | 0.450 | 0.338 | 0.394 |
| Catch/Angler Trip | 0.658 | 0.945 | 0.667 | 1.027 | 0.931 | 1.379 | 1.309 | 0.922 | 1.166 | 1.008 | 0.939 |
| Harv/Angler Hour | 0.067 | 0.090 | 0.065 | 0.075 | 0.079 | 0.104 | 0.107 | 0.073 | 0.082 | 0.061 | 0.071 |
| Catch/Angler Hr. | 0.123 | 0.185 | 0.129 | 0.180 | 0.179 | 0.259 | 0.247 | 0.164 | 0.213 | 0.183 | 0.170 |

***Table A6. Parameters used to assess angling quality among boats interviewed April 15 – September 30, 1985-2016. 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 32-year data series; therefore, data on bag limits are presented only for 2006-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Part A: Boats seeking any or all species of trout and salmon. | | | | | | | | | | | |
| Percent boats with zero harvest of: | | | | | | | | | | | |
| Any Trout or Salmon | 57.4% | 49.1% | 55.6% | 51.1% | 51.6% | 45.3% | 44.9% | 50.5% | 46.5% | 52.4% | 49.1% |
| Any Fish Species | 57.2% | 48.9% | 55.3% | 50.8% | 51.5% | 45.2% | 44.8% | 50.3% | 46.4% | 52.3% | 48.9% |
| Percent boats with zero catch of: | | | | | | | | | | | |
| Any Trout or Salmon | 41.6% | 31.5% | 41.1% | 32.4% | 35.1% | 26.7% | 24.3% | 31.4% | 29.4% | 34.3% | 31.4% |
| Any Fish Species | 40.2% | 30.8% | 39.6% | 31.9% | 34.5% | 26.1% | 23.8% | 30.5% | 29.0% | 33.7% | 30.9% |
| 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 | 0.9% | 1.1% | 2.1% | 3.1% | 1.2% | 2.6% | 5.3% | 11.8% | 8.5% | 11.1% | 13.5% |
| Charters-All Anglers | 0.0% | 0.0% | 0.7% | 1.9% | 0.6% | 0.0% | 2.0% | 1.9% | 0.8% | 3.6% | 2.6% |
| Noncharter Boats | 0.0% | 0.1% | 0.1% | 0.0% | 0.0% | 0.5% | 0.0% | 0.4% | 0.0% | 0.2% | 0.3% |
| 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 | 16.1% | 21.8% | 12.1% | 24.2% | 19.5% | 21.4% | 22.1% | 14.3% | 11.5% | 5.8% | 9.5% |
| Charters-All Anglers | 1.9% | 3.6% | 1.9% | 3.1% | 4.3% | 2.8% | 4.6% | 3.0% | 0.9% | 0.4% | 1.3% |
| Noncharter Boats | 0.5% | 2.7% | 0.9% | 1.4% | 1.9% | 3.0% | 3.7% | 1.3% | 1.5% | 0.8% | 1.3% |
| Part B: Boats seeking smallmouth bass during the traditional open season. | | | | | | | | | | | |
| Percent boats with zero harvest of: | | | | | | | | | | | |
| Smallmouth Bass | 77.2% | 77.2% | 82.1% | 84.7% | 79.0% | 82.7% | 79.7% | 76.5% | 71.1% | 86.3% | 78.4% |
| Any Fish Species | 67.8% | 59.6% | 65.6% | 71.2% | 65.0% | 72.3% | 63.9% | 67.4% | 63.5% | 70.6% | 68.2% |
| Percent boats with zero catch of: | | | | | | | | | | | |
| Smallmouth Bass | 42.8% | 43.1% | 50.3% | 53.6% | 56.2% | 58.8% | 53.6% | 45.8% | 40.0% | 50.2% | 43.7% |
| Any Fish Species | 28.2% | 22.4% | 27.7% | 36.5% | 37.6% | 35.1% | 34.6% | 31.4% | 27.6% | 37.6% | 28.4% |
| Percent boats harvesting the daily bag limit of 5 smallmouth bass per angler: | | | | | | | | | | | |
| All Boats Combined | 3.7% | 2.8% | 1.0% | 0.3% | 1.2% | 2.6% | 0.6% | 2.5% | 5.8% | 1.5% | 0.0% |

***Table A7a. Coho salmon harvest and catch data collected April 15 – September 30, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 9,803 | 14,541 | 4,912 | 12,931 | 9,223 | 7,380 | 8,259 | 4,871 | 5,653 | 2,078 | 2,173 |
| Catch | 12,858 | 25,510 | 6,666 | 21,376 | 12,908 | 11,915 | 12,494 | 7,704 | 8,442 | 4,260 | 3,219 |
| % Harvested | 75.7 | 57.0 | 73.7 | 60.5 | 71.5 | 61.9 | 66.1 | 63.2 | 67.0 | 48.8 | 67.5 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 2,671 | 1,604 | 618 | 1,446 | 1,178 | 968 | 392 | 266 | 349 | 12 | 108 |
| May | 2,111 | 6,168 | 1,176 | 3,087 | 1,353 | 946 | 1,787 | 1,646 | 2,101 | 94 | 272 |
| June | 523 | 2,515 | 33 | 441 | 918 | 653 | 163 | 454 | 369 | 37 | 87 |
| July | 395 | 265 | 143 | 476 | 1,864 | 2,362 | 503 | 235 | 238 | 121 | 348 |
| August | 2,335 | 2,367 | 513 | 1,816 | 2,860 | 853 | 3,437 | 1,170 | 691 | 417 | 800 |
| September | 1,769 | 1,622 | 2,429 | 5,666 | 1,049 | 1,599 | 1,978 | 1,100 | 1,906 | 1,397 | 557 |
| | | | | | | | | | 5,653 | | |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 4,173 | 9,014 | 1,310 | 5,692 | 5,269 | 3,635 | 3,001 | 2,365 | 2,541 | 458 | 834 |
| West/Central | 1,679 | 910 | 111 | 566 | 772 | 765 | 411 | 201 | 310 | - | 51 |
| East/Central | 2,403 | 2,702 | 1,251 | 2,727 | 1,537 | 1,546 | 1,968 | 1,594 | 1,566 | 959 | 891 |
| East | 1,548 | 1,915 | 2,240 | 3,945 | 1,645 | 1,434 | 2,880 | 711 | 1,235 | 661 | 398 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 3,686 | 2,352 | 976 | 2,183 | 1,543 | 2,324 | 686 | 332 | 1,209 | 440 | 108 |
| May | 2,957 | 13,798 | 2,107 | 9,559 | 2,164 | 1,926 | 4,047 | 3,145 | 3,537 | 1,412 | 851 |
| June | 856 | 3,799 | 255 | 685 | 1,542 | 1,277 | 734 | 986 | 547 | 61 | 160 |
| July | 606 | 386 | 242 | 686 | 2,734 | 3,357 | 830 | 627 | 286 | 261 | 526 |
| August | 2,730 | 3,313 | 513 | 2,096 | 3,652 | 1,190 | 3,888 | 1,434 | 897 | 584 | 1,016 |
| September | 2,023 | 1,863 | 2,573 | 6,167 | 1,272 | 1,840 | 2,308 | 1,179 | 1,965 | 1,502 | 557 |
| | | | | | | | | | 8442.000 | | |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 5,778 | 17,668 | 2,517 | 12,152 | 7,285 | 6,476 | 5,875 | 4,642 | 4,450 | 2,119 | 1,518 |
| West/Central | 2,577 | 1,383 | 304 | 1,354 | 1,636 | 1,837 | 1,072 | 592 | 801 | 238 | 236 |
| East/Central | 2,832 | 3,960 | 1,506 | 3,388 | 2,050 | 1,922 | 2,350 | 1,728 | 1,955 | 1,194 | 1,016 |
| East | 1,672 | 2,499 | 2,340 | 4,482 | 1,937 | 1,679 | 3,197 | 742 | 1,237 | 709 | 450 |
| Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 99.3 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| % Catch | 99.3 | 100.0 | 100.0 | 100.0 | 100.0 | 99.5 | 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 | 41.3 | 44.8 | 51.4 | 39.8 | 56.9 | 42.1 | 40.6 | 45.6 | 39.2 | 55.0 | 44.2 |
| % Catch | 34.4 | 37.9 | 40.6 | 26.2 | 44.2 | 28.2 | 28.5 | 31.5 | 30.9 | 35.0 | 29.8 |

***Table A7b. Coho salmon harvest and catch rate data collected April 15 – September 30, 1985-2016. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.100 | 0.252 | 0.096 | 0.208 | 0.184 | 0.149 | 0.179 | 0.103 | 0.114 | 0.045 | 0.056 |
| Catch/Boat Trip | 0.132 | 0.443 | 0.130 | 0.345 | 0.258 | 0.239 | 0.271 | 0.162 | 0.171 | 0.092 | 0.083 |
| Harv/Angler Trip | 0.035 | 0.085 | 0.032 | 0.068 | 0.061 | 0.050 | 0.060 | 0.033 | 0.036 | 0.015 | 0.018 |
| Catch/Angler Trip | 0.046 | 0.148 | 0.044 | 0.113 | 0.085 | 0.080 | 0.090 | 0.052 | 0.054 | 0.030 | 0.026 |
| Harv/Angler Hour | 0.006 | 0.015 | 0.006 | 0.011 | 0.011 | 0.009 | 0.011 | 0.005 | 0.006 | 0.002 | 0.003 |
| Catch/Angler Hr. | 0.008 | 0.026 | 0.008 | 0.019 | 0.015 | 0.014 | 0.016 | 0.009 | 0.009 | 0.005 | 0.004 |
| Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.281 | 0.535 | 0.215 | 0.401 | 0.451 | 0.384 | 0.166 | 0.103 | 0.182 | 0.005 | 0.034 |
| May | 0.129 | 0.560 | 0.162 | 0.210 | 0.144 | 0.118 | 0.213 | 0.208 | 0.250 | 0.011 | 0.040 |
| June | 0.054 | 0.429 | 0.007 | 0.085 | 0.237 | 0.151 | 0.032 | 0.072 | 0.067 | 0.009 | 0.023 |
| July | 0.031 | 0.026 | 0.015 | 0.054 | 0.202 | 0.217 | 0.054 | 0.024 | 0.027 | 0.015 | 0.041 |
| August | 0.088 | 0.142 | 0.031 | 0.120 | 0.158 | 0.060 | 0.266 | 0.074 | 0.041 | 0.034 | 0.080 |
| September | 0.086 | 0.149 | 0.229 | 0.389 | 0.153 | 0.166 | 0.247 | 0.214 | 0.242 | 0.134 | 0.084 |
| Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.163 | 0.559 | 0.105 | 0.307 | 0.370 | 0.247 | 0.237 | 0.173 | 0.210 | 0.040 | 0.075 |
| West/Central | 0.104 | 0.131 | 0.026 | 0.073 | 0.139 | 0.152 | 0.074 | 0.030 | 0.050 | 0.000 | 0.013 |
| East/Central | 0.088 | 0.164 | 0.073 | 0.142 | 0.092 | 0.102 | 0.145 | 0.104 | 0.099 | 0.069 | 0.064 |
| East | 0.057 | 0.106 | 0.129 | 0.238 | 0.122 | 0.098 | 0.203 | 0.059 | 0.081 | 0.046 | 0.040 |
| Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.379 | 0.784 | 0.340 | 0.605 | 0.591 | 0.923 | 0.290 | 0.129 | 0.630 | 0.195 | 0.034 |
| May | 0.182 | 1.253 | 0.290 | 0.649 | 0.230 | 0.232 | 0.482 | 0.398 | 0.420 | 0.163 | 0.126 |
| June | 0.098 | 0.648 | 0.054 | 0.132 | 0.398 | 0.296 | 0.143 | 0.156 | 0.100 | 0.014 | 0.042 |
| July | 0.046 | 0.038 | 0.026 | 0.078 | 0.296 | 0.308 | 0.090 | 0.065 | 0.032 | 0.032 | 0.063 |
| August | 0.103 | 0.199 | 0.031 | 0.138 | 0.202 | 0.084 | 0.301 | 0.090 | 0.053 | 0.047 | 0.102 |
| September | 0.101 | 0.171 | 0.243 | 0.424 | 0.185 | 0.191 | 0.288 | 0.229 | 0.250 | 0.144 | 0.084 |
| Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.233 | 1.096 | 0.202 | 0.655 | 0.511 | 0.436 | 0.464 | 0.339 | 0.368 | 0.187 | 0.137 |
| West/Central | 0.166 | 0.199 | 0.071 | 0.175 | 0.294 | 0.364 | 0.192 | 0.089 | 0.128 | 0.037 | 0.060 |
| East/Central | 0.104 | 0.240 | 0.088 | 0.177 | 0.122 | 0.127 | 0.173 | 0.113 | 0.123 | 0.086 | 0.073 |
| East | 0.061 | 0.139 | 0.134 | 0.271 | 0.144 | 0.115 | 0.225 | 0.062 | 0.081 | 0.049 | 0.045 |
| Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.293 | 0.712 | 0.289 | 0.522 | 0.614 | 0.377 | 0.440 | 0.240 | 0.228 | 0.117 | 0.113 |
| Catch/Boat Trip | 0.321 | 1.056 | 0.310 | 0.569 | 0.668 | 0.407 | 0.467 | 0.261 | 0.269 | 0.152 | 0.113 |
| Harv/Angler Trip | 0.059 | 0.138 | 0.056 | 0.103 | 0.118 | 0.072 | 0.086 | 0.046 | 0.043 | 0.022 | 0.021 |
| Catch/Angler Trip | 0.064 | 0.205 | 0.059 | 0.112 | 0.128 | 0.078 | 0.092 | 0.050 | 0.051 | 0.029 | 0.021 |
| Harv/Angler Hour | 0.008 | 0.020 | 0.008 | 0.015 | 0.018 | 0.011 | 0.013 | 0.007 | 0.006 | 0.003 | 0.003 |
| Catch/Angler Hr. | 0.009 | 0.029 | 0.009 | 0.016 | 0.020 | 0.012 | 0.014 | 0.007 | 0.008 | 0.004 | 0.003 |
| Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.067 | 0.166 | 0.056 | 0.149 | 0.096 | 0.103 | 0.128 | 0.069 | 0.086 | 0.026 | 0.040 |
| Catch/Boat Trip | 0.099 | 0.327 | 0.093 | 0.302 | 0.174 | 0.206 | 0.232 | 0.138 | 0.147 | 0.076 | 0.075 |
| Harv/Angler Trip | 0.026 | 0.064 | 0.022 | 0.056 | 0.037 | 0.041 | 0.049 | 0.027 | 0.033 | 0.010 | 0.016 |
| Catch/Angler Trip | 0.039 | 0.127 | 0.037 | 0.113 | 0.067 | 0.081 | 0.089 | 0.054 | 0.056 | 0.030 | 0.029 |
| Harv/Angler Hour | 0.005 | 0.013 | 0.004 | 0.010 | 0.007 | 0.008 | 0.009 | 0.005 | 0.006 | 0.002 | 0.003 |
| Catch/Angler Hr. | 0.007 | 0.025 | 0.007 | 0.020 | 0.013 | 0.015 | 0.017 | 0.010 | 0.010 | 0.005 | 0.005 |

***Table A8. Total length (inches), weight (lbs), and age statistics for coho salmon sampled April 15 - September 30 during the 1985-2016 NYSDEC Lake Ontario fishing boat surveys.***

| | Year Sampled | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg. | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **Mean length and weight data for coho salmon sampled April 15 - September 30:** | | | | | | | | | | | |
| Mean Length (in) | 24.0 | 24.6 | 25.5 | 23.9 | 25.1 | 24.0 | 26.1 | 25.0 | 23.8 | 23.7 | 25.6 |
| Mean Weight (lbs) | - | 6.6 | 8.1 | 6.3 | 7.2 | 6.3 | 8.3 | 6.7 | 6.4 | 6.6 | 7.7 |
| **Estimated weight (lbs) for standard length coho salmon sampled April 15 - September 30:** | | | | | | | | | | | |
| Standard Length | | | | | | | | | | | |
| 18.0 inches | - | 1.80 | 1.97 | 1.90 | 1.84 | 1.87 | 2.01 | 1.97 | 1.84 | 1.99 | 1.78 |
| 20.0 inches | - | 2.67 | 2.92 | 2.82 | 2.75 | 2.79 | 2.92 | 2.84 | 2.76 | 3.06 | 2.67 |
| 22.0 inches | - | 3.83 | 4.16 | 4.04 | 3.96 | 4.01 | 4.11 | 3.95 | 4.00 | 4.52 | 3.87 |
| 24.0 inches | - | 5.32 | 5.75 | 5.61 | 5.52 | 5.57 | 5.60 | 5.35 | 5.60 | 6.45 | 5.42 |
| 26.0 inches | - | 7.19 | 7.75 | 7.59 | 7.50 | 7.54 | 7.45 | 7.07 | 7.64 | 8.94 | 7.39 |
| 28.0 inches | - | 9.46 | 10.15 | 9.98 | 9.90 | 9.92 | 9.66 | 9.10 | 10.13 | 12.02 | 9.79 |
| 30.0 inches | - | 12.33 | 13.18 | 13.00 | 12.96 | 12.95 | 12.41 | 11.61 | 13.30 | 16.01 | 12.86 |
| **Percent length composition of coho salmon sampled April 15 - September 30:** | | | | | | | | | | | |
| <15.0 in | 0.5% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 2.6% | 0.0% |
| 15.0-15.9 in | 0.7% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| 16.0-16.9 in | 0.6% | 0.0% | 0.9% | 0.7% | 0.0% | 0.0% | 0.0% | 0.0% | 3.8% | 0.0% | 0.0% |
| 17.0-17.9 in | 2.1% | 1.5% | 1.8% | 4.3% | 0.0% | 1.4% | 0.0% | 0.0% | 7.7% | 0.0% | 1.9% |
| 18.0-18.9 in | 3.4% | 2.5% | 6.4% | 6.1% | 0.5% | 7.7% | 0.8% | 2.4% | 10.3% | 2.6% | 1.9% |
| 19.0-19.9 in | 6.2% | 6.5% | 10.1% | 7.6% | 3.3% | 6.3% | 3.1% | 4.9% | 5.1% | 2.6% | 3.8% |
| 20.0-20.9 in | 10.0% | 8.5% | 2.8% | 7.2% | 1.9% | 10.6% | 7.7% | 4.9% | 5.1% | 2.6% | 7.5% |
| 21.0-21.9 in | 12.1% | 15.9% | 0.9% | 10.1% | 12.2% | 9.6% | 7.7% | 8.5% | 3.8% | 5.3% | 3.8% |
| 22.0-22.9 in | 10.3% | 9.0% | 1.8% | 10.4% | 7.5% | 5.3% | 7.7% | 13.4% | 2.6% | 21.1% | 5.7% |
| 23.0-23.9 in | 8.5% | 5.0% | 3.7% | 2.2% | 9.9% | 6.7% | 4.6% | 8.5% | 3.8% | 7.9% | 3.8% |
| 24.0-24.9 in | 6.6% | 3.0% | 3.7% | 4.0% | 15.0% | 9.6% | 3.8% | 9.8% | 7.7% | 23.7% | 3.8% |
| 25.0-25.9 in | 5.9% | 1.0% | 5.5% | 6.8% | 11.7% | 11.1% | 5.4% | 8.5% | 5.1% | 18.4% | 9.4% |
| 26.0-26.9 in | 6.1% | 8.0% | 15.6% | 11.2% | 9.9% | 5.8% | 6.2% | 6.1% | 16.7% | 5.3% | 9.4% |
| 27.0-27.9 in | 7.4% | 11.9% | 15.6% | 15.5% | 8.5% | 8.7% | 14.6% | 11.0% | 15.4% | 5.3% | 22.6% |
| 28.0-28.9 in | 7.3% | 13.4% | 17.4% | 9.4% | 5.6% | 9.1% | 16.9% | 4.9% | 7.7% | 0.0% | 11.3% |
| 29.0-29.9 in | 5.6% | 7.5% | 8.3% | 3.6% | 7.5% | 4.8% | 9.2% | 11.0% | 2.6% | 2.6% | 9.4% |
| 30.0-30.9 in | 3.8% | 6.0% | 2.8% | 0.7% | 3.8% | 2.4% | 8.5% | 1.2% | 1.3% | 0.0% | 5.7% |
| 31.0-31.9 in | 1.8% | 0.5% | 0.0% | 0.0% | 1.4% | 0.5% | 3.1% | 2.4% | 0.0% | 0.0% | 0.0% |
| 32.0-32.9 in | 0.9% | 0.0% | 1.8% | 0.0% | 1.4% | 0.0% | 0.0% | 2.4% | 0.0% | 0.0% | 0.0% |
| >32.9 in | 0.3% | 0.0% | 0.9% | 0.4% | 0.0% | 0.5% | 0.8% | 0.0% | 1.3% | 0.0% | 0.0% |
| **Percent age composition of coho salmon sampled April 15 - September 30:** | | | | | | | | | | | |
| Age-1 | 4.5% | 1.6% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Age-2 | 94.7% | 93.8% | 93.3% | 99.6% | 99.9% | 99.3% | 98.0% | 100.0% | 97.2% | 100.0% | 100.0% |
| Age-3 | 0.8% | 4.6% | 6.7% | 0.0% | 0.1% | 0.7% | 2.0% | 0.0% | 2.8% | 0.0% | 0.0% |
| **Length data (inches) for age-2 coho salmon sampled April 15 - September 30:** | | | | | | | | | | | |
| April Mean | 20.6 | 20.6 | 18.7 | 18.5 | 21.4 | 19.4 | 21.0 | 20.5 | 18.3 | - | 18.9 |
| September Mean | 28.1 | 28.2 | 27.4 | 27.2 | 29.3 | 28.2 | 28.2 | 28.1 | 26.3 | 24.1 | 27.6 |
| Avg Monthly Gain | 1.6 | 1.72 | 1.89 | 1.97 | 1.72 | 1.93 | 1.59 | 1.68 | 1.90 | - | 1.94 |

***Table A9a. Chinook salmon harvest and catch data collected April 15 – September 30, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 53,183 | 53,336 | 35,520 | 54,964 | 31,676 | 46,333 | 55,137 | 38,292 | 47,935 | 34,951 | 34,405 |
| Catch | 74,411 | 84,842 | 55,776 | 101,427 | 61,960 | 97,899 | 88,851 | 62,570 | 76,626 | 58,870 | 60,435 |
| % Harvested | 71.3 | 62.9 | 63.7 | 54.2 | 51.1 | 47.3 | 62.1 | 61.2 | 62.6 | 59.4 | 56.9 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 1,794 | 15 | 117 | 200 | 156 | 86 | 2,180 | 115 | 0 | 145 | 70 |
| May | 7,445 | 4,422 | 4,385 | 12,978 | 3,932 | 1,594 | 5,358 | 4,102 | 8,067 | 9,138 | 3,235 |
| June | 2,219 | 3,584 | 1,334 | 887 | 3,804 | 2,166 | 4,858 | 2,277 | 3,133 | 955 | 2,454 |
| July | 7,015 | 13,883 | 5,293 | 16,984 | 5,282 | 17,509 | 11,004 | 8,560 | 11,074 | 6,857 | 14,596 |
| August | 21,494 | 20,112 | 16,195 | 13,086 | 13,909 | 16,885 | 21,746 | 20,670 | 16,908 | 12,030 | 7,850 |
| September | 13,216 | 11,320 | 8,195 | 10,829 | 4,592 | 8,093 | 9,991 | 2,568 | 8,754 | 5,826 | 6,201 |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 22,286 | 17,947 | 14,790 | 23,605 | 10,927 | 14,042 | 17,459 | 17,417 | 13,314 | 14,349 | 16,444 |
| West/Central | 5,637 | 4,072 | 880 | 2,957 | 1,750 | 2,047 | 3,277 | 2,223 | 2,458 | 3,593 | 872 |
| East/Central | 12,102 | 16,863 | 11,126 | 18,057 | 12,160 | 17,550 | 16,097 | 13,258 | 20,796 | 10,808 | 12,269 |
| East | 13,158 | 14,454 | 8,724 | 10,345 | 6,839 | 12,694 | 18,305 | 5,394 | 11,367 | 6,200 | 4,820 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 2,554 | 45 | 117 | 448 | 156 | 267 | 3,781 | 164 | 232 | 261 | 70 |
| May | 11,923 | 11,611 | 9,057 | 40,831 | 5,866 | 4,511 | 11,827 | 6,948 | 13,020 | 18,854 | 7,318 |
| June | 5,107 | 7,531 | 2,999 | 3,537 | 10,250 | 8,483 | 10,058 | 5,200 | 7,829 | 3,594 | 6,366 |
| July | 11,022 | 20,033 | 9,946 | 23,944 | 16,280 | 42,582 | 19,848 | 15,682 | 14,608 | 10,525 | 25,456 |
| August | 28,055 | 31,108 | 21,965 | 19,623 | 23,084 | 31,239 | 31,097 | 30,649 | 29,562 | 17,823 | 13,432 |
| September | 15,751 | 14,514 | 11,692 | 13,043 | 6,307 | 10,817 | 12,239 | 3,926 | 11,375 | 7,813 | 7,793 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 35,113 | 35,059 | 26,841 | 53,358 | 23,577 | 43,599 | 34,937 | 32,474 | 25,615 | 28,640 | 30,833 |
| West/Central | 9,466 | 8,209 | 2,810 | 9,887 | 9,774 | 7,038 | 9,223 | 6,622 | 10,001 | 6,896 | 2,676 |
| East/Central | 15,178 | 22,138 | 14,994 | 26,077 | 20,061 | 30,606 | 22,321 | 16,963 | 27,082 | 15,710 | 20,206 |
| East | 14,653 | 19,436 | 11,132 | 12,105 | 8,548 | 16,657 | 22,370 | 6,511 | 13,928 | 7,624 | 6,720 |
| Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 99.8 | 99.9 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| % Catch | 99.8 | 99.9 | 100.0 | 100.0 | 100.0 | 99.9 | 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 | 41.3 | 46.1 | 52.8 | 41.6 | 42.8 | 40.2 | 42.7 | 47.1 | 51.5 | 50.9 | 53.0 |
| % Catch | 35.8 | 36.0 | 43.0 | 27.8 | 35.8 | 32.3 | 32.3 | 38.3 | 38.9 | 39.4 | 45.5 |

***Table A9b. Chinook salmon harvest and catch rate data collected April 15 – September 30, 1985-2016. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.551 | 0.925 | 0.693 | 0.886 | 0.633 | 0.935 | 1.197 | 0.806 | 0.970 | 0.757 | 0.887 |
| Catch/Boat Trip | 0.798 | 1.472 | 1.089 | 1.635 | 1.238 | 1.975 | 1.928 | 1.316 | 1.550 | 1.276 | 1.559 |
| Harv/Angler Trip | 0.190 | 0.310 | 0.232 | 0.290 | 0.209 | 0.314 | 0.398 | 0.261 | 0.308 | 0.245 | 0.282 |
| Catch/Angler Trip | 0.275 | 0.493 | 0.365 | 0.534 | 0.408 | 0.662 | 0.640 | 0.426 | 0.492 | 0.412 | 0.496 |
| Harv/Angler Hour | 0.033 | 0.055 | 0.041 | 0.048 | 0.038 | 0.056 | 0.070 | 0.043 | 0.052 | 0.042 | 0.047 |
| Catch/Angler Hr. | 0.048 | 0.088 | 0.064 | 0.089 | 0.073 | 0.118 | 0.113 | 0.070 | 0.083 | 0.070 | 0.082 |
| Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.116 | 0.005 | 0.041 | 0.055 | 0.060 | 0.034 | 0.921 | 0.045 | 0.000 | 0.064 | 0.022 |
| May | 0.398 | 0.402 | 0.604 | 0.881 | 0.418 | 0.198 | 0.639 | 0.519 | 0.958 | 1.056 | 0.478 |
| June | 0.207 | 0.611 | 0.280 | 0.171 | 0.981 | 0.502 | 0.946 | 0.360 | 0.571 | 0.221 | 0.648 |
| July | 0.531 | 1.359 | 0.572 | 1.943 | 0.572 | 1.606 | 1.189 | 0.886 | 1.255 | 0.842 | 1.737 |
| August | 0.813 | 1.204 | 0.982 | 0.860 | 0.769 | 1.196 | 1.684 | 1.299 | 0.999 | 0.975 | 0.785 |
| September | 0.658 | 1.042 | 0.774 | 0.744 | 0.670 | 0.839 | 1.249 | 0.500 | 1.113 | 0.558 | 0.936 |
| Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.857 | 1.113 | 1.189 | 1.272 | 0.766 | 0.954 | 1.378 | 1.274 | 1.101 | 1.264 | 1.487 |
| West/Central | 0.369 | 0.580 | 0.205 | 0.383 | 0.314 | 0.406 | 0.587 | 0.335 | 0.393 | 0.557 | 0.223 |
| East/Central | 0.438 | 1.022 | 0.651 | 0.941 | 0.726 | 1.159 | 1.184 | 0.868 | 1.312 | 0.775 | 0.887 |
| East | 0.467 | 0.802 | 0.501 | 0.624 | 0.507 | 0.867 | 1.288 | 0.451 | 0.746 | 0.430 | 0.483 |
| Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.181 | 0.015 | 0.041 | 0.124 | 0.060 | 0.106 | 1.598 | 0.064 | 0.121 | 0.116 | 0.022 |
| May | 0.659 | 1.055 | 1.247 | 2.772 | 0.624 | 0.560 | 1.410 | 0.878 | 1.547 | 2.178 | 1.081 |
| June | 0.495 | 1.285 | 0.630 | 0.680 | 2.643 | 1.967 | 1.958 | 0.821 | 1.426 | 0.832 | 1.682 |
| July | 0.888 | 1.962 | 1.074 | 2.739 | 1.763 | 3.906 | 2.145 | 1.624 | 1.655 | 1.293 | 3.029 |
| August | 1.095 | 1.864 | 1.332 | 1.291 | 1.278 | 2.208 | 2.407 | 1.926 | 1.746 | 1.444 | 1.344 |
| September | 0.809 | 1.334 | 1.104 | 0.896 | 0.920 | 1.122 | 1.529 | 0.764 | 1.446 | 0.749 | 1.177 |
| Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 1.435 | 2.175 | 2.158 | 2.875 | 1.654 | 2.959 | 2.757 | 2.375 | 2.118 | 2.523 | 2.788 |
| West/Central | 0.694 | 1.172 | 0.655 | 1.280 | 1.753 | 1.394 | 1.652 | 0.998 | 1.596 | 1.070 | 0.684 |
| East/Central | 0.570 | 1.341 | 0.877 | 1.359 | 1.198 | 2.022 | 1.640 | 1.111 | 1.708 | 1.127 | 1.461 |
| East | 0.532 | 1.078 | 0.640 | 0.731 | 0.634 | 1.137 | 1.575 | 0.545 | 0.914 | 0.529 | 0.674 |
| Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 1.614 | 2.685 | 2.148 | 2.319 | 1.588 | 2.260 | 3.087 | 1.946 | 2.542 | 1.820 | 2.138 |
| Catch/Boat Trip | 1.989 | 3.335 | 2.749 | 2.859 | 2.596 | 3.838 | 3.765 | 2.588 | 3.069 | 2.370 | 3.226 |
| Harv/Angler Trip | 0.322 | 0.522 | 0.412 | 0.457 | 0.304 | 0.433 | 0.606 | 0.374 | 0.481 | 0.349 | 0.407 |
| Catch/Angler Trip | 0.397 | 0.649 | 0.527 | 0.563 | 0.498 | 0.736 | 0.739 | 0.497 | 0.581 | 0.454 | 0.614 |
| Harv/Angler Hour | 0.045 | 0.074 | 0.060 | 0.066 | 0.047 | 0.068 | 0.092 | 0.054 | 0.071 | 0.054 | 0.059 |
| Catch/Angler Hr. | 0.055 | 0.092 | 0.077 | 0.081 | 0.077 | 0.116 | 0.112 | 0.072 | 0.086 | 0.070 | 0.089 |
| Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.371 | 0.593 | 0.395 | 0.615 | 0.436 | 0.670 | 0.822 | 0.529 | 0.586 | 0.472 | 0.534 |
| Catch/Boat Trip | 0.596 | 1.120 | 0.748 | 1.403 | 0.958 | 1.603 | 1.564 | 1.009 | 1.178 | 0.982 | 1.088 |
| Harv/Angler Trip | 0.146 | 0.230 | 0.156 | 0.230 | 0.169 | 0.264 | 0.316 | 0.205 | 0.223 | 0.187 | 0.210 |
| Catch/Angler Trip | 0.235 | 0.434 | 0.296 | 0.524 | 0.371 | 0.632 | 0.602 | 0.391 | 0.448 | 0.389 | 0.427 |
| Harv/Angler Hour | 0.028 | 0.045 | 0.030 | 0.040 | 0.033 | 0.050 | 0.060 | 0.036 | 0.041 | 0.034 | 0.038 |
| Catch/Angler Hr. | 0.045 | 0.085 | 0.057 | 0.092 | 0.072 | 0.119 | 0.114 | 0.070 | 0.082 | 0.071 | 0.077 |

***Table A10. Total length (inches), weight (lbs), and age statistics for Chinook salmon sampled April 15 - September 30 during the 1985-2016 NYSDEC Lake Ontario fishing boat surveys.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg. | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Mean length and weight data for chinook salmon sampled April 15 - September 30: | | | | | | | | | | | |
| Mean Length (in) | 32.0 | 32.6 | 32.1 | 31.6 | 29.7 | 29.6 | 31.4 | 32.6 | 31.1 | 31.1 | 30.1 |
| Mean Weight (lbs) | - | 14.5 | 15.4 | 14.5 | 13.4 | 12.8 | 14.1 | 15.6 | 13.5 | 13.6 | 13.5 |
| Estimated weight (lbs) for standard length chinook salmon sampled July & August: | | | | | | | | | | | |
| Standard Length: | | | | | | | | | | | |
| 16.0 inches | - | 1.37 | 1.47 | 1.31 | 1.47 | 1.36 | 1.34 | 1.47 | 1.38 | 1.33 | 1.40 |
| 20.0 inches | - | 2.81 | 3.01 | 2.77 | 3.04 | 2.89 | 2.82 | 2.98 | 2.85 | 2.83 | 2.95 |
| 24.0 inches | - | 5.07 | 5.47 | 5.15 | 5.55 | 5.39 | 5.23 | 5.34 | 5.18 | 5.26 | 5.46 |
| 28.0 inches | - | 8.33 | 9.00 | 8.65 | 9.18 | 9.09 | 8.76 | 8.72 | 8.55 | 8.84 | 9.13 |
| 32.0 inches | - | 12.84 | 13.92 | 13.62 | 14.27 | 14.35 | 13.77 | 13.38 | 13.25 | 13.93 | 14.31 |
| 36.0 inches | - | 18.82 | 20.44 | 20.32 | 21.04 | 21.46 | 20.50 | 19.52 | 19.49 | 20.79 | 21.28 |
| 40.0 inches | - | 26.40 | 28.74 | 28.97 | 29.69 | 30.64 | 29.17 | 27.27 | 27.44 | 29.64 | 30.23 |
| Percent length composition of chinook salmon sampled April 15 - September 30: | | | | | | | | | | | |
| <16.0 in | 1.3% | 0.6% | 0.3% | 0.3% | 0.2% | 0.9% | 0.5% | 0.5% | 0.9% | 1.2% | 1.9% |
| 16.0-17.9 in | 2.8% | 0.3% | 1.2% | 1.3% | 2.4% | 3.5% | 0.8% | 1.7% | 1.9% | 0.8% | 2.5% |
| 18.0-19.9 in | 3.4% | 0.8% | 1.9% | 3.1% | 9.1% | 7.8% | 1.6% | 2.8% | 1.9% | 1.6% | 4.3% |
| 20.0-21.9 in | 3.2% | 0.8% | 1.9% | 2.1% | 8.9% | 5.7% | 3.5% | 2.8% | 3.0% | 1.0% | 5.0% |
| 22.0-23.9 in | 3.5% | 1.7% | 3.6% | 3.0% | 8.7% | 3.9% | 3.0% | 2.8% | 2.6% | 2.5% | 7.9% |
| 24.0-25.9 in | 4.5% | 3.8% | 6.3% | 5.6% | 5.5% | 4.3% | 5.3% | 2.6% | 4.4% | 7.9% | 6.8% |
| 26.0-27.9 in | 6.2% | 6.0% | 7.0% | 6.4% | 5.9% | 5.8% | 6.8% | 4.9% | 10.4% | 8.3% | 5.4% |
| 28.0-29.9 in | 7.2% | 8.6% | 6.4% | 7.9% | 5.7% | 6.7% | 12.8% | 9.2% | 10.3% | 11.8% | 9.3% |
| 30.0-31.9 in | 8.1% | 15.2% | 12.1% | 12.6% | 6.3% | 13.7% | 14.0% | 9.9% | 16.4% | 15.9% | 9.3% |
| 32.0-33.9 in | 11.0% | 17.5% | 12.6% | 17.5% | 10.2% | 21.2% | 17.7% | 14.4% | 15.0% | 18.6% | 12.4% |
| 34.0-35.9 in | 14.3% | 22.1% | 17.1% | 19.9% | 12.9% | 16.2% | 15.9% | 15.5% | 13.6% | 16.9% | 12.8% |
| 36.0-37.9 in | 17.7% | 15.7% | 17.1% | 14.7% | 12.6% | 7.5% | 9.6% | 16.2% | 11.6% | 9.5% | 14.7% |
| 38.0-39.9 in | 11.9% | 6.1% | 11.1% | 4.7% | 7.0% | 1.9% | 6.1% | 12.3% | 7.1% | 3.3% | 6.6% |
| 40.0-41.9 in | 4.3% | 0.7% | 1.3% | 0.8% | 4.3% | 0.8% | 2.2% | 3.8% | 1.1% | 0.8% | 1.2% |
| 42.0-43.9 in | 0.5% | 0.0% | 0.0% | 0.1% | 0.4% | 0.0% | 0.1% | 0.5% | 0.0% | 0.0% | 0.0% |
| >43.9 in | 0.0% | 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 | 11.5% | 3.2% | 3.1% | 4.8% | 33.7% | 22.2% | 5.0% | 10.7% | 8.3% | 3.7% | 9.1% |
| Age-2 | 35.2% | 46.4% | 47.9% | 29.5% | 24.9% | 68.9% | 70.8% | 37.0% | 52.7% | 46.5% | 43.0% |
| Age-3 | 49.6% | 47.7% | 46.6% | 64.8% | 38.6% | 8.6% | 24.1% | 52.0% | 36.5% | 49.1% | 46.9% |
| Age-4 | 3.7% | 2.7% | 2.3% | 0.9% | 2.8% | 0.2% | 0.2% | 0.3% | 2.5% | 0.7% | 1.0% |
| Age-3&4 combined | 53.3% | 50.4% | 49.0% | 65.7% | 41.4% | 8.8% | 24.2% | 52.3% | 39.0% | 49.8% | 47.9% |

***Table A11. Mean length at age data (total length in inches) for Chinook salmon sampled July-September during the 1991-2016 NYSDEC Lake Ontario fishing boat surveys.***

| Age | Year Sampled | July Mean Length | July (n) | August Mean Length | August (n) | September Mean Length | September (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) |
| | 2013 | 19.46 | (14) | 20.94 | (26) | 24.98 | (5) |
| | 2014 | 17.85 | (13) | 19.55 | (24) | 20.48 | (12) |
| | 2015 | 18.33 | (3) | 17.34 | (12) | 17.97 | (3) |
| | 2016 | 18.54 | (21) | 19.00 | (9) | 22.13 | (3) |
| | 91-'16 avg | 18.90 | | 19.62 | | 21.66 | |
| 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) |
| | 2013 | 30.49 | (48) | 31.12 | (75) | 33.09 | (18) |
| | 2014 | 29.36 | (83) | 29.97 | (104) | 32.00 | (63) |
| | 2015 | 27.63 | (81) | 29.39 | (80) | 31.10 | (50) |
| | 2016 | 25.73 | (81) | 29.33 | (31) | 29.87 | (36) |
| | 91-'16 avg | 29.13 | | 30.46 | | 32.04 | |

***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) |
| | 2013 | 36.72 | (64) | 37.50 | (124) | 37.32 | (27) |
| | 2014 | 35.58 | (48) | 36.47 | (58) | 36.70 | (80) |
| | 2015 | 34.82 | (60) | 35.88 | (67) | 35.04 | (47) |
| | 2016 | 34.92 | (57) | 36.18 | (50) | 36.68 | (73) |
| | 91-'16 avg | 35.91 | | 36.81 | | 37.07 | |
| 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) | 40.00 | (1) | - | (0) |
| | 2013 | 40.50 | (1) | - | (0) | - | (0) |
| | 2014 | 37.73 | (3) | 37.17 | (3) | 37.61 | (7) |
| | 2015 | - | (0) | 39.00 | (1) | - | (0) |
| | 2016 | 36.65 | (2) | 37.20 | (1) | 39.30 | (1) |
| | 91-'16 avg | 37.84 | | 38.26 | | 38.81 | |

***Table A12. Chinook salmon relative harvest (age-specific harvest per 50,000 boat trips) by year class and year sampled, from the 1985-2016 NYSDEC Lake Ontario fishing boat surveys.***

| Year Class | Fing Equiv Stocked | Chinook Salmon Harvested Per 50,000 Boat Trips | | | | |
|---|---|---|---|---|---|---|
| | | Age-1 | Age-2 | Age-3 | Age-4 | Total |
| 1981 | 862,840 | | | | 531 | |
| 1982 | 1,175,354 | | | 7,510 | 392 | |
| 1983 | 2,544,180 | | 5,837 | 9,043 | 1,267 | |
| 1984 | 2,957,230 | 5,022 | 8,347 | 15,102 | 1,185 | 29,665 |
| 1985 | 3,252,830 | 3,990 | 10,715 | 13,297 | 2,478 | 30,481 |
| 1986 | 2,810,771 | 4,026 | 8,038 | 21,317 | 1,112 | 34,494 |
| 1987 | 3,368,296 | 3,148 | 11,346 | 13,699 | 1,904 | 30,110 |
| 1988 | 3,104,104 | 3,017 | 7,040 | 13,759 | 784 | 24,630 |
| 1989 | 3,018,754 | 1,161 | 7,423 | 9,109 | 1,238 | 18,931 |
| 1990 | 2,964,722 | 1,779 | 6,428 | 11,901 | 1,217 | 21,325 |
| 1991 | 3,129,453 | 3,471 | 8,902 | 18,263 | 1,155 | 31,790 |
| 1992 | 3,004,329 | 3,334 | 12,489 | 11,690 | 2,645 | 30,212 |
| 1993 | 1,846,892 | 822 | 4,168 | 8,955 | 1,057 | 15,002 |
| 1994 | 1,221,491 | 357 | 1,976 | 4,135 | 364 | 6,832 |
| 1995 | 1,364,090 | 5,357 | 17,531 | 13,108 | 795 | 36,790 |
| 1996 | 1,495,138 | 3,334 | 6,754 | 14,007 | 0 | 24,096 |
| 1997 | 1,911,040 | 1,821 | 6,189 | 9,800 | 151 | 17,961 |
| 1998 | 1,903,929 | 3,616 | 7,016 | 7,159 | 209 | 18,000 |
| 1999 | 1,767,524 | 2,907 | 9,847 | 7,405 | 64 | 20,224 |
| 2000 | 1,906,543 | 2,716 | 8,562 | 19,445 | 326 | 31,048 |
| 2001 | 1,893,686 | 1,774 | 11,839 | 15,862 | 440 | 29,953 |
| 2002 | 1,908,002 | 1,751 | 25,606 | 38,454 | 1,758 | 67,570 |
| 2003 | 1,700,374 | 3,020 | 18,954 | 23,849 | 1,262 | 47,085 |
| 2004 | 1,962,565 | 2,103 | 11,925 | 22,083 | 812 | 36,923 |
| 2005 | 2,075,169 | 3,710 | 21,455 | 16,162 | 399 | 41,727 |
| 2006 | 1,898,083 | 1,483 | 16,602 | 28,719 | 873 | 47,677 |
| 2007 | 2,055,075 | 1,090 | 13,076 | 12,225 | 81 | 26,472 |
| 2008 | 1,038,844 | 2,113 | 7,877 | 4,041 | 99 | 14,129 |
| 2009 | 1,981,055 | 10,663 | 32,236 | 14,404 | 116 | 57,418 |
| 2010 | 1,911,756 | 10,398 | 42,386 | 20,939 | 1,207 | 74,929 |
| 2011 | 2,060,874 | 2,966 | 14,922 | 17,690 | 284 | 35,862 |
| 2012 | 1,816,778 | 4,314 | 25,569 | 18,581 | 453 | 48,917 |
| 2013 | 2,010,290 | 4,019 | 17,609 | 20,797 | | 42,424 |
| 2014 | 2,229,494 | 1,400 | 19,079 | | | 20,479 |
| 2015 | 1,939,992 | 4,036 | | | | 4,036 |

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

| Year Sampled | Salmonid Boat Trips | Chinook Salmon Harvested Per 50,000 Boat Trips | | | | |
|---|---|---|---|---|---|---|
| | | Age-1 | Age-2 | Age-3 | Age-4 | Total |
| 1985 | 126,155 | 5,022 | 5,837 | 7,510 | 531 | 18,900 |
| 1986 | 148,950 | 3,990 | 8,347 | 9,043 | 392 | 21,772 |
| 1987 | 165,678 | 4,026 | 10,715 | 15,102 | 1,267 | 31,122 |
| 1988 | 160,805 | 3,148 | 8,038 | 13,297 | 1,185 | 25,699 |
| 1989 | 177,223 | 3,017 | 11,346 | 21,317 | 2,478 | 38,159 |
| 1990 | 181,867 | 1,161 | 7,040 | 13,699 | 1,112 | 23,013 |
| 1991 | 152,357 | 1,779 | 7,423 | 13,759 | 1,904 | 24,865 |
| 1992 | 118,054 | 3,471 | 6,428 | 9,109 | 784 | 19,845 |
| 1993 | 103,125 | 3,334 | 8,902 | 11,901 | 1,238 | 25,375 |
| 1994 | 102,718 | 822 | 12,489 | 18,263 | 1,217 | 32,791 |
| 1995 | 92,346 | 357 | 4,168 | 11,690 | 1,155 | 17,371 |
| 1996 | 70,151 | 5,357 | 1,976 | 8,955 | 2,645 | 18,932 |
| 1997 | 64,351 | 3,334 | 17,531 | 4,135 | 1,057 | 26,058 |
| 1998 | 64,060 | 1,821 | 6,754 | 13,108 | 364 | 22,046 |
| 1999 | 60,573 | 3,616 | 6,189 | 14,007 | 795 | 24,608 |
| 2000 | 64,589 | 2,907 | 7,016 | 9,800 | 0 | 19,723 |
| 2001 | 63,026 | 2,716 | 9,847 | 7,159 | 151 | 19,910 |
| 2002 | 50,826 | 1,774 | 8,562 | 7,405 | 209 | 17,949 |
| 2003 | 47,622 | 1,751 | 11,839 | 19,445 | 64 | 33,099 |
| 2004 | 57,397 | 3,020 | 25,606 | 15,862 | 326 | 44,813 |
| 2005 | 57,510 | 2,103 | 18,954 | 38,454 | 440 | 59,952 |
| 2006 | 47,812 | 3,710 | 11,925 | 23,849 | 1,758 | 41,244 |
| 2007 | 57,620 | 1,483 | 21,455 | 22,083 | 1,262 | 46,283 |
| 2008 | 51,229 | 1,090 | 16,602 | 16,162 | 812 | 34,668 |
| 2009 | 62,028 | 2,113 | 13,076 | 28,719 | 399 | 44,306 |
| 2010 | 50,059 | 10,663 | 7,877 | 12,225 | 873 | 31,639 |
| 2011 | 49,548 | 10,398 | 32,236 | 4,041 | 81 | 46,756 |
| 2012 | 46,059 | 2,966 | 42,386 | 14,404 | 99 | 59,855 |
| 2013 | 47,520 | 4,314 | 14,922 | 20,939 | 116 | 40,290 |
| 2014 | 49,434 | 4,019 | 25,569 | 17,690 | 1,207 | 48,484 |
| 2015 | 46,142 | 1,400 | 17,609 | 18,581 | 284 | 37,873 |
| 2016 | 38,776 | 4,036 | 19,079 | 20,797 | 453 | 44,364 |

***Table A13. Number of fingerling equivalents and average size (grams) of Chinook salmon stocked into Lake Ontario from 1981-2015 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 Chinook Salmon | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Salmon River | | Caledonia | | Pen Reared | | Hatchery | | Pen Reared | | | |
| 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 | 6.0 | | | 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 |
| 2012 | 1,013,110 | 6.6 | | | 497,970 | 6.3 | 245,758 | 6.5 | 59,940 | 10.7 | 1,816,778 | 6.7 |
| 2013 | 1,212,907 | 4.7 | | | 443,566 | 5.5 | 294,324 | 5.6 | 59,494 | 8.4 | 2,010,290 | 5.2 |
| 2014 | 1,394,560 | 4.9 | | | 505,990 | 6.0 | 246,124 | 5.6 | 82,820 | 8.1 | 2,229,494 | 5.5 |
| 2015 | 1,181,352 | 4.6 | | | 450,800 | 5.9 | 220,275 | 5.3 | 87,565 | 8.1 | 1,939,992 | 5.3 |

***Table A14a. Rainbow trout harvest and catch data collected April 15 – September 30, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **Seasonal (5½ month) estimates of harvest and catch for all fishing boats:** | | | | | | | | | | | |
| Harvest | 23,914 | 12,861 | 19,685 | 24,060 | 23,856 | 16,131 | 12,617 | 17,203 | 16,729 | 9,212 | 9,487 |
| Catch | 33,924 | 25,892 | 33,943 | 54,501 | 46,249 | 36,533 | 32,975 | 34,611 | 37,462 | 17,509 | 16,639 |
| % Harvested | 69.7 | 49.7 | 58.0 | 44.1 | 51.6 | 44.2 | 38.3 | 49.7 | 44.7 | 52.6 | 57.0 |
| **Monthly estimates of harvest for all fishing boats:** | | | | | | | | | | | |
| April | 1,205 | 228 | 262 | 473 | 463 | 56 | 199 | 76 | 101 | 127 | 65 |
| May | 5,320 | 2,619 | 2,481 | 1,698 | 1,548 | 410 | 939 | 2,099 | 2,315 | 1,773 | 451 |
| June | 3,499 | 1,112 | 978 | 813 | 2,406 | 1,095 | 2,156 | 965 | 5,102 | 614 | 1,228 |
| July | 3,074 | 3,666 | 2,889 | 5,816 | 4,831 | 7,299 | 4,301 | 5,488 | 2,461 | 1,750 | 4,097 |
| August | 8,106 | 3,613 | 9,800 | 10,096 | 13,568 | 4,587 | 4,381 | 7,567 | 5,670 | 3,876 | 3,531 |
| September | 2,710 | 1,622 | 3,275 | 5,164 | 1,040 | 2,684 | 640 | 1,009 | 1,080 | 1,072 | 113 |
| **Seasonal estimates of harvest among geographic areas for all fishing boats:** | | | | | | | | | | | |
| West | 14,211 | 8,537 | 14,945 | 19,388 | 18,973 | 11,637 | 8,622 | 11,437 | 9,225 | 6,143 | 7,764 |
| West/Central | 2,746 | 1,578 | 760 | 1,728 | 1,447 | 2,023 | 1,245 | 2,333 | 1,871 | 1,057 | 485 |
| East/Central | 5,737 | 2,335 | 3,603 | 2,221 | 3,065 | 2,340 | 1,852 | 3,036 | 4,800 | 1,442 | 1,016 |
| East | 1,220 | 411 | 377 | 722 | 370 | 131 | 898 | 397 | 833 | 570 | 222 |
| **Monthly estimates of catch for all fishing boats:** | | | | | | | | | | | |
| April | 2,038 | 429 | 565 | 1,197 | 867 | 305 | 442 | 379 | 649 | 387 | 214 |
| May | 7,849 | 7,264 | 5,840 | 7,418 | 2,724 | 2,060 | 3,100 | 4,824 | 6,341 | 3,816 | 1,191 |
| June | 5,095 | 2,708 | 2,197 | 2,676 | 4,828 | 1,813 | 6,515 | 2,077 | 13,747 | 2,384 | 2,245 |
| July | 4,222 | 6,504 | 6,026 | 9,053 | 8,856 | 18,448 | 11,100 | 11,489 | 4,050 | 3,560 | 7,005 |
| August | 10,897 | 6,520 | 14,823 | 22,335 | 27,121 | 9,037 | 10,858 | 14,198 | 11,072 | 5,701 | 5,689 |
| September | 3,822 | 2,467 | 4,492 | 11,822 | 1,851 | 4,869 | 960 | 1,644 | 1,603 | 1,661 | 296 |
| **Seasonal estimates of catch among geographic areas for all fishing boats:** | | | | | | | | | | | |
| West | 19,934 | 16,537 | 23,556 | 35,347 | 36,512 | 26,897 | 22,064 | 23,021 | 16,603 | 9,899 | 12,792 |
| West/Central | 4,811 | 3,130 | 1,727 | 12,065 | 3,891 | 3,377 | 5,355 | 5,055 | 7,394 | 2,949 | 1,207 |
| East/Central | 7,676 | 5,382 | 8,040 | 5,824 | 5,166 | 5,164 | 4,195 | 5,957 | 10,976 | 3,456 | 2,099 |
| East | 1,502 | 843 | 620 | 1,266 | 681 | 1,096 | 1,361 | 578 | 2,489 | 1,204 | 541 |
| **Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon:** | | | | | | | | | | | |
| % Harvest | 99.7 | 100.0 | 99.8 | 100.0 | 100.0 | 99.8 | 100.0 | 100.0 | 99.7 | 100.0 | 100.0 |
| % Catch | 99.6 | 99.9 | 99.7 | 99.8 | 99.9 | 99.9 | 100.0 | 99.9 | 99.9 | 100.0 | 100.0 |
| **Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon:** | | | | | | | | | | | |
| % Harvest | 50.9 | 50.0 | 59.4 | 50.7 | 49.8 | 50.2 | 45.9 | 54.3 | 56.5 | 50.3 | 63.3 |
| % Catch | 40.5 | 36.8 | 47.0 | 34.7 | 35.5 | 33.5 | 27.1 | 39.0 | 38.7 | 36.8 | 44.1 |

***Table A14b. Rainbow trout harvest and catch rate data collected April 15 – September 30, 1985-2016. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.249 | 0.223 | 0.384 | 0.388 | 0.477 | 0.325 | 0.274 | 0.362 | 0.337 | 0.200 | 0.245 |
| Catch/Boat Trip | 0.354 | 0.449 | 0.661 | 0.877 | 0.923 | 0.737 | 0.716 | 0.728 | 0.757 | 0.379 | 0.429 |
| Harv/Angler Trip | 0.085 | 0.075 | 0.129 | 0.127 | 0.157 | 0.109 | 0.091 | 0.117 | 0.107 | 0.065 | 0.078 |
| Catch/Angler Trip | 0.121 | 0.150 | 0.221 | 0.287 | 0.305 | 0.247 | 0.238 | 0.235 | 0.240 | 0.123 | 0.137 |
| Harv/Angler Hour | 0.015 | 0.013 | 0.023 | 0.021 | 0.028 | 0.019 | 0.016 | 0.019 | 0.018 | 0.011 | 0.013 |
| Catch/Angler Hr. | 0.021 | 0.027 | 0.039 | 0.048 | 0.055 | 0.044 | 0.042 | 0.039 | 0.041 | 0.021 | 0.023 |
| Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.111 | 0.076 | 0.091 | 0.131 | 0.177 | 0.022 | 0.084 | 0.030 | 0.053 | 0.056 | 0.020 |
| May | 0.290 | 0.238 | 0.342 | 0.115 | 0.165 | 0.051 | 0.112 | 0.265 | 0.275 | 0.205 | 0.067 |
| June | 0.351 | 0.190 | 0.199 | 0.156 | 0.620 | 0.254 | 0.420 | 0.152 | 0.920 | 0.142 | 0.324 |
| July | 0.225 | 0.359 | 0.312 | 0.665 | 0.523 | 0.669 | 0.465 | 0.569 | 0.279 | 0.215 | 0.488 |
| August | 0.298 | 0.217 | 0.594 | 0.665 | 0.750 | 0.323 | 0.339 | 0.476 | 0.335 | 0.314 | 0.353 |
| September | 0.149 | 0.149 | 0.309 | 0.355 | 0.152 | 0.278 | 0.080 | 0.196 | 0.137 | 0.103 | 0.017 |
| Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.653 | 0.530 | 1.201 | 1.044 | 1.331 | 0.789 | 0.680 | 0.836 | 0.763 | 0.541 | 0.702 |
| West/Central | 0.166 | 0.227 | 0.177 | 0.224 | 0.260 | 0.401 | 0.223 | 0.352 | 0.299 | 0.164 | 0.124 |
| East/Central | 0.185 | 0.141 | 0.209 | 0.116 | 0.183 | 0.155 | 0.136 | 0.199 | 0.303 | 0.103 | 0.073 |
| East | 0.034 | 0.023 | 0.022 | 0.044 | 0.027 | 0.009 | 0.063 | 0.033 | 0.052 | 0.040 | 0.022 |
| Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.200 | 0.143 | 0.197 | 0.332 | 0.332 | 0.121 | 0.187 | 0.147 | 0.338 | 0.172 | 0.067 |
| May | 0.442 | 0.660 | 0.804 | 0.504 | 0.290 | 0.256 | 0.370 | 0.610 | 0.753 | 0.441 | 0.176 |
| June | 0.521 | 0.459 | 0.449 | 0.515 | 1.238 | 0.417 | 1.268 | 0.328 | 2.495 | 0.552 | 0.593 |
| July | 0.300 | 0.637 | 0.647 | 1.035 | 0.959 | 1.692 | 1.199 | 1.188 | 0.459 | 0.437 | 0.834 |
| August | 0.399 | 0.391 | 0.899 | 1.465 | 1.500 | 0.638 | 0.841 | 0.892 | 0.654 | 0.462 | 0.569 |
| September | 0.210 | 0.227 | 0.424 | 0.811 | 0.270 | 0.505 | 0.120 | 0.320 | 0.204 | 0.159 | 0.045 |
| Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.911 | 1.026 | 1.893 | 1.904 | 2.561 | 1.826 | 1.741 | 1.682 | 1.373 | 0.872 | 1.156 |
| West/Central | 0.317 | 0.447 | 0.399 | 1.559 | 0.698 | 0.669 | 0.959 | 0.762 | 1.183 | 0.457 | 0.308 |
| East/Central | 0.252 | 0.326 | 0.466 | 0.300 | 0.307 | 0.340 | 0.309 | 0.390 | 0.692 | 0.248 | 0.152 |
| East | 0.042 | 0.047 | 0.036 | 0.076 | 0.050 | 0.075 | 0.096 | 0.048 | 0.160 | 0.084 | 0.054 |
| Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.879 | 0.702 | 1.340 | 1.236 | 1.391 | 0.981 | 0.759 | 1.008 | 0.973 | 0.474 | 0.704 |
| Catch/Boat Trip | 1.006 | 1.040 | 1.828 | 1.919 | 1.925 | 1.484 | 1.169 | 1.455 | 1.494 | 0.659 | 0.860 |
| Harv/Angler Trip | 0.175 | 0.136 | 0.257 | 0.244 | 0.267 | 0.188 | 0.149 | 0.194 | 0.184 | 0.091 | 0.134 |
| Catch/Angler Trip | 0.200 | 0.202 | 0.351 | 0.378 | 0.369 | 0.284 | 0.230 | 0.280 | 0.283 | 0.126 | 0.164 |
| Harv/Angler Hour | 0.024 | 0.019 | 0.037 | 0.035 | 0.041 | 0.030 | 0.023 | 0.028 | 0.027 | 0.014 | 0.019 |
| Catch/Angler Hr. | 0.027 | 0.029 | 0.051 | 0.055 | 0.057 | 0.045 | 0.035 | 0.040 | 0.042 | 0.019 | 0.024 |
| Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.140 | 0.133 | 0.187 | 0.227 | 0.289 | 0.194 | 0.178 | 0.206 | 0.182 | 0.126 | 0.115 |
| Catch/Boat Trip | 0.241 | 0.337 | 0.421 | 0.680 | 0.717 | 0.587 | 0.626 | 0.552 | 0.577 | 0.304 | 0.308 |
| Harv/Angler Trip | 0.055 | 0.052 | 0.074 | 0.085 | 0.112 | 0.077 | 0.068 | 0.080 | 0.069 | 0.050 | 0.045 |
| Catch/Angler Trip | 0.095 | 0.131 | 0.167 | 0.254 | 0.278 | 0.232 | 0.241 | 0.214 | 0.220 | 0.120 | 0.121 |
| Harv/Angler Hour | 0.010 | 0.010 | 0.014 | 0.015 | 0.022 | 0.014 | 0.013 | 0.014 | 0.013 | 0.009 | 0.008 |
| Catch/Angler Hr. | 0.018 | 0.026 | 0.032 | 0.045 | 0.054 | 0.044 | 0.046 | 0.038 | 0.040 | 0.022 | 0.022 |

***Table A15. Length (total length in inches) and weight (lbs) statistics for rainbow trout sampled April 15 – September 30 during the 1985-2016 NYSDEC Lake Ontario fishing boat surveys.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-05 avg. | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Mean length and weight data for rainbow trout sampled April 15 - September 30: | | | | | | | | | | | |
| Mean Length (in) | 24.3 | 24.9 | 25.1 | 25.0 | 25.3 | 24.7 | 24.9 | 24.5 | 24.6 | 25.3 | 24.6 |
| Mean Weight (lbs) | - | 6.0 | 6.2 | 6.0 | 6.8 | 6.1 | 5.9 | 6.0 | 5.9 | 6.1 | 5.9 |
| Estimated weight (lbs) for standard length rainbow trout sampled April 15 - September 30: | | | | | | | | | | | |
| Standard Length: | | | | | | | | | | | |
| 18.0 inches | - | 2.07 | 2.22 | 2.10 | 2.40 | 2.09 | 2.05 | 2.21 | 2.31 | 2.17 | 2.37 |
| 20.0 inches | - | 2.86 | 3.02 | 2.89 | 3.26 | 2.92 | 2.83 | 3.04 | 3.10 | 2.94 | 3.16 |
| 22.0 inches | - | 3.83 | 3.99 | 3.85 | 4.30 | 3.95 | 3.80 | 4.06 | 4.05 | 3.87 | 4.10 |
| 24.0 inches | - | 5.00 | 5.13 | 5.00 | 5.53 | 5.21 | 4.97 | 5.28 | 5.17 | 4.97 | 5.19 |
| 26.0 inches | - | 6.38 | 6.47 | 6.36 | 6.97 | 6.71 | 6.35 | 6.73 | 6.46 | 6.25 | 6.46 |
| 28.0 inches | - | 7.97 | 7.99 | 7.92 | 8.60 | 8.46 | 7.94 | 8.39 | 7.91 | 7.70 | 7.87 |
| 30.0 inches | - | 9.85 | 9.77 | 9.75 | 10.51 | 10.53 | 9.82 | 10.34 | 9.60 | 9.39 | 9.49 |
| 32.0 inches | - | 12.00 | 11.78 | 11.84 | 12.67 | 12.92 | 11.98 | 12.58 | 11.50 | 11.30 | 11.32 |
| Percent length composition of rainbow trout sampled April 15 - September 30: | | | | | | | | | | | |
| <15.0 in | 0.3% | 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% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 1.0% | 0.0% |
| 16.0-16.9 in | 1.0% | 0.0% | 0.3% | 0.2% | 0.0% | 0.0% | 0.0% | 0.0% | 0.9% | 0.0% | 0.0% |
| 17.0-17.9 in | 2.2% | 0.4% | 0.3% | 1.5% | 0.3% | 1.3% | 0.5% | 0.5% | 2.3% | 0.0% | 0.0% |
| 18.0-18.9 in | 4.5% | 3.5% | 3.8% | 1.2% | 1.1% | 1.3% | 0.5% | 0.5% | 3.6% | 2.0% | 0.0% |
| 19.0-19.9 in | 6.7% | 2.6% | 1.4% | 3.2% | 1.6% | 3.3% | 1.6% | 1.1% | 4.5% | 2.0% | 3.0% |
| 20.0-20.9 in | 8.2% | 7.5% | 4.8% | 5.4% | 4.1% | 4.6% | 5.3% | 8.1% | 1.8% | 2.9% | 10.1% |
| 21.0-21.9 in | 9.0% | 9.7% | 8.7% | 8.2% | 8.5% | 12.8% | 7.4% | 9.7% | 7.7% | 5.9% | 6.1% |
| 22.0-22.9 in | 9.1% | 8.4% | 10.4% | 9.2% | 11.8% | 12.1% | 10.1% | 14.1% | 7.7% | 9.8% | 15.2% |
| 23.0-23.9 in | 9.1% | 15.4% | 6.2% | 9.9% | 11.5% | 10.8% | 16.0% | 15.1% | 7.7% | 9.8% | 15.2% |
| 24.0-24.9 in | 8.0% | 5.3% | 9.3% | 7.7% | 10.4% | 7.5% | 12.2% | 9.2% | 14.4% | 13.7% | 9.1% |
| 25.0-25.9 in | 7.0% | 5.3% | 8.7% | 12.6% | 8.5% | 7.9% | 11.2% | 10.8% | 13.5% | 10.8% | 15.2% |
| 26.0-26.9 in | 6.2% | 7.5% | 12.5% | 10.1% | 11.8% | 11.1% | 7.4% | 8.1% | 10.8% | 11.8% | 5.1% |
| 27.0-27.9 in | 6.9% | 8.4% | 12.5% | 9.4% | 9.0% | 8.2% | 12.8% | 7.6% | 7.7% | 8.8% | 4.0% |
| 28.0-28.9 in | 5.8% | 10.1% | 9.3% | 9.9% | 7.4% | 9.5% | 5.3% | 5.4% | 9.5% | 6.9% | 5.1% |
| 29.0-29.9 in | 5.1% | 6.2% | 6.6% | 5.0% | 4.9% | 4.3% | 3.7% | 5.9% | 4.5% | 7.8% | 4.0% |
| 30.0-30.9 in | 4.2% | 4.4% | 2.8% | 4.0% | 4.9% | 3.6% | 3.2% | 1.1% | 1.4% | 3.9% | 5.1% |
| 31.0-31.9 in | 3.1% | 2.6% | 1.4% | 1.7% | 1.4% | 1.3% | 1.1% | 0.5% | 2.3% | 2.0% | 2.0% |
| 32.0-32.9 in | 1.8% | 1.8% | 0.0% | 0.7% | 1.9% | 0.0% | 0.5% | 0.5% | 0.0% | 1.0% | 0.0% |
| 33.0-33.9 in | 1.0% | 0.4% | 0.3% | 0.0% | 0.5% | 0.3% | 1.1% | 0.5% | 0.0% | 0.0% | 0.0% |
| >33.9 in | 0.8% | 0.0% | 0.7% | 0.0% | 0.3% | 0.0% | 0.0% | 1.1% | 0.0% | 0.0% | 1.0% |

### *Table A16. Atlantic salmon harvest and catch data collected April 15 – September 30, 1985-2016.*

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 323 | 14 | 79 | 532 | 624 | 398 | 310 | 200 | 66 | 275 | 236 |
| Catch | 1,204 | 214 | 233 | 1,273 | 1,826 | 1,519 | 592 | 599 | 639 | 638 | 704 |
| % Harvested | 25.3 | 6.5 | 33.9 | 41.8 | 34.2 | 26.2 | 52.4 | 33.4 | 10.3 | 43.1 | 33.5 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 62 | 0 | 0 | 105 | 98 | 128 | 29 | 0 | 28 | 24 | 15 |
| May | 140 | 0 | 28 | 222 | 79 | 95 | 183 | 175 | 25 | 24 | 54 |
| June | 47 | 14 | 0 | 15 | 24 | 54 | 46 | 0 | 0 | 12 | 27 |
| July | 28 | 0 | 16 | 66 | 301 | 76 | 51 | 25 | 14 | 169 | 140 |
| August | 41 | 0 | 0 | 124 | 108 | 25 | 0 | 0 | 0 | 25 | 0 |
| September | 6 | 0 | 35 | 0 | 15 | 21 | 0 | 0 | 0 | 20 | 0 |
| Seasonal estimates of harvest among four geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 80 | 14 | 51 | 226 | 205 | 236 | 126 | 51 | 39 | 0 | 41 |
| West/Central | 54 | 0 | 0 | 161 | 182 | 0 | 0 | 44 | 0 | 0 | 0 |
| East/Central | 92 | 0 | 0 | 74 | 204 | 106 | 93 | 105 | 0 | 136 | 102 |
| East | 97 | 0 | 28 | 71 | 33 | 56 | 91 | 0 | 27 | 139 | 93 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 222 | 0 | 0 | 201 | 273 | 296 | 56 | 48 | 180 | 132 | 62 |
| May | 387 | 72 | 88 | 430 | 223 | 439 | 387 | 251 | 215 | 194 | 66 |
| June | 157 | 114 | 64 | 66 | 231 | 171 | 46 | 77 | 0 | 37 | 87 |
| July | 200 | 28 | 16 | 211 | 648 | 212 | 90 | 165 | 162 | 209 | 397 |
| August | 169 | 0 | 30 | 365 | 372 | 340 | 13 | 58 | 82 | 25 | 92 |
| September | 68 | 0 | 35 | 0 | 79 | 62 | 0 | 0 | 0 | 41 | 0 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 283 | 116 | 52 | 363 | 560 | 526 | 242 | 186 | 121 | 26 | 112 |
| West/Central | 212 | 70 | 36 | 337 | 397 | 366 | 46 | 77 | 112 | 0 | 0 |
| East/Central | 366 | 0 | 47 | 509 | 650 | 339 | 211 | 255 | 209 | 368 | 445 |
| East | 343 | 28 | 98 | 63 | 219 | 287 | 93 | 81 | 197 | 244 | 147 |
| Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 98.8 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| % Catch | 96.0 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 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 | 0.263 | 0.024 | 0.154 | 0.858 | 1.247 | 0.803 | 0.673 | 0.421 | 0.134 | 0.596 | 0.609 |
| Catch/Boat Trip | 0.979 | 0.371 | 0.455 | 2.052 | 3.648 | 3.066 | 1.285 | 1.261 | 1.293 | 1.383 | 1.816 |
| Harv/Angler Trip | 0.091 | 0.008 | 0.052 | 0.280 | 0.411 | 0.269 | 0.224 | 0.136 | 0.042 | 0.193 | 0.194 |
| Catch/Angler Trip | 0.341 | 0.124 | 0.152 | 0.671 | 1.203 | 1.028 | 0.427 | 0.408 | 0.411 | 0.447 | 0.578 |
| Harv/Angler Hour | 0.016 | 0.001 | 0.009 | 0.047 | 0.074 | 0.048 | 0.039 | 0.022 | 0.007 | 0.033 | 0.032 |
| Catch/Angler Hr. | 0.058 | 0.022 | 0.027 | 0.111 | 0.217 | 0.183 | 0.075 | 0.067 | 0.070 | 0.076 | 0.096 |

## *Table A17a. Brown trout harvest and catch data collected April 15 – September 30, 1985-2016.*

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 31,028 | 27,855 | 14,989 | 23,148 | 18,311 | 32,937 | 23,305 | 18,969 | 20,626 | 12,590 | 14,608 |
| Catch | 44,043 | 46,258 | 22,030 | 33,484 | 32,604 | 49,661 | 39,507 | 27,793 | 44,487 | 20,780 | 20,871 |
| % Harvested | 69.8 | 60.2 | 68.0 | 69.1 | 56.2 | 66.3 | 59.0 | 68.3 | 46.4 | 60.6 | 70.0 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 8,189 | 5,795 | 1,420 | 4,023 | 3,855 | 3,558 | 5,802 | 2,730 | 5,094 | 3,247 | 5,180 |
| May | 11,005 | 9,083 | 3,828 | 11,256 | 2,266 | 12,255 | 5,436 | 7,810 | 5,404 | 3,138 | 3,377 |
| June | 4,216 | 4,052 | 4,164 | 2,393 | 611 | 4,941 | 1,456 | 3,315 | 612 | 3,591 | 339 |
| July | 3,859 | 4,570 | 3,280 | 576 | 7,782 | 6,695 | 5,631 | 2,656 | 5,202 | 1,188 | 1,957 |
| August | 3,192 | 4,100 | 1,945 | 4,538 | 3,543 | 4,968 | 4,307 | 2,197 | 3,593 | 1,045 | 2,775 |
| September | 565 | 256 | 352 | 362 | 255 | 519 | 672 | 259 | 721 | 380 | 980 |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 2,503 | 2,633 | 1,052 | 209 | 1,153 | 2,563 | 2,006 | 1,649 | 4,267 | 560 | 1,010 |
| West/Central | 3,039 | 2,667 | 541 | 1,744 | 1,487 | 2,163 | 2,792 | 1,566 | 2,958 | 503 | 2,534 |
| East/Central | 17,143 | 15,145 | 3,969 | 17,399 | 11,156 | 16,327 | 8,932 | 9,850 | 8,199 | 7,903 | 6,545 |
| East | 8,342 | 7,410 | 9,427 | 3,796 | 4,515 | 11,883 | 9,575 | 5,903 | 5,202 | 3,624 | 4,519 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 11,164 | 10,656 | 1,996 | 5,997 | 5,501 | 8,160 | 10,558 | 4,450 | 13,369 | 6,962 | 7,802 |
| May | 15,003 | 15,302 | 5,983 | 15,838 | 3,913 | 17,584 | 9,446 | 9,329 | 15,497 | 4,657 | 3,957 |
| June | 5,602 | 5,337 | 6,110 | 3,463 | 1,342 | 6,658 | 3,345 | 3,918 | 913 | 4,516 | 446 |
| July | 5,996 | 9,167 | 4,692 | 888 | 14,421 | 10,026 | 7,751 | 5,169 | 8,331 | 1,876 | 3,053 |
| August | 5,413 | 5,347 | 2,654 | 6,720 | 6,993 | 6,193 | 7,236 | 4,284 | 5,048 | 1,498 | 3,672 |
| September | 867 | 449 | 595 | 579 | 434 | 1,041 | 1,171 | 643 | 1,330 | 1,271 | 1,940 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 3,945 | 3,828 | 1,408 | 344 | 2,043 | 4,760 | 4,122 | 2,451 | 12,153 | 1,249 | 1,494 |
| West/Central | 6,115 | 6,652 | 1,162 | 3,182 | 3,005 | 5,710 | 6,836 | 4,933 | 6,544 | 1,785 | 4,364 |
| East/Central | 23,219 | 25,705 | 6,117 | 25,272 | 20,730 | 22,945 | 13,860 | 12,722 | 15,761 | 12,243 | 9,579 |
| East | 10,765 | 10,073 | 13,344 | 4,686 | 6,826 | 16,246 | 14,689 | 7,687 | 10,028 | 5,504 | 5,434 |
| Percent of seasonal harvest and catch made by boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 98.9 | 98.6 | 98.9 | 99.4 | 98.9 | 99.8 | 99.8 | 99.8 | 99.6 | 99.9 | 100.0 |
| % Catch | 98.5 | 98.9 | 98.3 | 98.9 | 97.8 | 99.8 | 98.8 | 99.5 | 99.8 | 99.8 | 99.8 |
| Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 46.2 | 51.1 | 43.9 | 70.3 | 54.7 | 53.3 | 55.6 | 72.9 | 57.9 | 62.6 | 61.1 |
| % Catch | 38.7 | 42.2 | 34.1 | 59.6 | 49.8 | 43.4 | 42.3 | 58.7 | 36.4 | 47.4 | 50.4 |

***Table A17b. Brown trout harvest and catch rate data collected April 15 – September 30, 1985-2016. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.323 | 0.477 | 0.289 | 0.371 | 0.362 | 0.664 | 0.505 | 0.398 | 0.416 | 0.273 | 0.377 |
| Catch/Boat Trip | 0.468 | 0.794 | 0.423 | 0.534 | 0.637 | 1.000 | 0.848 | 0.582 | 0.898 | 0.450 | 0.537 |
| Harv/Angler Trip | 0.111 | 0.160 | 0.097 | 0.121 | 0.119 | 0.223 | 0.168 | 0.129 | 0.132 | 0.088 | 0.120 |
| Catch/Angler Trip | 0.162 | 0.266 | 0.142 | 0.175 | 0.210 | 0.335 | 0.282 | 0.188 | 0.285 | 0.145 | 0.171 |
| Harv/Angler Hour | 0.019 | 0.028 | 0.017 | 0.020 | 0.021 | 0.040 | 0.030 | 0.021 | 0.022 | 0.015 | 0.020 |
| Catch/Angler Hr. | 0.028 | 0.047 | 0.025 | 0.029 | 0.038 | 0.060 | 0.050 | 0.031 | 0.048 | 0.025 | 0.028 |
| Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 1.007 | 1.933 | 0.494 | 1.114 | 1.477 | 1.413 | 2.452 | 1.060 | 2.653 | 1.442 | 1.620 |
| May | 0.630 | 0.825 | 0.527 | 0.764 | 0.241 | 1.522 | 0.648 | 0.987 | 0.642 | 0.363 | 0.499 |
| June | 0.459 | 0.655 | 0.851 | 0.438 | 0.140 | 1.134 | 0.283 | 0.523 | 0.106 | 0.831 | 0.090 |
| July | 0.300 | 0.438 | 0.352 | 0.066 | 0.834 | 0.614 | 0.603 | 0.272 | 0.583 | 0.144 | 0.233 |
| August | 0.122 | 0.240 | 0.116 | 0.298 | 0.196 | 0.352 | 0.334 | 0.138 | 0.212 | 0.085 | 0.278 |
| September | 0.029 | 0.024 | 0.033 | 0.025 | 0.029 | 0.054 | 0.084 | 0.050 | 0.092 | 0.036 | 0.148 |
| Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.108 | 0.163 | 0.082 | 0.011 | 0.081 | 0.174 | 0.158 | 0.119 | 0.353 | 0.049 | 0.091 |
| West/Central | 0.266 | 0.383 | 0.126 | 0.226 | 0.267 | 0.429 | 0.500 | 0.236 | 0.473 | 0.078 | 0.647 |
| East/Central | 0.595 | 0.899 | 0.226 | 0.908 | 0.658 | 1.079 | 0.653 | 0.645 | 0.514 | 0.567 | 0.473 |
| East | 0.266 | 0.406 | 0.541 | 0.220 | 0.330 | 0.808 | 0.674 | 0.494 | 0.339 | 0.251 | 0.453 |
| Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 1.413 | 3.555 | 0.695 | 1.661 | 2.108 | 3.241 | 4.462 | 1.719 | 6.963 | 3.093 | 2.440 |
| May | 0.878 | 1.390 | 0.816 | 1.074 | 0.416 | 2.184 | 1.126 | 1.179 | 1.841 | 0.538 | 0.584 |
| June | 0.608 | 0.867 | 1.228 | 0.617 | 0.329 | 1.518 | 0.579 | 0.615 | 0.161 | 1.039 | 0.118 |
| July | 0.461 | 0.888 | 0.505 | 0.102 | 1.498 | 0.920 | 0.827 | 0.529 | 0.938 | 0.229 | 0.363 |
| August | 0.219 | 0.312 | 0.158 | 0.441 | 0.387 | 0.439 | 0.560 | 0.269 | 0.298 | 0.121 | 0.362 |
| September | 0.048 | 0.041 | 0.056 | 0.035 | 0.056 | 0.108 | 0.146 | 0.120 | 0.167 | 0.122 | 0.293 |
| Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.172 | 0.237 | 0.111 | 0.019 | 0.143 | 0.323 | 0.325 | 0.176 | 1.004 | 0.110 | 0.135 |
| West/Central | 0.567 | 0.955 | 0.268 | 0.413 | 0.539 | 1.131 | 1.224 | 0.744 | 1.047 | 0.277 | 1.115 |
| East/Central | 0.819 | 1.533 | 0.345 | 1.306 | 1.201 | 1.513 | 1.000 | 0.830 | 0.991 | 0.877 | 0.689 |
| East | 0.346 | 0.554 | 0.760 | 0.274 | 0.501 | 1.105 | 1.020 | 0.641 | 0.656 | 0.381 | 0.545 |
| Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 1.053 | 1.556 | 0.754 | 1.650 | 1.174 | 2.128 | 1.698 | 1.492 | 1.231 | 0.805 | 1.047 |
| Catch/Boat Trip | 1.280 | 2.131 | 0.862 | 2.022 | 1.903 | 2.611 | 2.187 | 1.760 | 1.667 | 1.008 | 1.234 |
| Harv/Angler Trip | 0.210 | 0.302 | 0.145 | 0.325 | 0.225 | 0.408 | 0.333 | 0.287 | 0.233 | 0.154 | 0.199 |
| Catch/Angler Trip | 0.256 | 0.414 | 0.165 | 0.398 | 0.365 | 0.500 | 0.429 | 0.338 | 0.316 | 0.193 | 0.235 |
| Harv/Angler Hour | 0.029 | 0.043 | 0.021 | 0.047 | 0.035 | 0.064 | 0.050 | 0.041 | 0.035 | 0.024 | 0.029 |
| Catch/Angler Hr. | 0.035 | 0.059 | 0.024 | 0.057 | 0.057 | 0.079 | 0.065 | 0.049 | 0.047 | 0.030 | 0.034 |
| Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.196 | 0.273 | 0.194 | 0.129 | 0.195 | 0.371 | 0.268 | 0.134 | 0.216 | 0.129 | 0.188 |
| Catch/Boat Trip | 0.325 | 0.542 | 0.332 | 0.253 | 0.377 | 0.678 | 0.582 | 0.297 | 0.710 | 0.299 | 0.340 |
| Harv/Angler Trip | 0.077 | 0.106 | 0.077 | 0.048 | 0.075 | 0.146 | 0.103 | 0.052 | 0.082 | 0.051 | 0.074 |
| Catch/Angler Trip | 0.128 | 0.210 | 0.131 | 0.094 | 0.146 | 0.267 | 0.224 | 0.115 | 0.270 | 0.119 | 0.134 |
| Harv/Angler Hour | 0.014 | 0.021 | 0.015 | 0.008 | 0.015 | 0.027 | 0.020 | 0.009 | 0.015 | 0.009 | 0.013 |
| Catch/Angler Hr. | 0.024 | 0.041 | 0.025 | 0.017 | 0.028 | 0.050 | 0.042 | 0.020 | 0.049 | 0.022 | 0.024 |

***Table A18. Length (inches), weight (lbs), age, and fin clip statistics for brown trout sampled April 15 – September 30 during the 1985-2016 NYSDEC Lake Ontario fishing boat surveys.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **Mean length and weight data for brown trout sampled April 15 - September 30:** | | | | | | | | | | | |
| Mean Length (in) | 20.1 | 20.0 | 20.0 | 19.0 | 20.8 | 20.7 | 20.4 | 21.1 | 20.2 | 20.0 | 19.7 |
| Mean Weight (lbs) | - | 4.62 | 4.59 | 3.70 | 5.39 | 5.30 | 4.92 | 5.87 | 4.48 | 4.21 | 4.25 |
| **Estimated weight (lbs) for standard length brown trout sampled April 15 - September 30:** | | | | | | | | | | | |
| 16.0 inches | - | 2.01 | 2.11 | 1.99 | 2.32 | 2.16 | 1.96 | 2.32 | 1.89 | 1.71 | 1.86 |
| 18.0 inches | - | 2.98 | 3.06 | 2.88 | 3.30 | 3.15 | 2.89 | 3.30 | 2.76 | 2.55 | 2.75 |
| 20.0 inches | - | 4.28 | 4.30 | 4.05 | 4.54 | 4.44 | 4.13 | 4.56 | 3.90 | 3.69 | 3.94 |
| 22.0 inches | - | 5.94 | 5.83 | 5.50 | 6.06 | 6.06 | 5.70 | 6.10 | 5.33 | 5.14 | 5.43 |
| 24.0 inches | - | 8.01 | 7.71 | 7.27 | 7.89 | 8.04 | 7.64 | 7.96 | 7.08 | 6.97 | 7.30 |
| 26.0 inches | - | 10.55 | 9.96 | 9.41 | 10.06 | 10.44 | 10.00 | 10.16 | 9.21 | 9.21 | 9.56 |
| 28.0 inches | - | 13.54 | 12.58 | 11.89 | 12.54 | 13.23 | 12.78 | 12.69 | 11.68 | 11.87 | 12.23 |
| **Percent length composition of brown trout sampled April 15 - September 30:** | | | | | | | | | | | |
| <15.0 in | 1.4% | 0.0% | 0.0% | 0.4% | 0.2% | 0.1% | 0.0% | 0.3% | 1.2% | 0.3% | 0.3% |
| 15.0-15.9 in | 1.9% | 1.7% | 1.3% | 3.3% | 0.2% | 0.1% | 1.7% | 1.7% | 3.5% | 6.3% | 4.7% |
| 16.0-16.9 in | 6.0% | 5.0% | 7.0% | 16.7% | 3.1% | 1.6% | 4.8% | 3.5% | 8.9% | 12.9% | 16.2% |
| 17.0-17.9 in | 12.3% | 11.6% | 11.4% | 21.1% | 8.3% | 7.0% | 17.4% | 8.7% | 16.1% | 17.4% | 17.8% |
| 18.0-18.9 in | 18.2% | 17.5% | 17.8% | 20.7% | 14.0% | 16.6% | 15.7% | 16.7% | 13.2% | 10.8% | 13.1% |
| 19.0-19.9 in | 15.9% | 18.0% | 16.9% | 10.3% | 14.0% | 19.3% | 14.8% | 14.2% | 9.3% | 6.3% | 9.1% |
| 20.0-20.9 in | 12.3% | 17.0% | 14.1% | 8.6% | 18.8% | 16.9% | 10.2% | 10.4% | 9.3% | 6.3% | 8.8% |
| 21.0-21.9 in | 9.3% | 11.0% | 10.8% | 4.4% | 13.3% | 11.4% | 7.6% | 7.6% | 9.5% | 9.1% | 5.4% |
| 22.0-22.9 in | 7.0% | 6.6% | 7.7% | 4.2% | 10.2% | 10.1% | 5.7% | 6.3% | 8.8% | 8.4% | 5.7% |
| 23.0-23.9 in | 4.9% | 4.6% | 3.5% | 3.9% | 7.1% | 6.9% | 6.3% | 9.0% | 6.0% | 8.0% | 6.4% |
| 24.0-24.9 in | 3.7% | 2.9% | 4.2% | 3.3% | 2.4% | 3.9% | 5.9% | 6.9% | 5.6% | 4.9% | 3.7% |
| 25.0-25.9 in | 2.9% | 2.0% | 3.1% | 1.7% | 2.6% | 2.0% | 3.9% | 5.6% | 2.9% | 5.2% | 3.4% |
| 26.0-26.9 in | 2.1% | 1.1% | 2.0% | 0.9% | 3.8% | 2.0% | 1.7% | 4.5% | 2.3% | 2.8% | 1.7% |
| 27.0-27.9 in | 1.0% | 0.5% | 0.2% | 0.4% | 1.0% | 1.0% | 2.0% | 2.8% | 1.6% | 1.0% | 1.0% |
| 28.0-28.9 in | 0.7% | 0.1% | 0.0% | 0.0% | 0.7% | 0.6% | 1.5% | 0.7% | 1.0% | 0.3% | 1.7% |
| >28.9 in | 0.6% | 0.4% | 0.0% | 0.2% | 0.2% | 0.4% | 0.7% | 1.0% | 0.6% | 0.0% | 1.0% |
| **Percent fin clip composition of brown trout sampled April 15 - September 30:** | | | | | | | | | | | |
| No Clips | 74.7% | 86.6% | 88.4% | 81.4% | 87.6% | 88.7% | 92.4% | 91.0% | 88.1% | 91.3% | 89.0% |
| LV | 2.2% | 2.0% | 0.2% | 3.0% | 2.9% | 1.2% | 0.4% | 1.0% | 0.4% | 0.7% | 0.3% |
| LV-Ad | 4.2% | 1.9% | 3.1% | 6.1% | 2.6% | 0.6% | 1.7% | 1.0% | 1.9% | 1.4% | 0.3% |
| LP | 2.9% | 0.3% | 0.0% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| LP-Ad | 4.2% | 2.6% | 1.7% | 1.1% | 2.6% | 4.3% | 2.2% | 2.1% | 1.2% | 2.8% | 6.2% |
| Ad | 1.9% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% | 0.0% | 0.0% |
| RV | 3.9% | 2.8% | 4.8% | 4.4% | 2.1% | 0.6% | 0.7% | 3.5% | 6.2% | 2.1% | 2.1% |
| RV-Ad | 0.4% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.2% | 0.0% | 0.0% |
| RP | 4.3% | 2.0% | 1.4% | 2.6% | 1.0% | 2.6% | 1.5% | 1.0% | 1.4% | 0.3% | 1.4% |
| RP-Ad | 0.0% | 0.0% | 0.0% | 0.2% | 0.0% | 0.1% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Misc. | 1.2% | 1.7% | 0.4% | 0.9% | 1.2% | 1.9% | 1.1% | 0.3% | 0.4% | 1.4% | 0.7% |
| **Percent age composition of brown trout sampled April 15 - September 30:** | | | | | | | | | | | |
| Age-1 | 0.6% | 0.0% | 0.0% | 0.2% | 0.4% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% |
| Age-2 | 76.6% | 85.6% | 78.9% | 80.0% | 80.6% | 78.7% | 74.6% | 60.0% | 62.6% | 58.3% | 73.8% |
| Age-3 | 19.1% | 11.6% | 19.6% | 17.2% | 15.2% | 17.2% | 21.3% | 34.6% | 28.8% | 30.9% | 19.2% |
| Age-4 | 3.1% | 2.2% | 1.0% | 2.4% | 3.4% | 3.9% | 3.3% | 2.7% | 7.8% | 9.2% | 5.8% |
| Age-5+ | 0.7% | 0.5% | 0.5% | 0.2% | 0.4% | 0.3% | 0.7% | 2.6% | 0.8% | 1.6% | 1.2% |
| **Mean length (inches) of aged brown trout sampled in April 15-30:** | | | | | | | | | | | |
| Age-2 | - | 18.4 | 17.7 | 17.4 | 18.2 | 18.6 | 17.9 | 18.0 | 17.4 | 17.0 | 17.3 |
| Age-3 | - | 21.7 | 23.2 | 21.8 | 23.1 | 22.8 | 23.1 | 23.3 | 21.7 | 21.6 | 22.1 |

## *Table A19a. Lake trout harvest and catch data collected April 15 – September 30, 1985-2016.*

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 31,272 | 2,570 | 2,875 | 4,842 | 5,403 | 7,017 | 7,829 | 20,511 | 15,870 | 18,780 | 18,426 |
| Catch | 67,291 | 7,147 | 6,757 | 11,241 | 11,753 | 24,336 | 22,206 | 35,533 | 33,108 | 52,294 | 36,336 |
| % Harvested | 41.4 | 36.0 | 42.5 | 43.1 | 46.0 | 28.8 | 35.3 | 57.7 | 47.9 | 35.9 | 50.7 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 2,761 | 555 | 15 | 388 | 188 | 255 | 1,442 | 1,393 | 757 | 596 | 2,063 |
| May | 6,038 | 345 | 594 | 190 | 2,461 | 840 | 2,311 | 6,311 | 2,207 | 6,148 | 5,228 |
| June | 5,854 | 1,142 | 387 | 501 | 262 | 1,478 | 1,456 | 4,455 | 2,561 | 1,151 | 3,833 |
| July | 9,219 | 122 | 1,229 | 254 | 1,845 | 2,266 | 1,216 | 4,346 | 3,967 | 3,062 | 2,951 |
| August | 6,472 | 390 | 465 | 3,026 | 648 | 1,871 | 899 | 2,066 | 6,230 | 5,718 | 2,036 |
| September | 928 | 15 | 184 | 483 | 0 | 308 | 505 | 1,941 | 148 | 2,105 | 2,314 |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 6,437 | 963 | 602 | 190 | 739 | 1,751 | 1,417 | 1,605 | 1,717 | 3,038 | 2,670 |
| West/Central | 3,438 | 391 | 609 | 1,018 | 885 | 1,358 | 1,491 | 5,327 | 6,099 | 4,038 | 4,040 |
| East/Central | 7,682 | 115 | 209 | 317 | 1,552 | 1,950 | 2,134 | 6,602 | 2,500 | 4,183 | 5,473 |
| East | 13,716 | 1,101 | 1,454 | 3,318 | 2,227 | 1,959 | 2,786 | 6,977 | 5,553 | 7,521 | 6,243 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 6,288 | 765 | 15 | 1,235 | 464 | 885 | 3,823 | 1,955 | 3,728 | 2,214 | 8,084 |
| May | 12,054 | 2,993 | 1,539 | 2,558 | 5,660 | 8,956 | 8,397 | 12,288 | 7,417 | 28,246 | 11,692 |
| June | 12,473 | 1,457 | 927 | 1,395 | 552 | 3,789 | 3,533 | 7,818 | 5,812 | 2,611 | 6,078 |
| July | 20,405 | 371 | 2,276 | 705 | 3,247 | 7,626 | 2,871 | 7,971 | 6,150 | 7,553 | 4,920 |
| August | 14,115 | 1,285 | 1,712 | 4,699 | 1,678 | 2,484 | 2,903 | 3,178 | 9,563 | 8,836 | 2,594 |
| September | 1,956 | 275 | 288 | 649 | 151 | 596 | 679 | 2,323 | 438 | 2,834 | 2,968 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 17,680 | 3,962 | 2,924 | 2,387 | 2,095 | 11,226 | 6,487 | 5,219 | 7,740 | 28,107 | 10,329 |
| West/Central | 8,736 | 1,158 | 1,681 | 3,296 | 3,346 | 3,772 | 3,699 | 9,099 | 10,454 | 6,697 | 7,158 |
| East/Central | 15,800 | 265 | 289 | 1,120 | 3,079 | 6,419 | 6,121 | 11,400 | 4,652 | 6,145 | 9,732 |
| East | 25,075 | 1,763 | 1,864 | 4,438 | 3,233 | 2,920 | 5,899 | 9,815 | 10,262 | 11,345 | 9,116 |
| 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 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| % Catch | 99.5 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 99.7 | 100.0 | 100.0 |
| Percent of seasonal harvest and catch made by charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| % Harvest | 62.0 | 56.7 | 81.3 | 88.7 | 69.6 | 64.9 | 67.2 | 77.9 | 72.5 | 82.0 | 80.0 |
| % Catch | 43.2 | 26.7 | 48.0 | 55.0 | 48.1 | 33.1 | 33.5 | 60.2 | 46.8 | 39.5 | 53.1 |

***Table A19b. Lake trout harvest and catch rate data collected April 15 – September 30, 1985-2016. Table includes estimates for all boats targeting trout and salmon, and charter and non-charter boats targeting trout and salmon.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal rates of harvest and catch for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.259 | 0.045 | 0.056 | 0.078 | 0.108 | 0.142 | 0.170 | 0.432 | 0.321 | 0.407 | 0.475 |
| Catch/Boat Trip | 0.590 | 0.124 | 0.132 | 0.181 | 0.235 | 0.491 | 0.482 | 0.748 | 0.668 | 1.133 | 0.937 |
| Harv/Angler Trip | 0.090 | 0.015 | 0.019 | 0.026 | 0.036 | 0.047 | 0.056 | 0.140 | 0.102 | 0.131 | 0.151 |
| Catch/Angler Trip | 0.204 | 0.042 | 0.044 | 0.059 | 0.077 | 0.165 | 0.160 | 0.242 | 0.212 | 0.366 | 0.298 |
| Harv/Angler Hour | 0.016 | 0.003 | 0.003 | 0.004 | 0.006 | 0.008 | 0.010 | 0.023 | 0.017 | 0.022 | 0.025 |
| Catch/Angler Hr. | 0.035 | 0.007 | 0.008 | 0.010 | 0.014 | 0.029 | 0.028 | 0.040 | 0.036 | 0.062 | 0.049 |
| Monthly harvest rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.228 | 0.185 | 0.005 | 0.107 | 0.072 | 0.101 | 0.609 | 0.541 | 0.394 | 0.265 | 0.645 |
| May | 0.260 | 0.031 | 0.082 | 0.013 | 0.262 | 0.104 | 0.276 | 0.798 | 0.262 | 0.710 | 0.772 |
| June | 0.491 | 0.195 | 0.081 | 0.096 | 0.068 | 0.343 | 0.283 | 0.703 | 0.467 | 0.266 | 1.013 |
| July | 0.557 | 0.012 | 0.133 | 0.029 | 0.200 | 0.208 | 0.131 | 0.450 | 0.449 | 0.376 | 0.351 |
| August | 0.211 | 0.023 | 0.028 | 0.199 | 0.036 | 0.132 | 0.070 | 0.130 | 0.368 | 0.463 | 0.204 |
| September | 0.047 | 0.001 | 0.017 | 0.033 | 0.000 | 0.032 | 0.063 | 0.378 | 0.019 | 0.202 | 0.349 |
| Seasonal harvest rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.193 | 0.060 | 0.048 | 0.010 | 0.052 | 0.119 | 0.112 | 0.117 | 0.142 | 0.268 | 0.241 |
| West/Central | 0.297 | 0.056 | 0.142 | 0.132 | 0.159 | 0.269 | 0.267 | 0.803 | 0.976 | 0.626 | 1.032 |
| East/Central | 0.217 | 0.007 | 0.012 | 0.017 | 0.093 | 0.129 | 0.157 | 0.433 | 0.158 | 0.300 | 0.396 |
| East | 0.367 | 0.061 | 0.084 | 0.200 | 0.165 | 0.134 | 0.196 | 0.584 | 0.364 | 0.522 | 0.626 |
| Monthly catch rates per boat trip for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| April | 0.750 | 0.255 | 0.005 | 0.342 | 0.178 | 0.351 | 1.616 | 0.759 | 1.942 | 0.984 | 2.528 |
| May | 0.568 | 0.272 | 0.212 | 0.174 | 0.602 | 1.113 | 1.001 | 1.553 | 0.871 | 3.263 | 1.725 |
| June | 1.080 | 0.249 | 0.195 | 0.268 | 0.142 | 0.879 | 0.688 | 1.234 | 1.059 | 0.599 | 1.606 |
| July | 1.225 | 0.036 | 0.246 | 0.081 | 0.352 | 0.699 | 0.310 | 0.826 | 0.697 | 0.928 | 0.586 |
| August | 0.467 | 0.077 | 0.104 | 0.309 | 0.093 | 0.176 | 0.225 | 0.200 | 0.565 | 0.716 | 0.259 |
| September | 0.100 | 0.025 | 0.027 | 0.045 | 0.022 | 0.062 | 0.085 | 0.452 | 0.056 | 0.272 | 0.448 |
| Seasonal catch rates per boat trip among geographic areas for boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| West | 0.610 | 0.246 | 0.235 | 0.129 | 0.147 | 0.763 | 0.512 | 0.382 | 0.633 | 2.476 | 0.934 |
| West/Central | 0.795 | 0.166 | 0.392 | 0.427 | 0.600 | 0.747 | 0.662 | 1.372 | 1.673 | 1.039 | 1.829 |
| East/Central | 0.458 | 0.016 | 0.017 | 0.058 | 0.184 | 0.424 | 0.450 | 0.747 | 0.293 | 0.439 | 0.704 |
| East | 0.684 | 0.098 | 0.107 | 0.268 | 0.240 | 0.199 | 0.415 | 0.821 | 0.673 | 0.787 | 0.913 |
| Seasonal rates of harvest and catch for charter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 1.070 | 0.159 | 0.268 | 0.435 | 0.440 | 0.552 | 0.690 | 1.724 | 1.185 | 1.574 | 1.727 |
| Catch/Boat Trip | 1.780 | 0.208 | 0.372 | 0.626 | 0.662 | 0.976 | 0.975 | 2.309 | 1.596 | 2.111 | 2.262 |
| Harv/Angler Trip | 0.218 | 0.031 | 0.051 | 0.086 | 0.084 | 0.106 | 0.135 | 0.331 | 0.224 | 0.302 | 0.329 |
| Catch/Angler Trip | 0.358 | 0.041 | 0.071 | 0.123 | 0.127 | 0.187 | 0.191 | 0.444 | 0.302 | 0.405 | 0.431 |
| Harv/Angler Hour | 0.030 | 0.004 | 0.007 | 0.012 | 0.013 | 0.017 | 0.020 | 0.048 | 0.033 | 0.046 | 0.048 |
| Catch/Angler Hr. | 0.049 | 0.006 | 0.010 | 0.018 | 0.020 | 0.029 | 0.029 | 0.064 | 0.045 | 0.062 | 0.062 |
| Seasonal rates of harvest and catch for noncharter boats seeking any or all species of trout and salmon: | | | | | | | | | | | |
| Harv/Boat Trip | 0.137 | 0.023 | 0.013 | 0.010 | 0.040 | 0.060 | 0.067 | 0.119 | 0.110 | 0.093 | 0.122 |
| Catch/Boat Trip | 0.400 | 0.108 | 0.083 | 0.097 | 0.147 | 0.394 | 0.384 | 0.370 | 0.441 | 0.870 | 0.563 |
| Harv/Angler Trip | 0.053 | 0.009 | 0.005 | 0.004 | 0.015 | 0.024 | 0.026 | 0.046 | 0.042 | 0.037 | 0.048 |
| Catch/Angler Trip | 0.156 | 0.042 | 0.033 | 0.036 | 0.057 | 0.155 | 0.148 | 0.143 | 0.168 | 0.344 | 0.221 |
| Harv/Angler Hour | 0.010 | 0.002 | 0.001 | 0.001 | 0.003 | 0.004 | 0.005 | 0.008 | 0.008 | 0.007 | 0.009 |
| Catch/Angler Hr. | 0.029 | 0.008 | 0.006 | 0.006 | 0.011 | 0.029 | 0.028 | 0.025 | 0.031 | 0.062 | 0.040 |

***Table A20. Length and weight statistics for lake trout sampled April 15 - September 30 during the 1985-2016 NYSDEC Lake Ontario fishing boat surveys.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Mean length and weight of lake trout sampled April - September: | | | | | | | | | | | |
| Mean Length (in) | 25.1 | 26.8 | 26.5 | 25.1 | 23.4 | 25.5 | 26.3 | 25.9 | 27.2 | 27.5 | 27.5 |
| Mean weight (lbs) | - | 8.61 | 8.03 | 6.81 | 5.71 | 7.37 | 8.00 | 7.41 | 8.46 | 8.82 | 8.76 |
| Percent length composition of lake trout sampled April - September: | | | | | | | | | | | |
| <15.0 inches | 0.1% | 0.0% | 0.0% | 0.0% | 0.8% | 0.0% | 0.0% | 0.0% | 0.5% | 0.0% | 0.3% |
| 15-15.9 inches | 0.1% | 0.0% | 0.0% | 0.0% | 0.8% | 0.0% | 0.0% | 0.0% | 0.0% | 0.0% | 0.3% |
| 16-16.9 inches | 0.3% | 1.9% | 0.0% | 1.3% | 1.6% | 0.0% | 0.0% | 0.4% | 0.0% | 1.7% | 0.0% |
| 17-17.9 inches | 1.1% | 1.9% | 0.0% | 0.0% | 4.1% | 0.8% | 0.9% | 2.5% | 0.0% | 2.6% | 1.2% |
| 18-18.9 inches | 1.7% | 1.9% | 0.0% | 3.8% | 7.3% | 2.5% | 3.4% | 2.9% | 0.0% | 2.6% | 1.8% |
| 19-19.9 inches | 3.9% | 3.8% | 2.0% | 10.1% | 2.4% | 4.2% | 1.7% | 2.5% | 1.8% | 0.9% | 2.1% |
| 20-20.9 inches | 5.0% | 5.7% | 0.0% | 7.6% | 10.6% | 4.2% | 2.6% | 3.6% | 0.9% | 0.0% | 2.6% |
| 21-21.9 inches | 8.2% | 5.7% | 6.0% | 3.8% | 13.0% | 6.7% | 6.8% | 4.7% | 1.4% | 0.0% | 5.3% |
| 22-22.9 inches | 10.6% | 3.8% | 14.0% | 3.8% | 9.8% | 7.5% | 4.3% | 4.3% | 5.1% | 3.0% | 5.6% |
| 23-23.9 inches | 13.5% | 3.8% | 14.0% | 3.8% | 14.6% | 10.8% | 3.4% | 6.1% | 4.1% | 3.0% | 2.9% |
| 24-24.9 inches | 14.1% | 5.7% | 6.0% | 10.1% | 4.9% | 8.3% | 6.8% | 8.7% | 8.8% | 5.7% | 1.8% |
| 25-25.9 inches | 9.9% | 3.8% | 6.0% | 11.4% | 3.3% | 15.0% | 14.5% | 10.5% | 11.5% | 8.7% | 5.9% |
| 26-26.9 inches | 5.8% | 3.8% | 6.0% | 5.1% | 5.7% | 7.5% | 11.1% | 8.7% | 13.8% | 9.6% | 7.6% |
| 27-27.9 inches | 2.8% | 9.4% | 10.0% | 17.7% | 1.6% | 11.7% | 15.4% | 15.5% | 10.6% | 13.5% | 13.2% |
| 28-28.9 inches | 2.1% | 13.2% | 12.0% | 8.9% | 7.3% | 1.7% | 5.1% | 10.8% | 12.9% | 9.6% | 9.7% |
| 29-29.9 inches | 3.6% | 11.3% | 6.0% | 1.3% | 4.1% | 2.5% | 4.3% | 7.9% | 11.1% | 14.3% | 10.0% |
| 30-30.9 inches | 5.9% | 9.4% | 4.0% | 3.8% | 4.1% | 4.2% | 7.7% | 4.7% | 7.8% | 9.1% | 11.1% |
| 31-31.9 inches | 4.9% | 7.5% | 0.0% | 2.5% | 1.6% | 3.3% | 7.7% | 1.8% | 3.7% | 6.5% | 5.3% |
| 32-32.9 inches | 2.6% | 0.0% | 6.0% | 3.8% | 2.4% | 5.0% | 0.9% | 2.2% | 1.4% | 2.2% | 4.4% |
| 33-33.9 inches | 2.2% | 0.0% | 4.0% | 1.3% | 0.0% | 1.7% | 0.0% | 1.1% | 2.8% | 3.9% | 3.2% |
| 34-34.9 inches | 1.3% | 1.9% | 2.0% | 0.0% | 0.0% | 1.7% | 2.6% | 1.1% | 1.4% | 0.9% | 4.1% |
| >34.9 inches | 0.5% | 5.7% | 2.0% | 0.0% | 0.0% | 0.8% | 0.9% | 0.0% | 0.5% | 2.2% | 1.8% |
| 30.0+ inches | 17.3% | 24.5% | 18.0% | 11.4% | 8.1% | 16.7% | 19.7% | 10.8% | 17.5% | 24.8% | 29.9% |
| 25.0-29.9 inches | 24.1% | 41.5% | 40.0% | 44.3% | 22.0% | 38.3% | 50.4% | 53.4% | 59.9% | 55.7% | 46.3% |

***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, 1985-2016.*

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 48,557 | 19,058 | 11,104 | 6,833 | 4,892 | 6,442 | 5,683 | 7,536 | 12,538 | 2,942 | 3,701 |
| Catch | 247,759 | 78,661 | 50,727 | 30,494 | 18,048 | 25,795 | 24,032 | 21,446 | 31,807 | 16,821 | 26,719 |
| % Harvested | 20.8 | 24.2 | 21.9 | 22.4 | 27.1 | 25.0 | 23.6 | 35.1 | 39.4 | 17.5 | 13.9 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 3 | 0 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| May | 55 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| June | 8,083 | 2,651 | 4,721 | 1,565 | 1,258 | 268 | 1,178 | 1,073 | 6,740 | 0 | 520 |
| July | 14,350 | 7,280 | 2,084 | 647 | 1,643 | 668 | 2,702 | 3,846 | 2,520 | 1,306 | 1,164 |
| August | 17,010 | 5,987 | 2,687 | 1,695 | 1,727 | 3,331 | 1,377 | 853 | 2,928 | 738 | 797 |
| September | 9,057 | 3,139 | 1,612 | 2,923 | 265 | 2,176 | 426 | 1,764 | 350 | 899 | 1,220 |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 3,582 | 1,048 | 882 | 163 | 182 | 254 | 800 | 556 | 208 | 118 | - |
| West/Central | 3,318 | 626 | 376 | 108 | 43 | 261 | 36 | 48 | 176 | - | - |
| East/Central | 24,793 | 9,579 | 3,522 | 3,250 | 1,785 | 700 | 1,940 | 1,214 | 589 | 1,078 | 978 |
| East | 16,865 | 7,805 | 6,324 | 3,312 | 2,882 | 5,227 | 2,907 | 5,718 | 11,566 | 1,746 | 2,723 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 535 | 91 | 979 | 240 | 136 | 22 | 82 | 438 | 480 | 60 | 781 |
| May | 6,316 | 915 | 1,180 | 1,264 | 483 | 1,299 | 1,558 | 350 | 364 | 1,564 | 1,470 |
| June | 32,182 | 15,557 | 16,685 | 5,734 | 2,159 | 1,604 | 4,987 | 2,859 | 12,380 | 2,296 | 6,792 |
| July | 78,560 | 19,726 | 12,168 | 3,983 | 4,437 | 8,026 | 9,561 | 10,239 | 7,057 | 4,831 | 4,720 |
| August | 88,753 | 32,958 | 13,757 | 11,115 | 8,571 | 10,407 | 5,611 | 2,732 | 8,957 | 5,187 | 7,691 |
| September | 41,413 | 9,414 | 5,958 | 8,159 | 2,263 | 4,437 | 2,234 | 4,829 | 2,570 | 2,884 | 5,266 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 22,823 | 6,354 | 6,400 | 1,610 | 2,565 | 2,459 | 5,768 | 3,009 | 4,818 | 3,059 | 2,744 |
| West/Central | 36,196 | 10,043 | 2,140 | 2,143 | 384 | 799 | 1,048 | 634 | 672 | 1,013 | 253 |
| East/Central | 125,007 | 42,400 | 22,653 | 15,862 | 9,462 | 5,830 | 6,648 | 5,916 | 4,088 | 7,265 | 12,720 |
| East | 63,733 | 19,864 | 19,534 | 10,878 | 5,638 | 16,706 | 10,567 | 11,888 | 22,229 | 5,484 | 11,002 |
| Percent of seasonal harvest and catch made by boats seeking smallmouth bass during the **traditional open season**: | | | | | | | | | | | |
| % Harvest | 92.5 | 92.8 | 87.6 | 69.0 | 83.8 | 96.4 | 88.5 | 94.5 | 98.4 | 99.2 | 96.7 |
| % Catch | 87.7 | 79.7 | 77.7 | 58.2 | 62.6 | 78.1 | 85.9 | 86.4 | 91.8 | 82.4 | 78.6 |
| Estimates of catch by boats seeking smallmouth bass during the **catch and release season**: | | | | | | | | | | | |
| April | - | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| May | - | 0.0 | 196 | 422 | 28 | 0 | 196 | 0 | 0 | 1116 | 1293 |
| June | - | 3482.0 | 88 | 24 | 55 | 502 | 24 | 146 | 195 | 48 | 1571 |
| Total | - | 3482 | 284 | 446 | 83 | 502 | 220 | 146 | 195 | 1164 | 2864 |
| Percent of seasonal catch made by boats seeking smallmouth bass during the **catch and release season**: | | | | | | | | | | | |
| % Catch | - | 0.044266 | 0.6% | 1.5% | 0.5% | 1.9% | 0.9% | 0.7% | 0.6% | 6.9% | 10.7% |

***Table A21b. Smallmouth bass harvest and catch rate data collected April 15 – September 30, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal rates of harvest and catch for boats seeking smallmouth bass during the **traditional open season**: | | | | | | | | | | | |
| Harv/Boat Trip | 1.978 | 1.219 | 0.760 | 0.544 | 0.700 | 0.992 | 0.811 | 1.667 | 1.794 | 0.599 | 0.676 |
| Catch/Boat Trip | 9.390 | 4.323 | 3.082 | 2.047 | 1.928 | 3.219 | 3.327 | 4.337 | 4.244 | 2.847 | 3.969 |
| Harv/Angler Trip | 0.859 | 0.534 | 0.341 | 0.250 | 0.339 | 0.451 | 0.372 | 0.784 | 0.868 | 0.295 | 0.300 |
| Catch/Angler Trip | 4.102 | 1.893 | 1.380 | 0.939 | 0.933 | 1.464 | 1.528 | 2.040 | 2.052 | 1.400 | 1.759 |
| Harv/Angler Hour | 0.255 | 0.171 | 0.117 | 0.097 | 0.126 | 0.145 | 0.120 | 0.226 | 0.242 | 0.104 | 0.096 |
| Catch/Angler Hr. | 1.221 | 0.606 | 0.472 | 0.363 | 0.346 | 0.471 | 0.492 | 0.587 | 0.572 | 0.493 | 0.565 |
| Monthly harvest rates per boat trip for boats seeking smallmouth bass during the **traditional open season**: | | | | | | | | | | | |
| April & May | - | - | - | - | - | - | - | - | - | - | - |
| June | 1.798 | 0.885 | 1.807 | 0.877 | 1.948 | 0.259 | 0.701 | 1.188 | 3.514 | 0.000 | 0.548 |
| July | 1.677 | 1.460 | 0.401 | 0.125 | 0.694 | 0.225 | 0.943 | 2.716 | 1.355 | 0.550 | 0.748 |
| August | 2.254 | 1.152 | 0.702 | 0.399 | 0.498 | 1.886 | 0.829 | 0.823 | 1.256 | 0.621 | 0.385 |
| September | 2.226 | 1.283 | 0.530 | 1.070 | 0.305 | 2.353 | 0.585 | 1.384 | 0.384 | 1.122 | 1.268 |
| Seasonal harvest rates per boat trip among geographic areas for boats seeking smallmouth bass during the **traditional open season**: | | | | | | | | | | | |
| West | 1.178 | 0.521 | 0.783 | 0.118 | 0.169 | 0.312 | 0.605 | 1.577 | 0.126 | 0.150 | 0.000 |
| West/Central | 0.842 | 0.238 | 0.107 | 0.074 | 0.065 | 0.333 | 0.000 | 0.085 | 0.289 | 0.000 | 0.000 |
| East/Central | 2.088 | 1.306 | 0.538 | 0.584 | 0.388 | 0.209 | 0.720 | 0.991 | 0.280 | 0.472 | 0.330 |
| East | 2.724 | 2.055 | 1.470 | 1.053 | 2.013 | 2.761 | 1.449 | 2.454 | 3.421 | 1.186 | 1.267 |
| Monthly catch rates per boat trip for boats seeking smallmouth bass during the **traditional open season**: | | | | | | | | | | | |
| April & May | - | - | - | - | - | - | - | - | - | - | - |
| June | 6.049 | 2.514 | 6.279 | 2.796 | 2.907 | 0.612 | 2.940 | 2.256 | 6.299 | 3.368 | 5.489 |
| July | 8.966 | 3.690 | 2.148 | 0.932 | 1.581 | 2.871 | 3.766 | 7.177 | 3.292 | 2.017 | 3.095 |
| August | 11.289 | 6.358 | 2.628 | 2.236 | 2.058 | 4.803 | 3.210 | 2.326 | 3.808 | 3.958 | 3.397 |
| September | 9.787 | 3.606 | 2.473 | 2.701 | 1.779 | 3.944 | 3.016 | 3.759 | 2.881 | 3.360 | 5.048 |
| Seasonal catch rates per boat trip among geographic areas for boats seeking smallmouth bass during the **traditional open season**: | | | | | | | | | | | |
| West | 6.622 | 2.758 | 5.000 | 0.796 | 1.605 | 1.450 | 5.397 | 6.534 | 3.585 | 3.227 | 0.897 |
| West/Central | 7.973 | 2.292 | 0.732 | 1.031 | 0.514 | 0.739 | 0.534 | 1.043 | 0.775 | 0.122 | 1.833 |
| East/Central | 10.053 | 5.434 | 2.881 | 2.499 | 1.545 | 1.103 | 2.086 | 4.285 | 1.661 | 2.807 | 4.119 |
| East | 9.781 | 4.428 | 4.329 | 2.748 | 3.585 | 8.264 | 5.204 | 4.862 | 6.468 | 3.384 | 4.294 |
| 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 | 0.764 | 0.661 | 7.098 | 8.045 |
| Catch/Angler Trip | - | 3.831 | 0.402 | 0.417 | 0.153 | 1.887 | 0.170 | 0.327 | 0.293 | 3.660 | 3.788 |
| Catch/Angler Hr. | - | 1.625 | 0.151 | 0.181 | 0.099 | 1.035 | 0.072 | 0.188 | 0.124 | 1.257 | 0.867 |
| Monthly catch rates per boat trip for boats seeking smallmouth bass during the **catch and release season**: | | | | | | | | | | | |
| April | - | - | - | - | - | - | - | - | - | - | - |
| May | - | 0.000 | 4.558 | 1.323 | 0.118 | 0.000 | 0.590 | 0.000 | 0.000 | 10.731 | 13.061 |
| June | - | 9.949 | 0.272 | 0.074 | 1.000 | 2.523 | 0.127 | 1.390 | 0.878 | 0.800 | 6.113 |

***Table A22. Yellow perch harvest and catch data collected April 15 – September 30, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 8,756 | 25,630 | 33,589 | 51,653 | 18,405 | 31,830 | 16,701 | 6,572 | 6,066 | 6,960 | 10,483 |
| Catch | 19,198 | 87,736 | 67,342 | 102,442 | 61,816 | 65,394 | 35,836 | 15,345 | 17,966 | 17,384 | 18,176 |
| % Harvested | 53.0 | 29.2 | 49.9 | 50.4 | 29.8 | 48.7 | 46.6 | 42.8 | 33.8 | 40.0 | 57.7 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 9 | 0 | 29 | 0 | 1,198 | 0 | 2,653 | 972 | 0 | 0 | 0 |
| May | 972 | 1,220 | 1,357 | 0 | 7,656 | 112 | 4,203 | 2,016 | 0 | 0 | 25 |
| June | 1,698 | 7,566 | 10,349 | 34,963 | 3,665 | 2,194 | 6,116 | 973 | 0 | 24 | 1,150 |
| July | 1,970 | 5,039 | 3,612 | 2,810 | 1,906 | 5,637 | 1,913 | 304 | 2,453 | 6,042 | 7,062 |
| August | 1,623 | 5,149 | 6,114 | 7,816 | 3,648 | 16,979 | 1,755 | 2,040 | 3,535 | 12 | 40 |
| September | 2,485 | 6,656 | 12,128 | 6,064 | 332 | 6,908 | 61 | 267 | 78 | 882 | 2,205 |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 2,021 | 15 | 61 | 0 | 468 | 0 | 14 | 0 | 0 | 0 | 0 |
| West/Central | 890 | 908 | 3,824 | 1,035 | 1,080 | 30 | 2,816 | 1,136 | 0 | 759 | 2,014 |
| East/Central | 4,288 | 24,252 | 26,845 | 19,372 | 9,762 | 22,363 | 7,814 | 4,227 | 3,050 | 6,104 | 8,411 |
| East | 1,557 | 454 | 2,858 | 31,246 | 7,094 | 9,438 | 6,057 | 1,209 | 3,016 | 97 | 58 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 53 | 0 | 69 | 143 | 1,962 | 0 | 5,293 | 2,172 | 0 | 0 | 0 |
| May | 1,724 | 5,980 | 3,443 | 95 | 37,864 | 112 | 10,211 | 4,420 | 0 | 0 | 476 |
| June | 4,368 | 17,363 | 25,153 | 52,025 | 5,287 | 5,055 | 13,440 | 1,921 | 1,800 | 264 | 2,115 |
| July | 4,294 | 16,158 | 8,637 | 10,792 | 4,371 | 14,419 | 2,508 | 923 | 7,691 | 13,740 | 9,766 |
| August | 3,832 | 18,513 | 10,494 | 23,739 | 11,735 | 29,676 | 4,298 | 5,642 | 8,241 | 781 | 511 |
| September | 4,927 | 29,722 | 19,545 | 15,648 | 596 | 16,132 | 86 | 267 | 234 | 2,599 | 5,307 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 2,778 | 1,405 | 77 | 2,444 | 906 | 0 | 49 | 0 | 0 | 0 | 0 |
| West/Central | 1,957 | 2,878 | 5,999 | 1,749 | 2,026 | 193 | 4,384 | 3,890 | 45 | 2,411 | 5,399 |
| East/Central | 11,227 | 78,438 | 51,333 | 58,517 | 40,091 | 50,878 | 20,510 | 9,527 | 10,439 | 14,131 | 12,303 |
| East | 3,236 | 5,016 | 9,933 | 39,732 | 18,793 | 14,323 | 10,893 | 1,928 | 7,482 | 842 | 474 |

***Table A23. Walleye harvest and catch data collected April 15 – September 30, 1985-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1985-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Seasonal (5½ month) estimates of harvest and catch for all fishing boats: | | | | | | | | | | | |
| Harvest | 649 | 1,403 | 116 | 123 | 106 | 458 | 130 | 318 | 182 | 350 | 349 |
| Catch | 795 | 4,508 | 130 | 147 | 301 | 531 | 130 | 388 | 421 | 446 | 671 |
| % Harvested | 73.5 | 31.1 | 89.2 | 83.7 | 35.2 | 86.3 | 100.0 | 82.0 | 43.2 | 78.5 | 52.0 |
| Monthly estimates of harvest for all fishing boats: | | | | | | | | | | | |
| April | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| May | 103 | 0 | 28 | 14 | 0 | 16 | 50 | 0 | 50 | 26 | 63 |
| June | 55 | 1,112 | 32 | 0 | 0 | 26 | 0 | 23 | 12 | 0 | 0 |
| July | 47 | 114 | 28 | 0 | 0 | 88 | 80 | 0 | 0 | 0 | 0 |
| August | 347 | 77 | 28 | 109 | 44 | 160 | 0 | 27 | 120 | 252 | 286 |
| September | 97 | 101 | 0 | 0 | 62 | 168 | 0 | 267 | 0 | 72 | 0 |
| Seasonal estimates of harvest among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 57 | 187 | 29 | 44 | 106 | 86 | 84 | 0 | 92 | 246 | 247 |
| West/Central | 2 | 45 | 32 | 0 | 0 | 0 | 22 | 21 | 0 | 0 | 0 |
| East/Central | 55 | 34 | 56 | 14 | 0 | 0 | 0 | 0 | 40 | 0 | 12 |
| East | 535 | 1137 | 0 | 66 | 0 | 372 | 24 | 297 | 50 | 104 | 91 |
| Monthly estimates of catch for all fishing boats: | | | | | | | | | | | |
| April | 13 | 0 | 0 | 10 | 0 | 15 | 0 | 0 | 0 | 12 | 0 |
| May | 130 | 0 | 28 | 28 | 0 | 16 | 50 | 0 | 50 | 26 | 63 |
| June | 64 | 3,991 | 32 | 0 | 0 | 26 | 0 | 23 | 12 | 0 | 0 |
| July | 82 | 142 | 28 | 0 | 0 | 147 | 80 | 70 | 0 | 0 | 0 |
| August | 397 | 199 | 42 | 109 | 213 | 160 | 0 | 27 | 338 | 336 | 608 |
| September | 108 | 176 | 0 | 0 | 87 | 168 | 0 | 267 | 22 | 72 | 0 |
| Seasonal estimates of catch among geographic areas for all fishing boats: | | | | | | | | | | | |
| West | 100 | 413 | 43 | 47 | 180 | 142 | 84 | 59 | 163 | 327 | 572 |
| West/Central | 3 | 62 | 32 | 0 | 0 | 0 | 22 | 22 | 165 | 0 | 0 |
| East/Central | 85 | 66 | 55 | 29 | 0 | 20 | 0 | 0 | 41 | 0 | 11 |
| East | 607 | 3967 | 0 | 71 | 121 | 369 | 24 | 306 | 51 | 119 | 88 |

***Table A24. Estimates of sea and silver lampreys observed by boat anglers April 15 – September 30, 1986-2016.***

| | Year Surveyed | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1986-06 avg | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| **April 15 - September 30 estimated numbers of lamprey observed:** | | | | | | | | | | | |
| April | 216 | 564 | 87 | 218 | 429 | 558 | 575 | 68 | 100 | 118 | 199 |
| May | 640 | 2,117 | 688 | 1,769 | 551 | 1,618 | 1,266 | 835 | 595 | 775 | 363 |
| June | 332 | 1,059 | 296 | 150 | 372 | 769 | 294 | 353 | 384 | 212 | 92 |
| July | 396 | 2,147 | 390 | 1,358 | 486 | 1,155 | 460 | 789 | 567 | 460 | 730 |
| August | 603 | 2,009 | 954 | 1,142 | 697 | 842 | 707 | 829 | 951 | 767 | 199 |
| September | 185 | 528 | 399 | 526 | 64 | 184 | 138 | 53 | 401 | 63 | 97 |
| Total | 2,372 | 8,423 | 2,814 | 5,164 | 2,599 | 5,125 | 3,441 | 2,927 | 2,998 | 2,375 | 1,680 |
| **April 15 - September 30 estimated numbers of lamprey observed among four geographic areas:** | | | | | | | | | | | |
| West | 951 | 2830 | 1194 | 2026 | 946 | 1163 | 1,147 | 969 | 894 | 1,251 | 766 |
| West/Central | 298 | 713 | 18 | 540 | 338 | 565 | 609 | 396 | 308 | 267 | 49 |
| East/Central | 642 | 3051 | 845 | 2126 | 799 | 1812 | 1,007 | 1,242 | 976 | 510 | 728 |
| East | 482 | 1829 | 757 | 472 | 516 | 1585 | 678 | 320 | 819 | 347 | 137 |
| **Percentage of lamprey observed that were attached to angler caught trout and salmon:** | | | | | | | | | | | |
| Percent | 99.1% | 98.5% | 98.3% | 97.0% | 98.9% | 96.8% | 97.9% | 98.4% | 98.3% | 99.1% | 96.6% |
| **April 15 - September 30 estimated number of lamprey attached to angler caught trout & salmon, per 1000 trout & salmon caught:** | | | | | | | | | | | |
| April | 10.98 | 39.57 | 23.32 | 19.36 | 48.73 | 45.60 | 29.72 | 9.28 | 5.16 | 11.35 | 12.18 |
| May | 14.12 | 41.48 | 27.82 | 23.08 | 26.78 | 45.50 | 34.03 | 22.70 | 12.93 | 13.55 | 14.48 |
| June | 13.74 | 50.56 | 23.58 | 12.67 | 19.85 | 34.61 | 12.13 | 17.58 | 13.31 | 16.06 | 5.98 |
| July | 13.07 | 58.84 | 16.74 | 38.27 | 10.50 | 14.04 | 10.83 | 19.18 | 16.88 | 19.18 | 17.64 |
| August | 11.56 | 42.18 | 22.87 | 20.45 | 11.08 | 16.68 | 12.63 | 15.41 | 16.91 | 22.21 | 7.51 |
| September | 9.03 | 26.98 | 20.28 | 16.30 | 6.34 | 9.57 | 7.95 | 5.46 | 24.00 | 4.17 | 7.16 |
| Total | 12.53 | 44.35 | 22.39 | 23.12 | 15.53 | 23.09 | 17.50 | 17.34 | 14.93 | 15.38 | 12.15 |
| **April - Sept. estimated number of lamprey attached to angler caught trout & salmon by geographic area, per 1000 trout & salmon caught:** | | | | | | | | | | | |
| West | 13.52 | 36.66 | 20.78 | 19.49 | 13.13 | 12.43 | 15.56 | 14.25 | 13.41 | 17.85 | 13.41 |
| West/Central | 12.15 | 34.61 | 2.32 | 17.93 | 15.27 | 25.57 | 23.22 | 15.01 | 8.72 | 14.38 | 3.13 |
| East/Central | 12.14 | 53.11 | 27.19 | 34.19 | 15.44 | 26.87 | 20.53 | 25.33 | 16.10 | 13.04 | 16.90 |
| East | 12.04 | 52.75 | 25.75 | 17.46 | 24.03 | 40.76 | 14.24 | 12.58 | 21.47 | 13.03 | 6.11 |
| **April 15 - September 30 percent composition of host species to which the lampreys were attached:** | | | | | | | | | | | |
| Coho Salmon | 2.4% | 3.4% | 4.3% | 2.6% | 3.2% | 3.4% | 2.9% | 1.6% | 2.6% | 0.0% | 0.0% |
| Chinook Salmon | 39.8% | 58.6% | 64.3% | 73.1% | 51.6% | 37.4% | 60.0% | 68.8% | 58.1% | 64.8% | 60.7% |
| Rainbow Trout | 7.1% | 5.6% | 10.4% | 10.9% | 14.0% | 5.6% | 8.6% | 5.6% | 18.8% | 10.2% | 7.1% |
| Atlantic Salmon | 0.6% | 0.0% | 0.0% | 0.0% | 3.2% | 0.0% | 2.1% | 0.0% | 0.0% | 0.0% | 1.2% |
| Brown Trout | 16.9% | 31.7% | 20.0% | 13.5% | 26.9% | 47.5% | 22.1% | 13.6% | 17.9% | 12.0% | 19.0% |
| Lake Trout | 33.1% | 0.7% | 0.9% | 0.0% | 1.1% | 6.1% | 4.3% | 10.4% | 2.6% | 13.0% | 11.9% |
| **April 15 - September 30 percent of total host-specific angler catch with attached lampreys:** | | | | | | | | | | | |
| Coho Salmon | 0.6% | 1.1% | 1.8% | 0.6% | 0.6% | 1.4% | 0.8% | 0.6% | 0.9% | 0.0% | 0.0% |
| Chinook Salmon | 1.5% | 5.7% | 3.1% | 3.5% | 2.1% | 1.9% | 2.3% | 3.1% | 2.2% | 2.6% | 1.6% |
| Rainbow Trout | 0.8% | 1.8% | 0.8% | 1.0% | 0.8% | 0.8% | 0.9% | 0.5% | 1.5% | 1.4% | 0.7% |
| Atlantic Salmon | 4.7% | 0.0% | 0.0% | 0.0% | 4.5% | 0.0% | 12.2% | 0.0% | 0.0% | 0.0% | 2.7% |
| Brown Trout | 1.2% | 5.6% | 2.4% | 2.0% | 2.1% | 4.7% | 1.9% | 1.4% | 1.2% | 1.4% | 1.4% |
| Lake Trout | 1.2% | 0.9% | 0.3% | 0.0% | 0.2% | 1.3% | 0.7% | 0.8% | 0.2% | 0.6% | 0.5% |

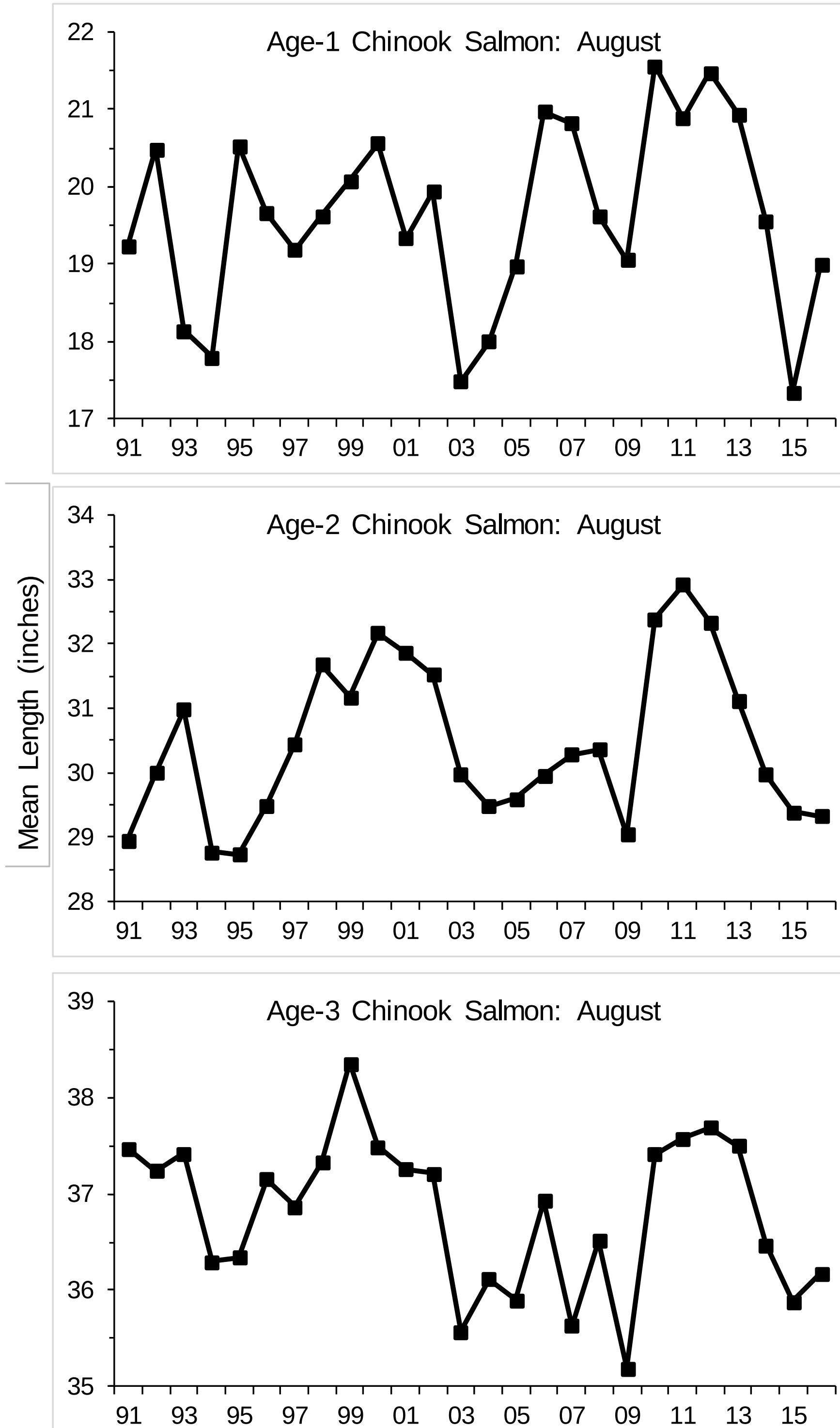


***Figure A1. Mean length (total length in inches) of age-1, age-2, and age-3 Chinook salmon sampled in August during the 1991-2016 NYSDEC Lake Ontario fishing boat surveys.***

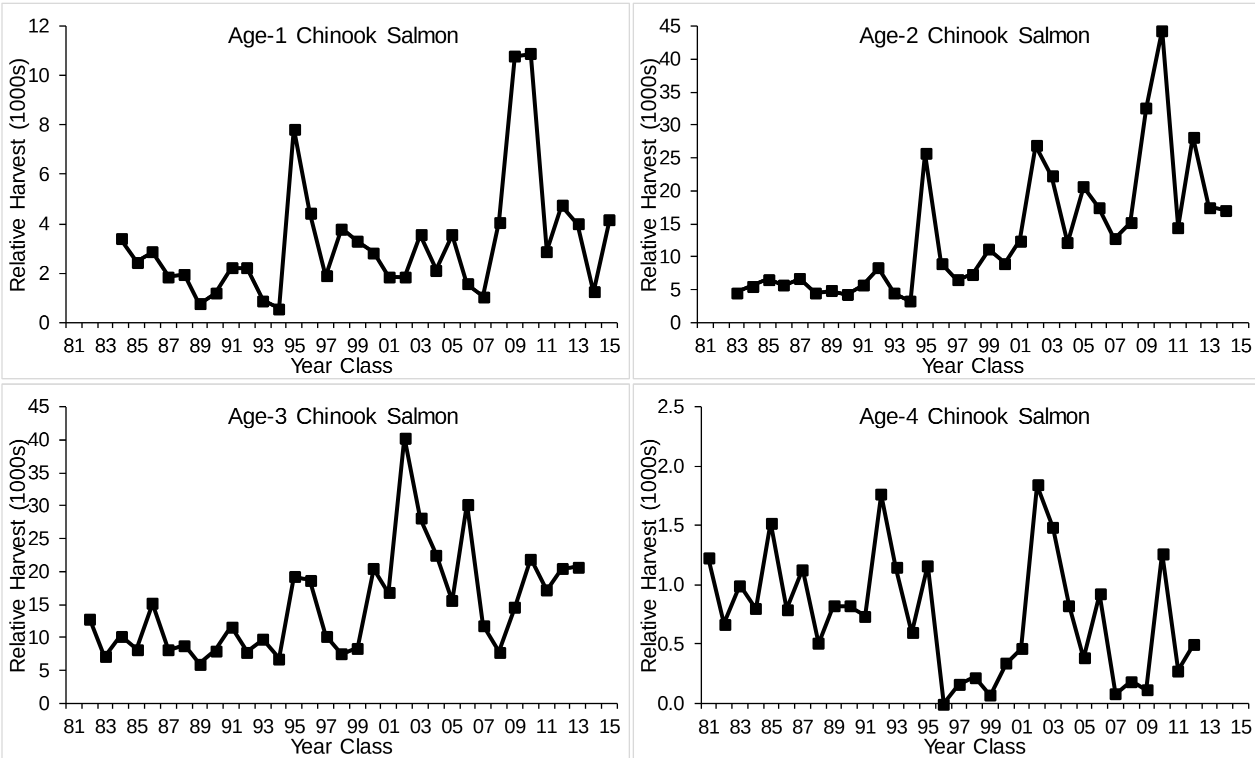


***Figure A2. Relative harvest (age-specific harvest per 50,000 fishing boat trips, per 2,000,000 fingerling equivalents stocked) of age-1, age-2, age-3, and age-4 Chinook salmon from the 1985-2016 NYSDEC Lake Ontario fishing boat surveys.***

## Relative Survival and Tributary Returns of Pen and Direct-stocked 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 (NYSDEC) and the Ontario Ministry of Natural Resources and Forestry (OMNRF) stock 2.3 million Chinook salmon into Lake Ontario at dozens of sites around the lake. An unknown number of wild Chinook salmon smolts are also produced in tributaries from natural spawning, and it was unknown how many of these wild fish survive and contribute to the sportfishery (Everitt 2006, Bishop et al. 2017). Recent mass marking studies conducted from 2008-2015 in Lake Ontario (Connerton et al. 2016) have determined that wild Chinook salmon makeup an important component of the lake and tributary Chinook fisheries.

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 and later "home to" their 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.

NYSDEC must also maintain a sufficient number of spawners returning to the SRH so that egg collection and stocking targets can be sustained. NYSDEC stocks approximately 350,000 Chinook salmon at the Salmon River annually to provide a fishery there and 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 these 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 was previously unknown. Recent mass marking studies by NYSDEC estimated that straying from NY stocking sites to the SRH averaged around 10% for the 2008-2010 stockings (Connerton et al 2016). These results necessarily assumed equal survival and straying among all stocking sites, which is probably not the case. More research is needed to determine the relative survival or straying of individual stocking sites or stocking strategies.

One strategy used by NYSDEC since 1998 to increase imprinting and survival of stocked fish is pen stocking, a technique in which small Chinook salmon (120 fish/lb, ~3.5 g) are transported from the hatchery to net pens at sites around the lake, and raised for about 3 weeks until they reach a target size (i.e., 90 fish/lb, ~5 g). Chinook salmon pen projects exist at eight sites in New York (Figure 1) at which volunteers feed and care for the fish during the pen holding period (Sanderson et al. 2016). Chinook salmon raised in net pens are typically released at sizes larger than salmon stocked directly from the hatchery on about the same date

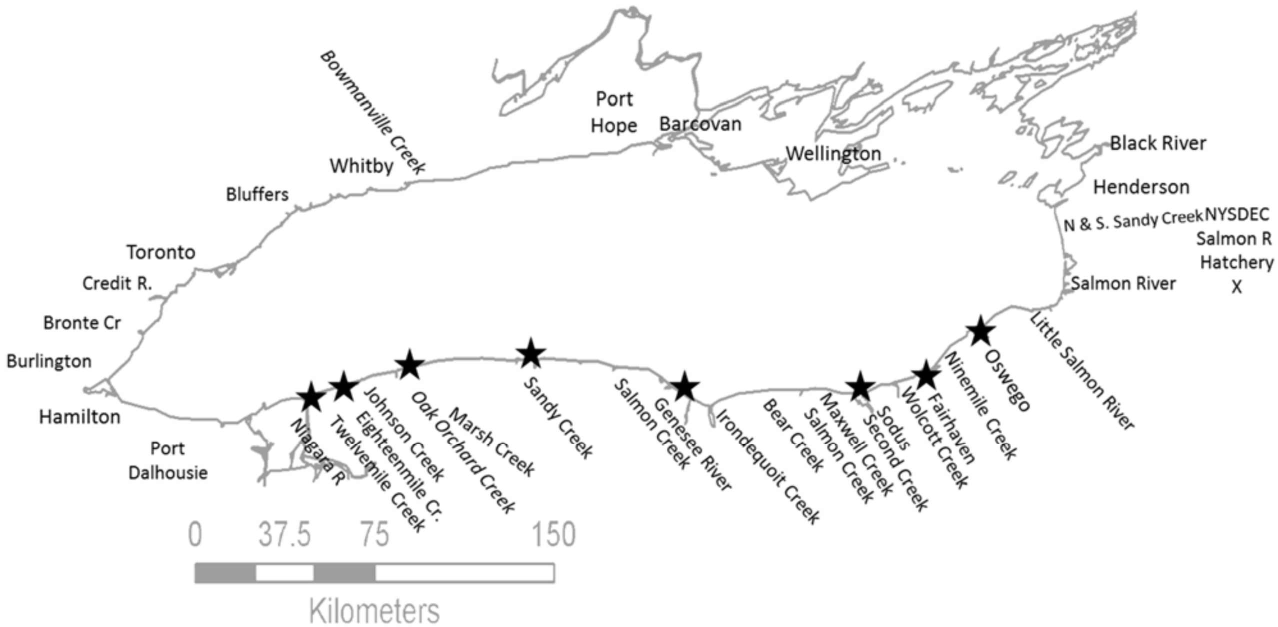


***Figure 1. Map of Lake Ontario showing sampling regions and other locations in this report. Sites where Chinook salmon were raised in pens are noted with stars.***

because temperatures and densities in pens are better for growth. Pen-raised salmon also become better acclimated to environmental conditions at stocking sites and are assumed to exhibit higher survival and better imprinting to the stocking site. Evaluations of pen stocked Chinook salmon in New York were conducted at Oak Orchard and Niagara from 1999-2002 and showed pen fish returned significantly better than direct-stocked fish at Oak Orchard, but not at Niagara (Bishop et al. 2006). The experimental design of that study was somewhat restricted because fish were manually fin clipped for stocking at only one of the two sites for each year class (YC) studied (1999 and 2001 YCs at Oak Orchard, 2000 and 2002 YCs at Niagara River), prohibiting comparisons between sites for the same YC. Furthermore, salmon were only recovered at Oak Orchard Creek and the Niagara River, so relative contributions to the lake fishery (i.e. relative survival of pen and shore stocked fish) were not determined. It was unknown whether returns to the tributaries were due to higher survival or better imprinting, or both. This study is the first comprehensive evaluation of New York's eight pen projects.

In 2008, NYSDEC purchased an automated fish-marking trailer (AutoFish) from Northwest Marine Technology Incorporated. The AutoFish system is capable of clipping the adipose (AD) fin 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"). Mass marking allows agencies to mark millions of salmon and trout, enabling the execution of studies that were previously not feasible. Previous reports summarized mass marking studies which determined the proportions of wild Chinook salmon to Lake Ontario's open-lake and tributary fisheries for the 2008-2011 year classes, and estimated the degree of homing by fish stocked at the Salmon River and straying to the Salmon River by hatchery fish stocked at other sites (Connerton et al. 2016).

This report evaluates the outcomes of pen stocking for increasing survival and imprinting to stocking sites. Our objectives were: 1) to compare the relative contributions of pen vs. direct-stocked Chinook salmon to the lake fishery (as a measure of survival); and 2) to compare the relative returns of pen and direct-stocked Chinook salmon to tributary fisheries (i.e., as a measure of imprinting). Although not a primary objective, we also determined the stocking origin of fish harvested during the lake and tributary seasons at individual stocking sites to understand Chinook movement in the lake and homing and straying to stocking sites.

## Methods

Mass Marking

Mass marking of Lake Ontario Chinook salmon was conducted from 2008-2013 (Table 1) by NYSDEC and OMNRF for various studies summarized previously (Connerton et al. 2016, OMNRF 2015).

To meet pen study objectives, salmon were AD clipped and tagged with unique CWTs at each of eight pen and direct-stocked sites (16 total) in 2010, 2011, and 2013 (Table 2). Marking and tagging of pen and direct-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. In 2013, temperatures at the Sandy Creek pen site were too warm so fish were not stocked into pens and no fish were clipped or tagged for this site (Table 1). At Oswego in 2013, AD-CWT fish in pens were released three days after being stocked into pens because of warm temperatures. Approximate numbers of marked fish for this study are provided in Table 2, but actual stocking numbers varied slightly and these numbers are provided in Connerton (2011, 2012, and 2014).

Different sites have different numbers of salmon allocated to pen and direct stocking, and different numbers of pens. NYSDEC regional managers established allocations at sites years prior to conducting the study. Allocations depended on the site conditions, the size of local fisheries, and abilities of volunteers to care for fish and pens. In the hatchery, Chinook parr were normally held at 37,500 fish per raceway tank which also constrained our study design somewhat. We designed the study so that the initial numbers of marked fish between treatments were approximately 1:1 to minimize recapture sample size requirements (Elrod and Frank 1990), and to maintain consistency with usual hatchery practices and stocking allocations.

We also planned for adequate numbers of marked fish to maximize the chances of recapturing enough fish to detect at least a 20% difference (if one exists) between treatments at $\alpha$=0.05 with a power of at least 80%. This threshold and confidence level was set after consultation with fisheries managers who decided that 20% poorer performance of pen-reared fish would warrant discontinuation of a pen project.

***Table 1. Numbers (1000s) of mass marked Chinook salmon stocked by Ontario and New York in Lake Ontario from 2008-2013. (AD=adipose clip, AD-CWT=adipose clip+tag).***

| Stocking | Mark | 2008 | 2009 | 2010 | 2011 | 2013 |
|---|---|---|---|---|---|---|
| New York | | | | | | |
| Salmon R. | AD-CWT | 356 | 360 | 339 | - | - |
| | AD | - | - | - | 356 | - |
| | No Mark | - | - | - | - | 360 |
| Pen Sites | AD-CWT | - | - | 431 | 433 | 394 |
| | AD | 233 | 314 | 76 | 75 | 58 |
| | No Mark | - | - | - | - | *55 |
| Direct Sites | AD-CWT | - | - | 420 | 418 | 386 |
| | AD | 210 | 1084 | 264 | 487 | - |
| | No Mark | - | - | - | - | 519 |
| Ontario | | | | | | |
| Credit R. | AD-CWT | 85 | 20 | 21 | 21 | - |
| | AD | - | 75 | 65 | 78 | - |
| | No Mark | | | | | 100 |
| Other Sites | AD | 442 | 351 | 381 | 380 | - |
| | AD-CWT | - | 101 | 202 | 104 | - |
| | No Mark | - | - | - | - | 607 |
| **Total** | | 1326 | 2305 | 2200 | 2352 | 2479 |

Notes: No marking was done in 2012.
*Sandy Creek Pen/Direct site was not marked in 2013.

Considering the above and hatchery limitations for holding tagged fish lots separately, not all fish at all sites were tagged (although all were clipped), and stocking equal numbers of pen and direct-stocked fish was not feasible at most sites. Fish were tagged in lots of 37,500 or less, and then depending on the stocking target for the site, some fish with only an AD clip were added to meet the stocking target for that site (Table 2).

Pen and direct-stocked fish were also not typically released on the same day and were not always released at the same location. Numbers stocked, stocking time and site conditions were different and may have influenced study outcomes but these differences were consistent with usual stocking practices and evaluating the outcomes of these practices was the aim of this study. For details of locations, pen stocking sizes and dates of stocking and release, see (Wilkinson et al 2011, 2012, and 2014). Mean dates of stocking at direct sites were May 14$^{th}$, 12$^{th}$, and 24$^{th}$; and mean dates of release at pen sites were May 8$^{th}$, 13$^{th}$, and 18$^{th}$ in 2010, 2011, and 2013 respectively.

***Table 2. Approximate+ numbers of AD clipped and coded-wire-tagged Chinook salmon stocked into pens or directly from the hatchery each year 2010-2011, and in 2013 for evaluating pen- vs. direct- stocking methods.***

| | **Pen Stocked** | | | | | | **Direct-stocked** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Site** | **# fish AD-CWT** | **# Fish AD only** | **Pen Total** | **#lots** | **# Pens** | **Pen Density** | **# fish AD-CWT** | **# Fish AD only** | **Direct Total** | **#lots** | **Total** |
| Black River | - | - | - | - | - | - | - | 159,000 | 159,000 | - | 159,000 |
| South Sandy | - | - | - | - | - | - | - | 100,000 | 100,000 | - | 100,000 |
| Salmon River | - | - | - | - | - | - | - | 352,000 | 352,000 | - | 352,000 |
| Oswego River | 37,500 | 4,390 | 41,890 | 1 | 2 | 20,945 | 37,500 | 60,310 | 97,810 | 1 | 139,700 |
| Fairhaven | 25,000 | | 25,000 | 1 | 1 | 25,000 | 25,000 | 62,200 | 87,200 | 1 | 112,200 |
| Sodus Bay | 37,500 | 12,500 | 50,000 | 1 | 2 | 25,000 | 37,500 | 22,500 | 60,000 | 1 | 110,000 |
| Genesee River | 75,000 | 10,250 | 85,250 | 2 | 4 | 21,313 | 75,000 | 10,250 | 85,250 | 2 | 170,500 |
| Sandy Creek# | 37,500 | 17,500 | 55,000 | 1 | 2 | 27,500 | 37,500 | 17,500 | 55,000 | 1 | 110,000 |
| Oak Orchard | 75,000 | 31,653 | 106,653 | 2 | 5 | 21,313 | 63,937 | 0 | 63,937 | 2 | 170,590 |
| Eighteenmile | 67,100 | | 67,100 | 2 | 3 | 22,367 | 67,100 | 0 | 67,100 | 2 | 134,200 |
| Niagara River | 75,000 | - | 75,000 | 2 | 1 | 75,000* | 75,000 | 53,500 | 128,500 | 2 | 203,500 |
| **Total** | **429,600** | **76,293** | **505,893** | **12** | **19** | | **418,537** | **837,260** | **1,255,797** | **12** | **1,761,690** |

* Pen dimensions are nearly identical at all sites except Niagara where all fish are held in one large holding pen.
+ Actual stocking numbers varied slightly and are provided in Connerton (2011, 2012, and 2014).
# Sandy Creek pen site was too warm in 2013 so pen and direct-stocked fish were not marked or tagged at this site in 2013.

Marking Quality Control

The AutoFish system's built-in quality control features 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 manually clipped and tagged. In addition, marking quality was manually verified by agency staff during AutoFish operation from 2008-2013. Each raceway of fish received a unique CWT code. For each raceway, 100 fish from each of the AutoFish' six marking lines were examined to ensure clip quality and CWT presence, and to detect any problems with individual marking lines. Samples of fish were also checked when exiting the trailer prior to entering the hatchery (100 fish per day), in raceways after entering the hatchery (100 fish per raceway), and at pens prior to release (approximately 100 fish per pen per year 2010-2011, and 2013).

Although tagged fish rarely shed their CWT, it is most likely to occur within 30 days after tagging. To estimate CWT retention for this study and to check clip quality each year, samples of Chinook salmon at SRH and at stocking sites were checked for an AD clip and a CWT at least 30 days post-tagging and prior to stocking using a portable CWT detector. At pen and direct stocking sites from 2010-2011 and in 2013, clipping quality and CWT retention were monitored by NYSDEC regional biologists prior to stocking. Samples of 50-100 fish per pen were checked for AD clip and CWT. Since not all fish at sites were tagged (Table 2), the percentages of tagged fish at each site were compared against expected percentages. The expected percentages of tagged fish were calculated for each stocking site based on the numbers tagged and the numbers marked with AD only. For example, at the Oswego River pen site, 37,500 salmon were marked with AD-CWT, and 4,390 salmon were marked AD clip, so the expected percentage of AD-CWT fish at that site was 89.5%.

We collected 30-100 pen and direct-stocked fish prior to stocking to read and verify CWT codes at each site. In 2010 and 2011, samples for CWT code verification were collected from tanks at the hatchery during loading of hatchery trucks, and in 2013 samples were collected from the hatchery truck at the stocking site. Other measures to ensure that tagged fish went to the correct site included: 1) placing the name of the site on hatchery tanks after clipping and tagging; 2) numbering each tank in the hatchery and recording tank numbers and site names on Autofish forms; 3) recording tank numbers, site names, stocking dates, and CWT codes on hatchery tank movement forms at time of stocking; and 4) retaining samples of CWT wire from each lot while marking. Tagged fish that died in the hatchery prior to stocking were subtracted to adjust stocking numbers.

Field Sampling

In New York, angler harvested Chinook salmon were sampled as part of the New York Lake Ontario Fishing

Boat Survey from April - September, 2011-2016 (Lantry and Eckert 2017). Two technicians were also deployed by the U.S. Fish and Wildlife Service (Service) from July-October 2011 and 2014-2015 (hereafter referred to as 'headhunters'), specifically to process Chinook salmon for clip and CWT recovery during the lake and tributary angling seasons. In 2012, 2013 and 2016, NYSDEC deployed two headhunters from June-October, and an additional two headhunters from July-October to increase sampling effort for recovery of CWTs. In each year of the study, Chinook salmon were measured for total length (TL) and 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, cleaning stations, and pen evaluation sites. At some ports, groups of anglers at marinas were contacted periodically by phone and arrangements were made to sample the day's harvest at private docks.

During fall tributary fishing (Sept. 15-Nov. 5, 2011-2016), headhunters focused on major tributaries and pen evaluation sites in New York including the Niagara River, Eighteenmile Creek, Oak Orchard Creek, Sandy Creek, and Genesee River in the western region, and Maxwell Creek, Sodus Bay tributaries (Sodus Creek and Second Creek), Sterling Creek, Oswego River, South Sandy Creek and Salmon River in the east (Figure 1). Extra NYSDEC technicians (6-8) were assigned to tributary sites to visit each site at least 15 days during the spawning run. Since most fish were sampled from fish cleaning stations, anglers were asked where their fish were caught to identify and record capture locations. Recovery efforts also included walking streams to sample anglers' harvest, sampling salmon carcasses in the streams (2012-2016), and electrofishing some streams (2013-2016).

Also in 2011-2016, freezers were placed at six locations along the lake for cooperating anglers to place Chinook salmon heads. Freezers were checked periodically; all snouts were scanned for the presence of a CWT and if present, were sent to the Service's Great Lakes Fish Tag and Recovery Laboratory (GLFTRL) in New Franken, WI for processing. These samples were only included in analyses of CWT recoveries.

## Data Analyses

### *Lake Recoveries of Pen vs Direct-Stocked Chinook*

To compare the relative contributions of pen vs. direct-stocked Chinook salmon to lake and tributary fisheries, CWTs recovered from age-1 and older Chinook salmon from 2011-2016 were grouped by unique codes which identified the fish's stocking origin (i.e., year, site, and pen or direct). Total recaptures for each origin were tabulated from 2011-2015 for lake and tributary sites. Pooling samples across years (i.e., across ages within treatments) would not be appropriate if survival or catchability of the fish from the treatment (pen) or control (direct) groups changed relative to each other because tag recovery ratios would not be constant through time (Elrod and Frank 1990); therefore, prior to pooling samples from paired releases across years, chi-square tests for homogeneity were performed and samples were pooled (i.e., across ages, within treatments) if the null hypothesis of homogeneity was not rejected.

The 2010-2011 and 2013 year classes were marked and tagged for the pen study. The 2010 and 2011 year classes were fully recruited to the fishery in 2014 and 2015 respectively (i.e., all ages were either harvested or matured and died). In 2016, ages 1-3 of the 2013 YC were recruited to the fishery, therefore we report on recoveries of pen and direct-stocked fish for all three year classes in this report. Only age-4 Chinook of the 2013 YC remain in 2017 which are relatively rare in Lake Ontario. For each year class, at each of eight sites, observed recovery ratios of pen vs. direct-stocked salmon were compared to expected (based on initial stocking ratios) using chi square Goodness-of-Fit tests. Logically, recovery ratios should equal stocking ratios if no differences in survival exist between the stocking methods. We assumed that recoveries are not biased toward fish of either group and that early hatchery rearing was identical prior to stocking (Elrod and Frank 1990).

### *Tributary Returns of Pen vs Direct-Stocked Chinook*

To compare returns of pen and direct-stocked salmon (i.e., to evaluate imprinting) to the eight pen stocking sites (Figure 1, Table 2), we sampled Chinook salmon in the tributaries September-November 2011-2016 at each pen site. For each tagged Chinook sampled, we determined stocking origin (as above), age, and year class from the retrieved CWT. At each site and for each stocking origin (pen or direct), the total number of salmon recovered was divided by the numbers stocked according to their stocking origin (pen or direct) to adjust for different numbers stocked at the sites and to permit comparison of returns. Since we were interested in evaluating imprinting only, numbers of returning pen and direct-stocked fish must be adjusted to account for differential, open lake survival of these treatments. We adjusted the site specific numbers for each YC returning to each site by dividing tributary returns by the ratio of pen and direct-stocked recoveries for that site from the lake fishery (Tables 4, 5, and 6). Since this ratio changed with age within a single YC, we used the age specific recovery ratios for each site and YC. For example, the recovery ratio of pen to direct-stocked salmon in the lake for age 2 salmon from the 2010 YC at Oak Orchard was 2.3 (Table 7, 32/14); therefore, the number of pen fish returning to Oak Orchard in the fall was first divided by the numbers stocked (number of 2010 YC pen-reared at Oak Orchard), then divided by 2.3.

The recovery ratios of pen to direct-stocked salmon sampled at each tributary were calculated and compared to stocking ratios using chi-square Goodness of Fit tests. Logically, recovery ratios should equal stocking ratios if no differences in returns (i.e., imprinting) exist between the stocking methods. Prior to pooling samples across years, tests of homogeneity were performed and samples were pooled if the null hypothesis of homogeneity was not rejected. If not homogenous, samples were tested separately for differences.

*Stocking Origin of Harvested Chinook*

To gain insights into Chinook salmon movement, mixing, and imprinting we determined the stocking origin of coded-wire tagged Chinook salmon harvested from eight stocking sites during the lake and tributary seasons. We considered three periods: 1) in the lake, a “pre-staging” period in July in which we hypothesized that the Chinook salmon population would be well mixed and predicted the harvest at individual ports would comprise Chinook from many stocking sites; 2) a “staging” period in September in which Chinook salmon would be homing to their stocking sites, so we predicted that the lake harvest at individual sites would comprise a higher percentage of fish stocked at those individual sites; and 3) in the tributaries, we hypothesized that if imprinting was successful, the majority of Chinook harvested at individual tributary sites in October would be comprised of fish stocked at the site. To evaluate movement, mixing and imprinting of stocked Chinook

***Table 3. Manual quality control results during operation of the AutoFish trailer at Salmon River Hatchery and post tagging in 2010, 2011 and 2013.***

| **Quality Control** | **Year*** | | |
|---|---|---|---|
| During Operation | 2010 | 2011 | 2013 |
| # fish checked for AD | 17,620 | 22,978 | 7,157 |
| % AD clipped | 99.2 | 99.7 | 99.5 |
| | | | |
| # fish checked for CWT | 13,539 | 12,097 | 7,157 |
| % with CWT | 99.6 | 99.8 | 99.8 |
| % no AD clip, no CWT | 0.04 | 0.12 | 0.17 |
| % AD clipped, no CWT | 0.13 | 0.04 | 0.18 |
| | | | |
| Checked 30 days post-tagging | | | |
| # of Fish Checked CWT | 2537 | 1932 | 1331 |
| % AD Clipped | 99.6 | 98.9 | 98.0 |
| % with CWT | 99.1 | 99.4 | 99.0 |

* No fish were marked in 2012

salmon from the eight stocking sites (Figure 1, Table 2), the numbers of tagged salmon sampled at each port or tributary were tabulated according to their stocking origin, i.e., the YC (2010, 2011, or 2013), stocking location (1 of 8 sites) and stocking method (pen vs direct) which were identified by their unique tag code. The numbers of tagged fish harvested at each lake port or tributary from 2011-2016 were adjusted for numbers stocked according to their stocking origin, and then the proportions of fish stocked at each site, at nearby sites (within 20 miles), and at distant sites were compared. Sample sizes at two sites (i.e., Niagara and Genesee River) were small in July, so percent composition was calculated in May for Niagara, and in August for Genesee. Niagara recoveries in May and September also included samples from Wilson harbor (Twelvemile Creek, Figure 1). Percent composition summaries of tributary returns in October only included samples at the specific tributaries except for Sodus (included samples from Maxwell Creek, Second Creek, Sodus Creek), and Fairhaven (included samples from Sterling, Ninemile and Wolcott Creeks).

All statistical analyses were conducted using R software version 3.3.2 (R Core Development Team 2016). Post-hoc tests for homogeneity among ages were done using the R package *fifer* (Fife 2017).

**Results and Discussion**

Marking Quality Control

Manual quality control (QC) checks during the marking and tagging process showed excellent results with greater than 99% of the fish sampled having an AD clip and greater than 99.6% of tagged fish sampled having a CWT (Table 3). Clipping quality and tag retention remained high when checked thirty days after tagging (Table 3).

Clipping quality measured at pen sites was excellent: in 2010 2,537 fish were examined in 19 pens with an average clipping percentage of 99.6% (standard deviation (σ) =1.0%); in 2011 1,932 fish were examined in 18 pens with average clipping percentage of 98.9% (σ=1.7%); and in 2013 1,331 fish were examined in 15 pens with an average of 98.0% (σ=1.0%). Tag retention was also high. As previously described, not all Chinook stocked at pen and direct-stocked sites were tagged (Table 2); therefore the percentages of tagged fish recorded at each site during QC checks were compared against expected. For all sites in all years the percentages of tagged fish were within +/- 1% of expected indicating high tag retention (99%).

In 2011 and 2013, samples of 100 fish per direct-stocked site were checked for clip quality and tag retention in hatchery tanks prior to adding AD only fish and stocking. In 2011, average clipping percentage was 99.4% among tanks (n=12 tanks, 1,201 fish, σ=0.9%), and average tag retention was 99.0% (σ = 1.1%) when checked 30 days post tagging. In 2013, average clipping percentage among tanks was 99.1% (n=11 tanks, 1,100 fish, σ=1.1%), and average tag retention was 99% (σ=1.0%) when checked approximately 21 days post tagging.

***Table 4. Recoveries per 50,000 stocked of coded-wire tagged Chinook salmon stocked into Lake Ontario by pen and direct stocking methods at eight sites in New York in 2010 (2010 YC). For sites with P-values <0.05 (in bold), returns of pen-stocked and direct-stocked fish were significantly different at α=0.05.***

| Site | Stocking Method | Number Tagged[1] | Recoveries in the Lake per 50,000 Tagged in Year: 2011 | 2012 | 2013 | 2014 | Total | $X^2$ Test for Homogeneity Across Years: $X^2$ | P | $X^2$ Test for Differences Pen vs Direct: $X^2$ | P | Lake Recovery Ratio (Pen:Direct) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Niagara | Pen | 73,817 | 8 | 29 | 17 | 1 | 55 | 0.05 | 0.9736 | 2.75 | 0.0972 | 1.3 |
| | Direct | 73,835 | 6 | 21 | 14 | 0 | 41 | | | | | |
| Eighteenmile | Pen | 64,743 | 10 | 53 | 13 | 1 | 75 | 1.39 | 0.4985 | 16.75 | **4.25E-05** | 2.2 |
| | Direct | 65,780 | 3 | 23 | 9 | 0 | 36 | | | | | |
| Oak Orchard | Pen | 61,152 | 8 | 32 | 13 | 1 | 54 | 1.64 | 0.4401 | 8.45 | **0.0036** | 1.9 |
| | Direct | 75,449 | 4 | 14 | 11 | 0 | 29 | | | | | |
| Sandy Creek | Pen | 37,097 | 11 | 38 | 13 | 0 | 62 | 3.87 | 0.1441 | 0.12 | 0.73 | 1.1 |
| | Direct | 36,877 | 7 | 28 | 21 | 0 | 56 | | | | | |
| Genesee River | Pen | 71,463 | 13 | 52 | 18 | 0 | 82 | 4.93 | 0.1109 | 6.54 | **0.0105** | 1.5 |
| | Direct | 75,300 | 5 | 28 | 20 | 0 | 54 | | | | | |
| Sodus Bay | Pen | 37,294 | 24 | 65 | 24 | 0 | 112 | 8.41 | 0.0150*+ | 6.08 | **0.0108**+ | 2.0 |
| | Direct | 37,800 | 5 | 28 | 22 | 1 | 57 | | | | | |
| Fairhaven | Pen | 24,895 | 8 | 52 | 19 | 0 | 79 | 3.20 | 0.2018 | 13.2 | **0.0003** | 3.3 |
| | Direct | 24,200 | 0 | 16 | 8 | 0 | 24 | | | | | |
| Oswego | Pen | 37,307 | 11 | 45 | 20 | 1 | 77 | 0.24 | 0.8860 | 4.55 | **0.0330** | 1.6 |
| | Direct | 37,061 | 8 | 27 | 13 | 0 | 48 | | | | | |
| | | | | | | | | **Average Recovery Ratio (Pen:Direct)=** | | | | **1.9** |

[1] Number stocked adjusted for percent tagged based on quality control checks for tags prior to stocking

+Sodus recoveries of pen and direct were not homogenous among years, with years 2011 and 2013 significantly different (adjusted *P*= 0.0209), so recoveries from 2012-2013 were pooled and tested for differences between pen and direct (shown above); recoveries from 2011 were tested separately ($X^2$ = 7.71, df = 1, *P*= 0.0054).

Note: The chi square statistics in this table are slightly different than presented in previous reports for this year class, but overall results are unchanged. Test of homogeneity were performed on recoveries per 50,000 tagged for this report to be consistent with other year classes (Tables 8 and 9); whereas previous reports for the 2010 YC used recoveries unadjusted for numbers stocked. Chi square tests for differences performed with Yates continuity correction.

***Table 5. Recoveries per 50,000 stocked of coded-wire tagged Chinook salmon stocked into Lake Ontario by pen and direct stocking methods at eight sites in New York in 2011 (2011 YC). For sites with P-values <0.05 (in bold), returns of pen-stocked and direct-stocked fish were significantly different at α=0.05.***

| Site | Stocking Method | Number Tagged[1] | Recoveries in the Lake Per 50,000 Tagged in Year | | | | | $X^2$ Test for Homogeneity Across Years | | $X^2$ Test for Differences Pen vs. Direct | | Lake Recovery Ratio |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2012 | 2013 | 2014 | 2015 | Total | $X^2$ | P | $X^2$ | P | (Pen:Direct) |
| Niagara | Pen | 72,998 | 3 | 16 | 30 | 0 | 49 | 0.64 | 0.7276 | 23.14 | **1.50E-06** | 2.84 |
| | Direct | 74,653 | 1 | 7 | 9 | 0 | 17 | | | | | |
| Eighteenmile | Pen | 66,208 | 10 | 61 | 59 | 1 | 131 | 1.92 | 0.3827 | 48.27 | **3.71E-12** | 2.65 |
| | Direct | 64,680 | 3 | 18 | 28 | 0 | 49 | | | | | |
| Oak Orchard | Pen | 71,940 | 13 | 54 | 60 | 1 | 128 | 5.29 | 0.0711 | 42.57 | **6.83E-11** | 2.43 |
| | Direct | 63,280 | 9 | 13 | 30 | 2 | 54 | | | | | |
| Sandy Creek | Pen | 37,898 | 19 | 54 | 54 | 1 | 129 | 1.54 | 0.4623 | 37.84 | **7.68E-10** | 3.45 |
| | Direct | 37,108 | 4 | 13 | 20 | 0 | 37 | | | | | |
| Genesee River | Pen | 73,918 | 8 | 47 | 48 | 1 | 105 | 1.82 | 0.4021 | 27.01 | **2.03E-07** | 2.00 |
| | Direct | 73,530 | 5 | 18 | 29 | 0 | 52 | | | | | |
| Sodus Bay | Pen | 35,872 | 9 | 37 | 61 | 0 | 107 | 1.68 | 0.4314 | 24.50 | **7.42E-06** | 2.64 |
| | Direct | 38,120 | 1 | 17 | 22 | 0 | 41 | | | | | |
| Fairhaven | Pen | 23,989 | 4 | 27 | 49 | 0 | 80 | 0.01 | 0.9946 | 7.44 | **0.0064** | 2.01 |
| | Direct | 25,040 | 2 | 14 | 24 | 0 | 40 | | | | | |
| Oswego | Pen | 36,333 | 4 | 17 | 36 | 0 | 57 | 1.99 | 0.3697 | 0.34 | 0.5590 | 1.14 |
| | Direct | 36,541 | 1 | 20 | 28 | 0 | 50 | | | | | |
| | | | | | | | | **Average Recovery Ratio (Pen:Direct) =** | | | | **2.40** |

[1] Number stocked adjusted for percent tagged based on quality control checks for tags prior to stocking

Note: The chi square statistics in this table are slightly different than presented in previous reports for this year class, but overall results are unchanged. Test of homogeneity were performed on recoveries per 50,000 tagged for this report to be consistent with other year classes (Tables 7 and 9); whereas previous reports for the 2011 YC used recoveries unadjusted for numbers stocked. Chi square tests for differences performed with Yates continuity correction.

Samples of tagged fish collected during pen and direct stockings to verify that CWT codes went to the correct site indicated that all fish went to the correct sites in all years, except in 2010 when three samples taken at SRH contained fish from another site. The Sodus pen sample contained 5 out of 40 fish from Fairhaven Pen; the Sodus Direct sample contained 1 out of 52 fish from Oak Orchard Direct; and the Fairhaven Pen sample contained 1 out 30 fish from Oswego Direct site. After reviewing all marking, hatchery and stocking records and evaluating all potential error sources, it is most likely that mixing occurred during sampling at SRH (residual fish in dip nets used to sample raceways) or during GLFTRL CWT processing and reading, and it is unlikely that fish were mixed during loading of hatchery trucks. Sampling and lab procedures were modified and in 2011 and 2013, no discrepancies were found.

Lake Recoveries of Pen vs Direct-Stocked Chinook

For the 2010 YC, a total of 981 tagged Chinook salmon from pen and direct stockings were recovered from the lake fishery from 2011-2014. In 2014, only four tagged age-4 fish were sampled from the lake fishery, so no additional analyses were pursued. All recoveries were adjusted for numbers tagged by each stocking method at each site. Results from the 2010 YC indicated that pen stocking provided an average of 1.9 higher relative recoveries per number tagged than direct stocking (Table 4, ranging from 1.3 to 3.3). Pen stocked recovery ratios were significantly greater for six of eight sites evaluated including Eighteenmile, Oak Orchard, Genesee, Sodus, Fairhaven and Oswego (Table 4). For the Niagara and Sandy Creek sites, pen to direct recovery ratios were insignificant at 1.3 and 1.1, respectively.

For the 2011 YC, a total of 1,230 tagged Chinook salmon from pen and direct stockings were recovered from the lake fishery from 2012-2014 (Table 5). In 2015, only five tagged age-4 fish from this YC were sampled, so no additional analyses were pursued. All recoveries were adjusted for numbers stocked by each method at each site. Similar to the 2010 YC, pen stocking provided on average 2.4 fold higher relative recoveries in the Lake compared to direct stocking, ranging from 1.14 to 3.45. Pen stocked recovery ratios were significantly greater for all sites except for the Oswego River (1.14).

***Table 6. Recoveries per 50,000 stocked of coded-wire tagged Chinook salmon stocked into Lake Ontario by pen and direct stocking methods at seven sites in New York in 2013 (2013 YC). For sites with P-values <0.05 (in bold), returns of pen-stocked and direct-stocked fish were significantly different at α=0.05.***

| Site | Stocking Method | Number Tagged[1] | Recoveries in the Lake Per 50,000 Tagged in Year 2014 | 2015 | 2016 | 2017 | Total | $X^2$ Test for Homogeneity Across Years $X^2$ | P | $X^2$ Test for Differences Pen vs. Direct $X^2$ | P | Lake Recovery Ratio (Pen:Direct) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Niagara | Pen | 75,554 | 3 | 34 | 38 | TBD | 75 | 1.74 | 0.42 | 21.71 | **3.16 E-06** | 2.2 |
| | Direct | 75,454 | 1 | 11 | 22 | TBD | 34 | | | | | |
| Eighteenmile | Pen | 65,839 | 13 | 57 | 45 | TBD | 115 | 0.14 | 0.93 | 34.38 | **4.53 E-09** | 2.3 |
| | Direct | 66,584 | 6 | 23 | 21 | TBD | 50 | | | | | |
| Oak Orchard | Pen | 75,111 | 5 | 61 | 44 | TBD | 110 | 1.07 | 0.59 | 57.28 | **3.77 E-14** | 3.5 |
| | Direct | 64,753 | 2 | 15 | 15 | TBD | 32 | | | | | |
| Genesee River | Pen | 74,967 | 9 | 59 | 40 | TBD | 108 | 4.08 | 0.13 | 43.00 | **5.49 E-11** | 2.6 |
| | Direct | 74,441 | 3 | 15 | 23 | TBD | 41 | | | | | |
| Sodus Bay | Pen | 36,979 | 8 | 62 | 31 | TBD | 101 | 6.96 | 0.03+ | 39.43 | **3.39 E-10** | 5.1 |
| | Direct | 37,483 | 0 | 8 | 12 | TBD | 20 | | | | | |
| Fairhaven | Pen | 25,359 | 8 | 76 | 27 | TBD | 111 | 0.70 | 0.71 | 10.49 | **0.0012** | 2.2 |
| | Direct | 25,790 | 2 | 36 | 13 | TBD | 52 | | | | | |
| Oswego | Pen | 37,389 | 13 | 65 | 27 | TBD | 105 | 6.51 | 0.04+ | 0.22 | 0.6430 | 0.9 |
| | Direct | 37,851 | 4 | 79 | 30 | TBD | 113 | | | | | |
| | | | | | | | | | **Average Recovery Ratio (Pen:Direct) =** | | | **2.7** |

[1] Number stocked adjusted for percent tagged based on quality control checks for tags prior to stocking
TBD=To be determined in 2017
+ Oswego and Sodus recoveries were not homogenous among years with 2013 and 2014 recoveries marginally significantly different at α=0.1 (Bonferroni adjusted P= 0.0584) at Oswego, and 2014 and 2015 marginally significantly different (Bonferroni adjusted P=0.1219).

For the 2013 YC, a total of 1,157 tagged Chinook salmon from pen and direct stockings were recovered from the lake fishery from 2014-2016 (Table 6). Pen stocking provided an average 2.7 fold higher relative recoveries compared to direct stocking, the highest average ratio of the three year classes studied. Ratios ranged from 0.9 to 5.1 for the seven sites evaluated, and recoveries of pen fish in the lake were significantly higher than direct-stocked Chinook at all sites except the Oswego River (0.9). Of the three year class studies at Oswego, only the 2010 year class showed a significant advantage for pen stocking. It should be noted, however, that the pen fish were held only for three days prior to release because of warm water temperatures in 2013 (>65°F, Sanderson and Wilkinson, 2006), and that water quality concerns were raised at the pen site in 2011 (Wilkinson et al. (2012). This site was moved in 2017 to a different location on the Oswego River to address these concerns.

Results at Oak Orchard showing higher relative recoveries of pen fish for all three YCs in the lake fishery, and at Niagara showing no significant difference for the 2010 YC, were consistent with the previous study by Bishop et al. (2006). In contrast, pen fish at Niagara exhibited significantly better recoveries in the lake for both the 2011 and 2013 YCs in this study, suggesting that pen stocking is beneficial at that site overall. Bishop et al. (2006) sampled salmon at tributaries only, and not from the lake fishery. Since returns to the tributaries by pen or direct-stocked salmon could result from differences in survival, imprinting, or a combination of the two, results of the current study emphasize the importance of sampling in the lake to understand survival differences between stocking methods. It's possible that results from the lake fishery in this study showing higher recoveries of pen fish may have resulted from differences in survival or in vulnerability to capture; however, both groups are fully recruited to the fishery and assumed to be equally vulnerable to harvest after age-1 (assuming maturity is the same), suggesting that pen fish do exhibit higher survival in their first year in Lake Ontario and subsequently contribute higher relative numbers of older aged fish to the fishery.

It is important to note that comparisons between individual pen sites were not an objective of this study. Sampling relied on angler caught fish, and was therefore subject to fish distribution, fishing effort, and success, which varied by location and year. Sampling effort was often directed primarily at sites with the greatest fishing effort and success varied, so the total

*Table 7. Relative return of pen and direct-stocked Chinook Salmon to eight tributary stocking sites in New York from 2011-2014 (2010 YC). Numbers returning to tributaries were adjusted by numbers tagged and by the lake recovery ratio (pen:direct) for that site to evaluate imprinting to stocking sites. (See Methods for more explanation). For sites with P-values <0.05 (in bold), return ratios of pen-stocked and direct-stocked fish observed at tributaries were significantly different than expected ratios based on numbers tagged at α=0.05.*

| Site | Number Tagged | | Recovered Per 50,000 Tagged | | Lake Recovery Ratio | Adjusted Tributary Return Ratio | $X^2$ Test for Homogeneity Pen vs. Direct | | $X^2$ Test for Differences Pen vs. Direct | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pen | Direct | Pen | Direct | Pen:Direct | Pen: Direct | $X^2$ | P | $X^2$ | P |
| Niagara | 73835 | 73817 | 65 | 60 | 1.3 | 0.84 | 0.74 | 0.69 | 0.84 | 0.3590 |
| Eighteenmile | 65779 | 64742 | 97 | 63 | 2.2 | 0.95 | 0.99 | 0.61 | 0.10 | 0.7540 |
| Oak Orchard | 75449 | 61152 | 63 | 25 | 1.9 | 1.61 | 1.32 | 0.52 | 6.86 | **0.0088** |
| Sandy Creek | 36877 | 37097 | 46 | 31 | 1.1 | 1.50 | 3.65 | 0.16 | 1.86 | 0.1720 |
| Genesee | 75300 | 71463 | 31 | 15 | 1.5 | 1.72 | 0.57 | 0.75 | 4.41 | **0.0357** |
| Sodus | 37800 | 37294 | 22 | 16 | 2.0 | 1.22 | * | 1.00 | 0.13 | 0.7190 |
| Fairhaven | 24200 | 24895 | 23 | 121 | 3.3 | 0.07 | * | 0.11 | 118.02 | **1.71E-27** |
| Oswego | 37307 | 37061 | 92 | 120 | 1.6 | 0.49 | 3.66 | 0.16 | 23.78 | **1.08E-06** |
| **Average Return Ratio (Pen: Direct)** | | | | | **1.9** | **1.05** | | | | |

Note: The numbers reported here are marginally different from those reported by Connerton et al. 2016 who reported recoveries per 50K stocked unadjusted for tag retention (mean=98.5% tagged).
* Fisher's exact Test used because recoveries at age 1 were zero for this site.

numbers of recoveries from each site may not reflect relative survival among sites unless fish from different sites are well mixed throughout the lake, e.g., prior to staging during spring and early summer.

Tributary Returns of Pen vs Direct-Stocked Chinook
We compared the relative return of pen and direct-stocked Chinook salmon stocked in 2010, 2011, and 2013 to tributaries during fall spawning from 2011-2016 at the eight stocking sites, hereafter referred to as return ratios (Tables 7-9).

To evaluate the imprinting of pen and direct-stocked salmon to these sites, the return ratios of pen vs direct-stocked salmon were adjusted for lake performance first and then compared (see methods above). After adjusting for lake performance, the average return ratio of pen and direct-stocked fish across all sites for the 2010 YC was 1.05 indicating no consistent difference between imprinting of pen and direct-stocked salmon, with results site dependent. There were no significant differences between return ratios of pen and direct-stocked salmon at four of eight sites including Niagara, Eighteenmile, Sandy Creek and Sodus Bay. At Oak Orchard and Genesee River, pen fish returned significantly better than direct-stocked fish indicating better imprinting at these sites. Although pen fish from Fairhaven and Oswego performed significantly better than direct-stocked fish in the lake, imprinting to these tributaries was significantly poorer by pen fish with adjusted return ratios of 0.07 and 0.49 respectively. The Fairhaven site is unusual because pens are held at a marina in Little Sodus Bay and are not associated with any tributary, whereas direct-stocked fish are stocked into Sterling Creek resulting in potential imprinting. Although recoveries were focused at this stream and at nearby Wolcott and Ninemile Creeks, and the majority of fish recovered in these streams were from the Fairhaven stockings, direct-stocked fish made up the majority. Efforts were also made to locate staging fish near the pen stocking site in the marina and none were found, despite anecdotal reports that Chinook were sometimes there.

After adjusting return ratios for lake performance, the average adjusted return ratios of the 2011 YC across all tributary sites was 1.21 indicating an imprinting advantage for pen fish overall; however, results varied between sites (Table 8). At Niagara, Eighteenmile Creek, and Oak Orchard pen fish returned significantly better than direct-stocked fish after adjusting for lake performance, with adjusted return ratios of 1.99, 1.49, and 1.53, respectively. Return ratios were marginally different at Genesee (1.35; P=0.1). In contrast, at Sandy Creek (0.74) and Fairhaven (0.29), adjusted return ratios indicated that penned Chinook imprinted significantly worse than direct-stocked Chinook for this year class. Poorer imprinting by Fairhaven penned salmon is probably

***Table 8. Relative return of pen and direct-stocked Chinook Salmon to eight tributary stocking sites in New York from 2012-2015 (2011 YC). Numbers returning to tributaries were adjusted by numbers tagged and by the lake recovery ratio (pen:direct) for that site to evaluate imprinting to stocking sites. (See Methods for more explanation). For sites with P-values <0.05 (in bold), return ratios of pen-stocked and direct-stocked fish observed at tributaries were significantly different than expected ratios based on numbers tagged at α=0.05.***

| Site | Number Tagged | | Recovered Per 50,000 Tagged | | Lake Recovery Ratio | Adjusted Tributary Return Ratio | $X^2$ Test for Homogeneity Pen vs. Direct | | $X^2$ Test for Differences Pen vs. Direct | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pen | Direct | Pen | Direct | Pen:Direct | Pen: Direct | $X^2$ | P | $X^2$ | P |
| Niagara | 72997 | 74654 | 118 | 38 | 2.88 | 1.99[#] | 13.55[#] | 1.1 E-03 | 11.31 | **0.0008** |
| Eighteenmile | 66208 | 64680 | 296 | 80 | 2.61 | 1.49 | 3.99 | 0.14 | 22.52 | **2.08 E-06** |
| Oak Orchard | 71940 | 63280 | 179 | 47 | 2.47 | 1.53 | 4.45 | 0.11 | 16.56 | **4.72 E-05** |
| Sandy Creek | 37898 | 37108 | 145 | 61 | 3.45 | 0.74 | *+ | 0.03 | 7.48 | **0.0062** |
| Genesee | 73918 | 73530 | 55 | 21 | 2.36 | 1.35 | 0.07 | 0.97 | 2.76 | 0.0964 |
| Sodus | 35872 | 38120 | 52 | 17 | 2.67 | 1.25 | * | 0.27 | 0.63 | 0.4276 |
| Fairhaven | 23989 | 25040 | 58 | 94 | 1.71 | 0.29 | 1.93 | 0.38 | 35.85 | **2.13 E-09** |
| Oswego | 37101 | 36333 | 100 | 88 | 1.16 | 1.10 | 0.37 | 0.83 | 0.22 | 0.6378 |
| **Average Return Ratio (Pen: Direct)** | | | | | **2.41** | **1.21** | | | | |

Notes: The numbers reported here are marginally different from those reported by Connerton et al. 2016 who reported recoveries per 50K stocked instead of tagged (unadjusted for tag retention [mean=98.5% tagged]).
* Fisher's exact Test used because recoveries at age 1 were zero for these sites.
+ Sandy Creek recoveries were not homogenous with 2013 marginally significantly different from 2014 (post hoc Bonferroni adjusted P=0.07), so only recoveries from 2012 and 2013 were pooled and tested (results above). Recoveries from 2014 (age 3) were tested separately and results indicated no difference between the adjusted return ratio and stocking ratio ($X^2$ = 0.43, df = 1, *P*=0.511).
[#] Niagara River recoveries were not homogenous with 2013 significantly different from 2014 (post hoc Bonferroni adjusted P=0.007), so only recoveries from 2012 and 2013 were pooled and tested (results above). Recoveries from 2014 (age 3) were tested separately and results indicated significantly higher returns by pen fish ($X^2$=6.61, df=1, P=0.012)

due to the reasons mentioned above (i.e., the pen site is not in a tributary). Regarding Sandy Creek, nothing unusual happened with pen stocking in 2011 (i.e., fish were held for 21 days and released); but the comparison showing poorer returns only included pooled returns from ages 1 and 2 (Table 7). When age-3 was tested separately (because recoveries were not homogenous among ages for this site), there was no difference between adjusted return ratios (1.05) and stocking ratios.

After accounting for lake survival for the 2013 YC, adjusted return ratios of pen and direct-stocked salmon averaged 1.41. Adjusted return ratios were significantly higher than stocking ratios at three out of the seven sites evaluated including at Niagara, Eighteenmile, and Oak Orchard with adjusted return ratios of 1.62, 1.87, and 2.87, respectively, indicating a pen imprinting advantage at these sites. Adjusted return ratios indicated poorer imprinting by pen fish at Sodus (0.71) and Fairhaven (0.47) but only significantly worse at Fairhaven. Returns at both of these sites indicated either worse imprinting by pen fish (at Fairhaven) or insignificant differences between pen and direct stocking (at Sodus) for all 3 YCs evaluated. These results are not surprising, given that neither site is associated with a tributary. Both pen sites do, however, provide a survival advantage for Chinook to the lake, which may be adequate for these sites given the lack of substantial tributary fisheries (Prindle and Bishop 2017).

Stocking Origin of Chinook Harvested at Sites

To gain insights into Chinook salmon movement, mixing, and imprinting we determined the stocking origin of coded-wire tagged Chinook salmon harvested from eight stocking sites during the lake and tributary seasons from 2011-2016 including fish tagged in 2010, 2011 and 2013 (Figures 2a-2d). We examined three periods: pre-staging, staging and spawning.

During the pre-staging period (May, July, or August), Chinook salmon harvested by anglers in the lake were comprised of fish stocked throughout the lake suggesting a mixed population in this period. Of the eight lake ports sampled, only 10.4% on average of the Chinook harvested by anglers in this period were stocked at the site (standard error [se] = +/- 1.2, range=4-16%), and only 19% on average were from

***Table 9. Relative return of pen and direct-stocked Chinook Salmon to eight tributary stocking sites in New York from 2014-2016 (2013 YC). Numbers returning to tributaries were adjusted by numbers tagged and by the lake recovery ratio (pen:direct) for each site to evaluate imprinting to stocking sites. (See Methods for more explanation). For sites with P-values <0.05 (in bold), return ratios of pen-stocked and direct-stocked fish observed at tributaries were significantly different than expected ratios based on numbers tagged at α=0.05.***

| Site | Number Tagged | | Recovered Per 50,000 Tagged | | Lake Recovery Ratio | Adjusted Tributary Return Ratio | $X^2$ Test for Homogeneity Pen vs. Direct | | $X^2$ Test for Differences Pen vs. Direct | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Pen | Direct | Pen | Direct | Pen:Direct | Pen: Direct | $X^2$ | P | $X^2$ | P |
| Niagara | 75554 | 75453 | 152 | 44 | 2.20 | 1.62 | 5.17 | 0.08 | 19.13 | **1.22E-05** |
| Eighteenmile | 65840 | 66584 | 200 | 47 | 2.30 | 1.87 | 7.49 | 0.02 | 24.10 | **9.16E-07** |
| Oak Orchard | 75111 | 64753 | 216 | 22 | 3.50 | 2.87 | 7.82 | 0.02 | 71.74 | **2.46E-17** |
| Genesee | 74967 | 74441 | 69 | 24 | 2.60 | 1.03 | * | 0.37 | 0.03 | 0.87 |
| Sodus | 36979 | 37483 | 39 | 16 | 5.1 | 0.71 | * | 1.00 | 1.71 | 0.19 |
| Fairhaven | 25359 | 25790 | 104 | 109 | 2.20 | 0.47 | 2.63 | 0.27 | 24.10 | **9.16E-07** |
| Oswego | 37102 | 38019 | 135 | 124 | 0.90 | 1.27 | 2.57 | 0.28 | 0.91 | 0.34 |
| **Average Return Ratio (Pen: Direct)** | | | | | **2.69** | **1.41** | | | | |

* Fisher's exact Test used because recoveries at age 1 were zero for these sites.
+ Eighteenmile recoveries were not homogenous with 2015 significantly different from 2016 (post hoc Bonferroni adjusted P=0.024), so only recoveries from 2014 and 2015 were pooled and tested (results above). Recoveries from 2016 (age 3) were tested separately and results indicated a significantly higher returns by pen fish ($X^2$ =3.67, df = 1, $P$=0.492).
[#] Oak Orchard recoveries were not homogenous with 2015 significantly different from 2016 (post hoc Bonferroni adjusted P=0.033), so only recoveries from 2014 and 2015 were pooled and tested (results above). Recoveries from 2016 (age 3) were tested separately and results indicated significantly higher returns by pen fish ($X^2$=24.58, P=7.14e-07)

nearby sites (mean=19.0% se=+/- 2.1%, range=10-30%), with the majority of harvested Chinook originating from stocking sites greater than 20 miles away. Overall, results from the pre-staging period indicated a mixed population in the lake with each port harvesting Chinook from 10-15 stocking sites (Figures 2a-2d). Harvests at east end sites were comprised of fish stocked on the west end and vice versa, and also included Chinook stocked in the Province of Ontario. In fact, Chinook stocked by Ontario made up an average of 16.6% (standard error+/- 3.4%) of the fish caught by New York anglers during the pre-staging period from 2011-2016 (Figure 2a-d), which is higher than expected based on their stocking numbers (i.e., Ontario tagged 11% of the Chinook stocked for the three year classes). Data from OMNRF tag recoveries suggest that New York stockings also contribute to Canadian sport fisheries. Of 315 tags recovered from angler-caught Chinook in Ontario waters from 2011-2014, New York Chinook made up 87.3% of the sample, compared with 87.7% tagged by NY in 2010 and 2011 (no headhunting by OMNRF in 2015-2016 to recover 2013 YC, see OMNRF annual reports 2011-2015). It should also be noted that Chinook stocked at Salmon River were not tagged in 2011 and 2013 and all recoveries were combined; therefore the percent composition presented for this site is biased low.

In September, stocked salmon became more segregated in the lake compared with July. The harvest at each of the eight sites consisted of a higher percentage of Chinook stocked at those sites and nearby sites (Figures 2a-2d) suggesting that Chinook began staging in this period. Across the eight ports sampled, 36% on average (se=+/- 5.0, range=17-60%)) of the Chinook harvested were stocked at the site, and an average of 29% (se=+/- 3.9, range=6-41%) were stocked at nearby sites. The number of stocking sites contributing to each port's fishery declined to a range of 4-9 sites compared to 10-15 in July. The contribution of OMNRF-stocked salmon to the harvest also declined compared with July suggesting that those fish were homing away from New York sites and likely towards Canadian stocking sites. Chinook harvested at western ports in September still consisted of fish originating from eastern stocking sites (e.g., Oswego at Niagara (3%) and Eighteenmile (6%), Figure 2a). Even when we only included presumably mature salmon (i.e., ages 3 and 4) in the analysis at eastern and western ports, we still found a mix of salmon in the harvest originating from eastern and western regions, suggesting that some mature Chinook either move towards their stocking sites later in October, or that these fish were straying.

In October, Chinook salmon caught in tributaries were comprised mainly of fish stocked at the site, and the majority of strays were from nearby stocking sites with relatively few strays from distant sites. For example, strays at Eighteenmile Creek consisted of salmon from Niagara River and Oak Orchard Creek stockings. At Sandy Creek, the majority of strays were from stockings at Oak Orchard Creek, Eighteenmile Creek, and the Genesee River; and at Sodus the majority of strays were from Fairhaven and Genesee stockings. This was not the case at the Oswego River where strays were from several sites including western (Oak Orchard, Eighteenmile Creek) and eastern sites (Sodus, Fairhaven), perhaps because of its proximity to the Salmon River. Chinook which imprinted to the SRH may have strayed to the Oswego River instead as they moved eastward. A sample from the Little Salmon River (a stream close to the Salmon River that is not stocked) also contained an unusual number of strays from several sites in 2013 (Connerton et al. 2014).

Of the eight sites sampled during October, an average of 68% (se=5.0%, range=47-88%) of the Chinook harvested by anglers were comprised of salmon stocked at the site, and an average of 19% (se=+/- 3.64, range=5-34%) of the fish were strays from nearby sites. The numbers of stocking sites contributing to each tributaries harvest were similar to September, i.e., 4-9 sites. In general, results of returns to stocking sites indicate that the majority of fish are imprinting to the tributary at which they are stocked. Moreover, straying is occurring mostly to nearby tributaries so local fisheries are still benefiting from these strays.

Chinook were apparently stocked into pens early enough and small enough (mean size 2010, 2011, and 2013 =3.5g) to permit imprinting, and were held until they reached a larger size (mean release size 2010, 2011, and 2013=6.0g) which apparently improved survival. Direct-stocked salmon were released into the lake at similar sizes (mean~4.3g) as pen fish when first stocked into pens, permitting imprinting; however, survival to the lake was poorer for direct-stocked fish than for pen fish, which resulted in fewer direct-stocked fish per number stocked returning to tributaries. There was some evidence (Tables 7-9) to suggest that pens also provided an imprinting advantage at some sites in some years.

Straying to the Salmon River and SRH occurs, and initial estimates of 10% on average for the 2008-2010 YCs were based on the assumption that Chinook stocked at all sites survive and stray equally (Connerton et al 2016). Clearly this is not the case, based on results reported herein. Although not an initial objective of this study, analyses dealing with straying will be presented in a future report.

## Summary

1. Results from the 2010, 2011 and 2013 YCs indicate that pen stocking at eight sites provided an average of 1.9, 2.4, and 2.7 greater contribution, respectively, to the lake fishery than direct stocking.

2. Results from the 2010, 2011 and 2013 YCs indicate that pen stocking provides better returns to tributaries (imprinting) than direct stocking at some sites in some years, with average return ratios of 1.1, 1.2 and 1.4 respectively.

3. Chinook salmon harvests in the lake in May-July were comprised of Chinook stocked at sites throughout the lake, indicating a well-mixed population prior to the staging period in September. Of the eight lake ports summarized, only 10% of the Chinook harvested by anglers on average were Chinook that were stocked at the site, or stocked at nearby sites (mean=17.2%), with the majority of harvested Chinook originating from stocking sites greater than 20 miles away.

4. In September, stocked salmon became more segregated in the lake compared with July. The lake harvest at each of the eight sites consisted of a higher percentage (mean=36%) of Chinook stocked at those sites and nearby sites (mean =29%) suggesting that Chinook began staging in this period.

5. The majority of Chinook caught by tributary anglers in October were Chinook that were stocked at those sites. Of eight tributary sites sampled in October, 68% of the Chinook salmon on average originated at those tributaries, indicating good imprinting of both pen and direct-stocked Chinook salmon. The majority of Chinook strays in tributaries were Chinook stocked at nearby sites which benefit local fisheries, including streams not previously stocked.

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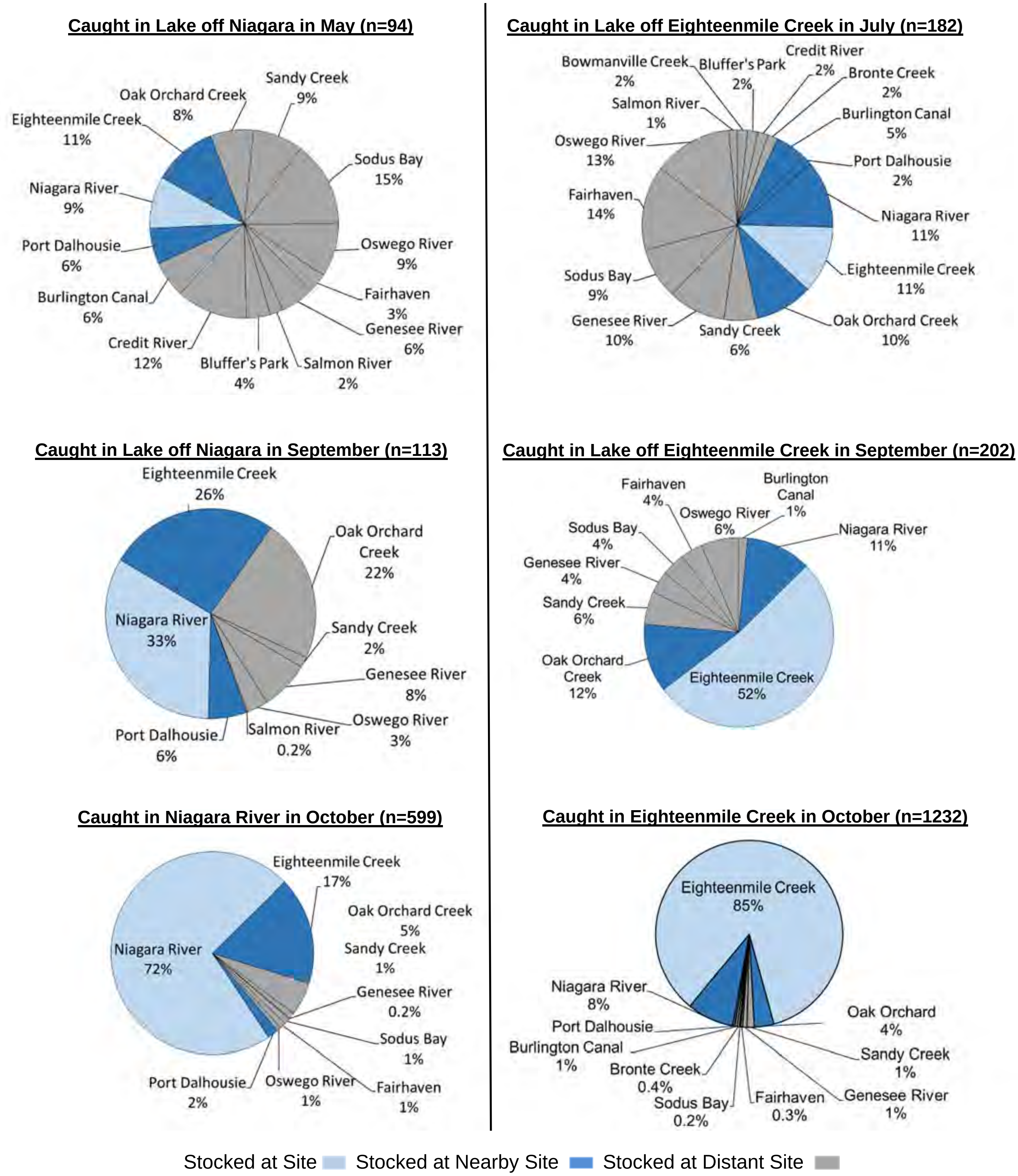


*Figure 2a. Stocking origin of Chinook salmon harvested by lake anglers off Niagara River in May and September; harvested by lake anglers off Eighteenmile Creek in July and September; and harvested by tributary anglers in October at both locations from 2011-2016. Each pie chart represents the percent composition of all tags recovered (# per 50,000 tagged) at each site in the aforementioned months from 2011-2016 including data from Chinook tagged in 2010, 2011 and 2013.*

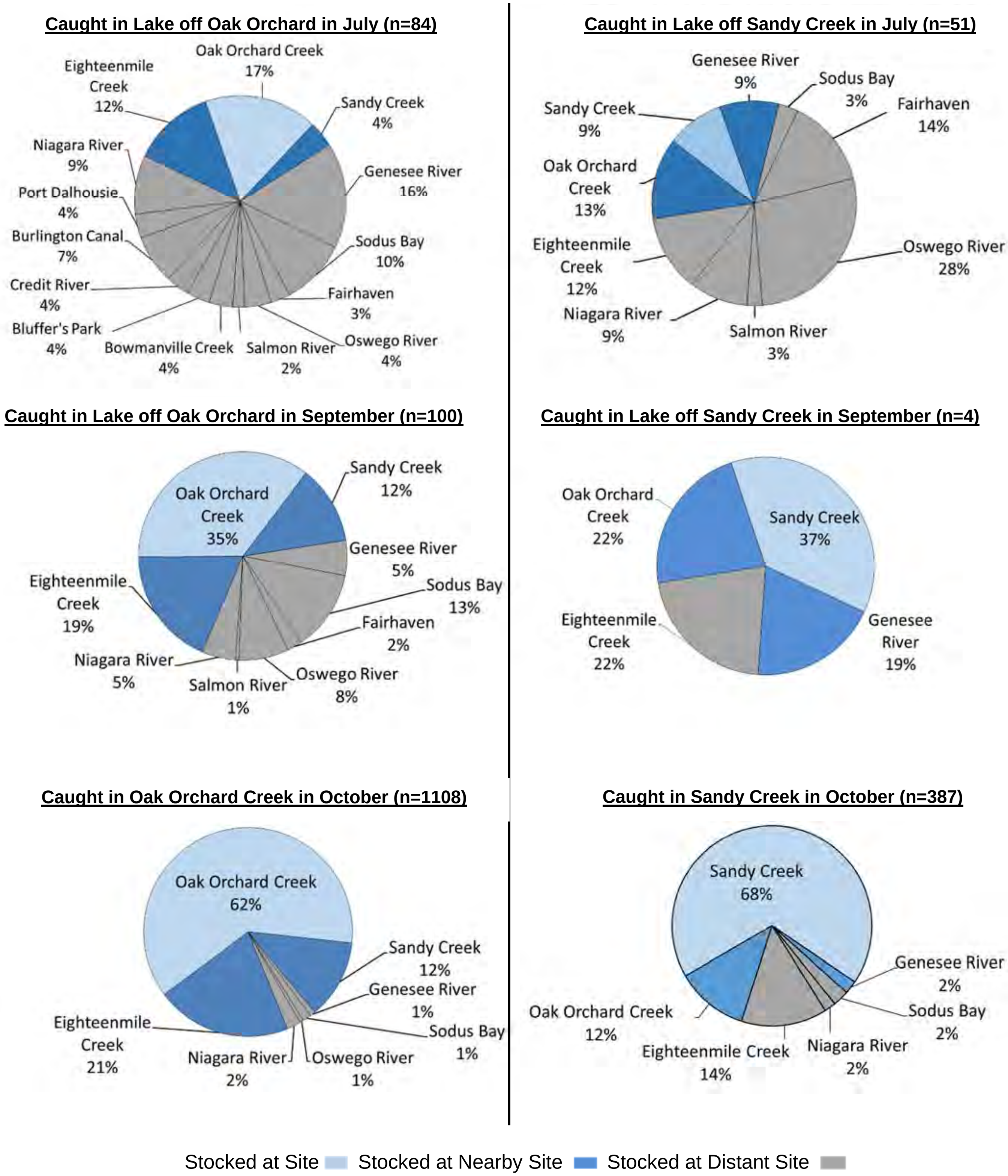


*Figure 2b. Stocking origin of Chinook salmon harvested by lake anglers off Oak Orchard and Sandy Creeks during July and September; and harvested by tributary anglers at both locations in October from 2011-2016. Each pie chart represents the percent composition of all tags recovered (# per 50,000 tagged) at each site in in the aforementioned months from 2011-2016 including data from Chinook tagged in 2010, 2011 and 2013.*

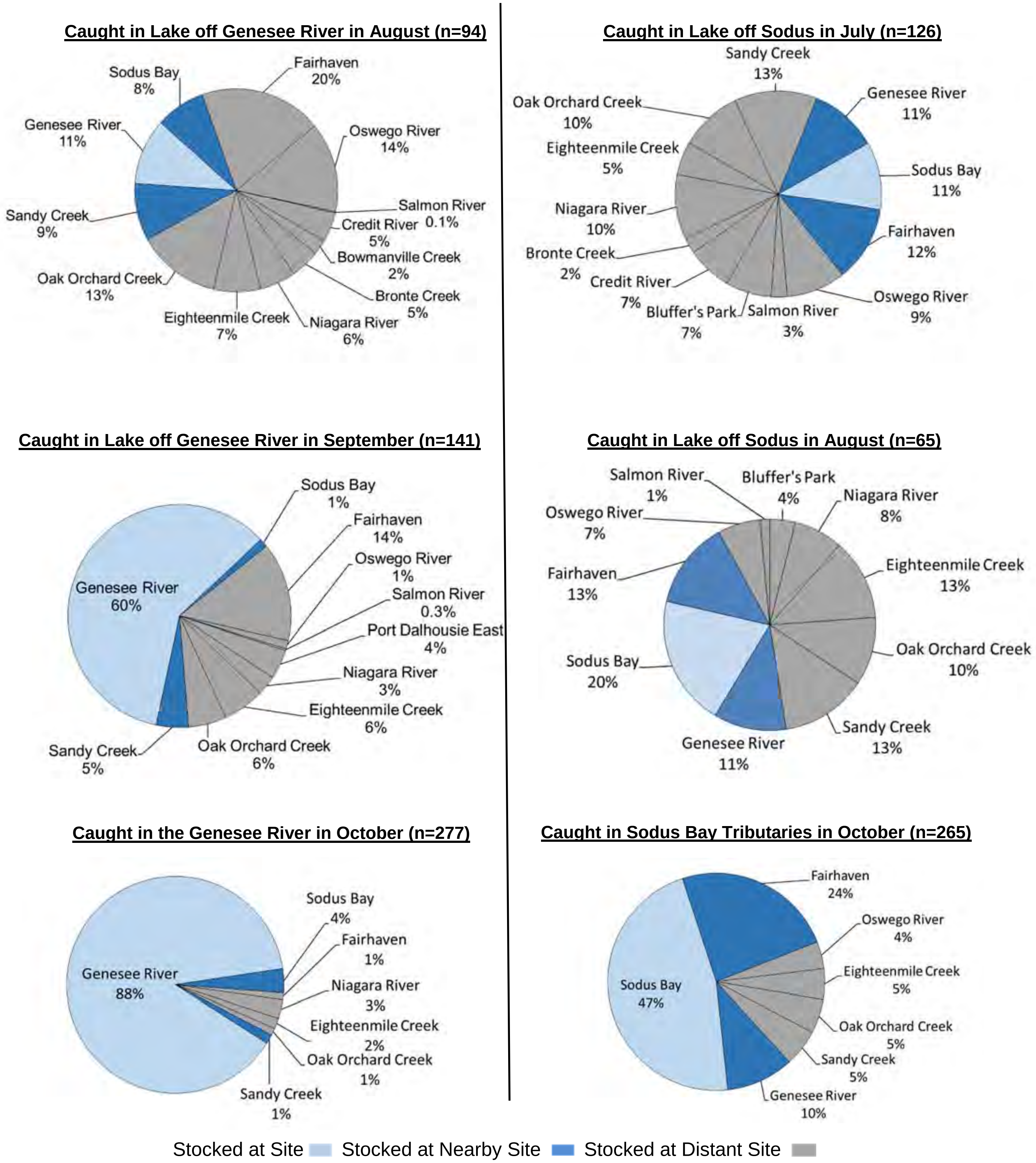


***Figure 2c. Stocking origin of Chinook salmon harvested by lake anglers off Genesee River in August and September; harvested by lake anglers off Sodus during July and September; and harvested by tributary anglers at both locations in October from 2011-2016. Each pie chart represents the percent composition of all tags recovered (number per 50,000 tagged) at each site in the aforementioned months from 2011-2016 including data from Chinook tagged in 2010, 2011 and 2013.***

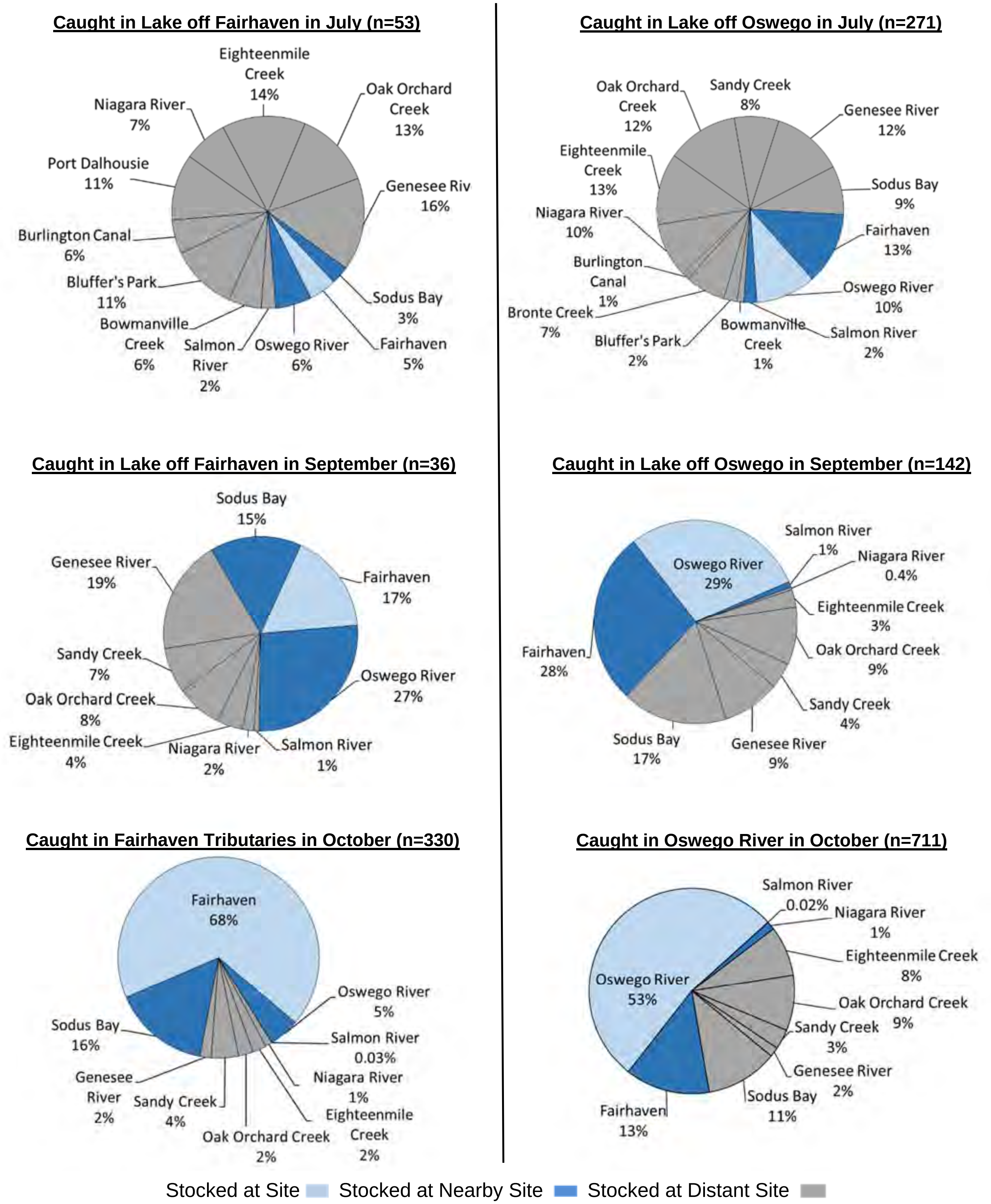


***Figure 2d. Stocking origin of Chinook salmon harvested by lake anglers off Fairhaven and Oswego during July and September; and harvested by tributary anglers at both locations in October from 2011-2016. Each pie chart represents the percent composition of all tags recovered (# per 50,000 tagged) at each site in the aforementioned months from 2011-2016 including data from Chinook tagged in 2010, 2011 and 2013.***

# Eastern Basin of Lake Ontario Warmwater Fisheries Assessment, 1976-2016

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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, 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 also proved valuable for examining impacts of Double-crested cormorant (*Phalacrocorax auritus*; DCC) predation on smallmouth bass and yellow perch populations in the eastern basin (e.g., O'Gorman and Burnett 2001, Lantry et al. 2002), and evaluating changes in body condition post-round goby (*Neogobius melanostomus*) invasion (Crane et al. 2015). This report focuses on 2016 abundance indices as they relate to previous years, and summarizes occurrence of round goby in predator diets, smallmouth bass age and growth trends, and walleye age structure.

## Methods

A standardized, stratified random design gillnetting assessment was conducted annually from 1976 through 2016 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 when there was any indication of net fouling or tampering and data from that set were excluded from analyses. In 1993, gear changed from multifilament 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 to be 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 water (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 alewife, 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 nets 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 to be zero when scheduled at a location with stable water temperatures <50°F for at least 9 ft off bottom.

In 2016, 29 randomly chosen netting locations were determined prior to initiation of the assessment on August 3. From August 3-14 we completed 26 unbiased net sets, one additional net set was canceled and catch of warmwater fish was assumed zero due to bottom water temperatures <50°F, and three net sets were biased and not re-set. Mean stratified catch-per-unit-effort (CPUE = fish per overnight net set) was calculated for each fish species captured and for the total warmwater fish catch. 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, total length (TL) and weight, and when possible sex and maturity (with the exception of longnose gar [*Lepisosteus osseus*]). Stomach contents of gamefish (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 2003-2016, in addition to scales, we collected otoliths from smallmouth bass >13.8 in, yellow perch >8.7 in, all walleye, and freshwater drum (*Aplodinotus grunniens*).

Species composition, depth stratum-specific species richness and CPUE, and trends in abundance indices were described. Additional data analyses completed for smallmouth bass include: 1) scales (1976-2016) and otoliths (2004-2016) were aged to determine age composition, age-specific CPUE and mean length-at-age; 2) relative weight (Wr) was determined for each fish (Wr = 100*actual weight ÷ standard weight [Ws]; where: $\log_{10}$ [Ws] = -5.329 + 3.20 [$\log_{10}$ TL]; Kolander et al. 1993, Anderson and Neumann 1996); 3) condition (Fulton's K) was calculated for each inch increment (7-19 in); and 4) average percent maturity of male and female age 1-7 bass sampled was determined.

## Results and Discussion

2016 Water Temperature

In 2016, bottom temperatures for all nets set in depth strata 1 (12-30 ft) and 2 (31-50 ft) ranged from 72.9°F to 77.4°F and 66.7°F to 75.4°F, respectively. In stratum 3 (51-100 ft), bottom temperatures at net set locations ranged from 49.3°F to 75.2°F. Four unbiased net sets in depth stratum 3 may have experienced some periods of water temperatures <50°F, given that 20 coldwater fish (4 cisco, 15 lake trout, and 1 rainbow smelt) were captured in those nets.

Species Richness and Composition

Since 1976, 45 fish species (34 warm and cool water species) were captured during the eastern basin gillnetting assessment (Table 1). In 2016, 614 fish were captured in unbiased net sets, representing 18 warm and cool water species (594 fish) and three coldwater species (20 fish). The greatest species richness and CPUE (14 species; CPUE=42.3) occurred in depth stratum 1, followed by depth strata 2 (10 species; CPUE=26.3) and 3 (5 species; CPUE=4.6). 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 cepedianum*) 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 gill net catches. From 1990-2013, smallmouth bass and yellow perch were the most common species, averaging 30.5% 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 and 2013 it was the third most commonly caught species and represented an average of 13.0% of the catch. Since then, white perch was the first (2014) or second (2015-2016) most commonly caught species, primarily due to reduced catches of other species. In 2015 and 2016, smallmouth bass was the most commonly caught species (30.1% of the 2016 total catch). Yellow perch was the third most commonly caught species in 2016 (19.1% of total catch).

Occurrence of Round Goby

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 spring bottom trawl assessment, and remaining at a variable, lower level since (Walsh et al. 2007, Weidel et al. 2017). Although present in Lake Ontario for some time, gobies did not appear in this assessment until 2005 when two were captured. Since then, they have appeared in low numbers (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.

Stomach contents from all predators captured were identified from 2000-2016. We first observed round gobies in predator diets in 2005 (i.e., a total of 16 gobies observed in bass stomachs). Their occurrence in smallmouth bass stomachs increased each year through 2013 when 84.0% of the non-empty bass stomachs contained goby. In 2014 and 2015, 76.3% and 71.7% of non-empty bass stomachs contained goby. In 2016, 78.9% of the 95 non-empty bass stomachs contained goby. Gobies were present in walleye diets each year from 2006-2010 and 2012-2016. Round gobies were also observed in the diets of northern pike, brown trout (*Salmo trutta*), lake trout, lake whitefish (*Coregonus clupeaformis*, rock bass (*Ambloplites rupestris*), yellow perch, and white perch. DCC in the eastern basin also consume round goby. Round goby first appeared in DCC 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), and were documented in DCC diets each year through 2013 (i.e., the most recent year of cormorant diet analysis; Johnson et al. 2010, Johnson et al. 2012, Johnson et al. 2013, Johnson et al. 2014). Gobies dominated DCC diets by 2004 at the Snake and Pigeon Island colonies, and by 2005 at the Little Galloo Island colony (Ross et al. 2005, Johnson et al. 2006).

Occurrence of Lake Sturgeon

Lake Sturgeon (*Acipenser fulvescens*) 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 (1976-1994; Table 1). From 1995-2016, at least one sturgeon was collected in 16 of the 22 years (two captured in 2016), suggesting improved population status. Improved status is likely attributable to restoration efforts (e.g., stocking and habitat improvement; Klindt and Gordon 2017).

Occurrence of Chain Pickerel

Chain pickerel (*Esox niger*) presence in Ontario waters was confirmed in 2008 (Hoyle and Lake 2011). This species was first captured in this assessment in 2013 when three were caught in two nets (each set in 15 ft water depth). Capture in this assessment is rare because nets are distributed at water depths 12-100 ft, beyond preferred chain pickerel habitat. It was also reported in angler catches during the Lake Ontario Fishing Boat Survey (FBS) each year 2008-2010 and 2013 (Lantry and Eckert 2017). Occurrence of chain pickerel in recent years is attributed to range expansion (Hoyle and Lake 2011). No chain pickerel were captured during this survey or reported during the FBS in 2014-2016 (Table 1; Lantry and Eckert 2017).

Index of Abundance: Total Warmwater Catch

The abundance index for warmwater fish in New York waters of Lake Ontario's eastern basin was highest during the early years of the assessment (1976-1979 mean CPUE=239) when the catch was dominated by white perch, yellow perch, gizzard shad, and rock bass (1976-1979 mean CPUEs = 90.1, 51.8, 34.7, and 13.5, respectively; Table 1, Figures 3-6). By 1984-1986, catch of these species declined nearly 80% (Table 1, Figure 2-6). 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). From 1996 to 2014, mean stratified CPUE for total warmwater fish varied without trend averaging 26.6 and ranging between 15.7 (2001) and 44.4 (2008; Table 1, Figure 2). CPUE declined in 2014 and 2015 to levels similar to the 1995 record low. In 2016, the mean stratified CPUE of 16.5 represents a 10.7% increase from 2015, but a 44.7% decrease compared to the previous 10-year (2006-2015) average. The recent reduced CPUE is largely attributed to decreased catches of yellow perch, smallmouth bass and white perch. Below average eastern basin water temperatures in recent years may have influenced fish distribution and production, and likely contributed to reduced catches.

Other species that influenced fish community trends in the eastern basin were alewife (*Alosa pseudoharengus*), walleye, and smallmouth bass. 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).

<u>White Perch Index of Abundance</u>

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% from the 1976-1979 to 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. CPUE has remained variable at about the same level since then (2008-2016 average = 4.8). Each year 2008-2011 and 2013 white perch was the third most common species in the assessment, representing 9.6%-19.4% of the total warm water fish catch (Table 1, Figure 3). In 2014, white perch CPUE (7.9) was comparable to 2008, but with the decrease in yellow perch CPUE, was the most commonly caught species (38.2% of total catch). It was the second mostly commonly caught species in 2015 and 2016 (CPUEs = 3.7 and 3.5, respectively).

<u>Yellow Perch Index of Abundance</u>

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, and remained near that level through 2013. Then catches declined and were at the lowest levels recorded in 2014 and 2015 (CPUEs = 1.7 and 0.8 fish per net night, respectively; Table 1). In 2016, catches increased to 3.1 fish per net night; however remained well below (-70.5%) the previous 10-year average. This decrease may be partly attributable to water temperature patterns and catch variability; however, angler reports of reduced catches (anecdotal and as reported in Lantry and Eckert 2017) suggest a lower yellow perch abundance in recent years.

Variability of yellow perch catch in gill nets is relatively high (long-term average RSE=37.7%) when compared to smallmouth bass (long-term average RSE=20.7%), and is likely attributable to the schooling nature of perch. For 2016, yellow perch RSE (47.7%) was the third highest in the data series and 26.5% higher than the long-term average.

Reduced population size and/or changes in distribution are likely contributing factors to reduced gillnet catches of yellow perch in 2014 to 2016. Yellow perch populations have been in decline in Ontario waters (e.g., Bay of Quinte and Ontario eastern outlet basin) for several years, as determined from the annual index netting and commercial fishery catches (OMNRF 2017), but only recently declined in New York waters (Figure 4). Although there were some reports of improved yellow perch fishing in 2016, angler catches reported in the Lake Ontario Fishing Boat Survey (Lantry and Eckert 2017) and several anecdotal reports of reduced fishing quality from eastern basin anglers indicates a reduced population. Yellow perch abundance, distribution and growth was likely influenced, in part, by two consecutive long, cold winters (2013/2014 and 2014/2015) followed by below average summer temperatures (2014 and 2015). More colder water within the area surveyed as compared to previous years may have contributed to the substantially decreased catches in 2014 and 2015 (the lowest values recorded; 1.7 fish/net and 0.8 fish/net, respectively).

DCC predation contributed to reduced population size during the 1990s (O'Gorman and Burnett 2001), however, we do not attribute the recent (2014-2016) reduced catch of yellow perch during this assessment to DCC predation. First, DCC population management began in 1999 and resulted in reduced DCC feeding days (the measure used to evaluate management efforts) and reduced fish consumption (i.e., reduced predation pressure on yellow perch; Johnson et al. 2010). Predation pressure on yellow perch was also reduced over a decade ago when round goby became the species most commonly consumed by the opportunistic DCC (Johnson et al. 2014).

In 2016, yellow perch total lengths ranged between 7.0 in (179 mm) and 11.9 in (303 mm), and averaged 8.5 in (215 mm). Approximately 22% of perch captured were ≥ 9 in (≥ 228.6 mm; Figure 17). Weights of yellow perch captured in 2016 ranged from 2.6 oz (73.0 g) to 15.6 oz (443.0 g).

Gizzard Shad Index of Abundance

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 23 of the 26 years from 1987-2012 (Table 1). In 2013, gizzard shad CPUE (2.01) increased to the highest level since 1981 (CPUE=2.8), likely due to the warm winters in 2011-2012 and 2012-2013. Since then gizzard shad CPUE has been low and variable (2016 CPUE = 0.7 fish per net night).

Rock Bass Index of Abundance

Rock bass CPUE peaked in 1978 at 22.1, declined through the early 1980s, varied without trend through the early 1990s. Abundance subsequently declined, and has been at a relatively stable level since 2011 (Figure 6). In 2016, the rock bass CPUE (1.4) was a slight decrease (-9.7%) compared to the previous 10-year average.

Alewife Index of Abundance

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. Catch of alewife was consistently low since the mid-1990s (2016 CPUE = 0.02 fish per net night). Although alewife is not fully vulnerable to our gear, the trend we observed was similar to those in Lake Ontario bottom trawl surveys (O'Gorman et al. 2000, Walsh et al. 2010). Declining alewife abundance and a shift in temporal distribution were particularly evident in the eastern basin (O'Gorman et al. 2000, O'Gorman et al. 2005).

Walleye Index of Abundance and Age Structure

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, but has remained relatively stable since the late 1990s (Figure 8). The 2016 CPUE of 1.3 was a 14.3% increase compared to 2015 and a 22.5% decrease compared to the previous 5-year average. The walleye population, however, is expected to remain near levels observed during the last decade because of strong year classes produced in 2011 and 2014. Variability of gill net catches was highest when CPUE was low (Figure 8) with RSE averaging 44.6% during 1980-1989. RSE fluctuated at a lower level without trend from 1990-2016 (average RSE=26.5%).

Walleye ages, interpreted from otoliths, indicated that strong year classes were produced in 2003, 2005, 2008, 2011, and 2014 (Figure 18). The 2003 year class was first captured at age 1 in 2004 when they represented 25.9% of the catch (n=21 age-1 fish; a record-high; Eckert 2005). Prior to 2004, age 1 walleye were rare in this assessment (n=17 during 1976-2003). Assessments in Ontario waters of Lake Ontario and New York waters of Lake Erie also identified a strong 2003 walleye year class (Einhouse et al. 2010, OMNR 2011a and 2011b). By 2016, the 2003 year class represented only 2.0% of total catch and CPUE was only 0.02 indicating that few fish from that year class remain. Good to strong 2005 and 2008 year classes were produced in Ontario waters (OMNR 2009, 2011a) and were well represented in this assessment until recently.

More recently, fall bottom trawling in the Bay of Quinte indicated that strong 2011 and 2014 year classes were produced there (OMNR 2012, OMNRF 2015). The 2015 and 2016 gillnet catches of age-4 and age-5 walleye in this assessment indicated good production of the 2011 year class in New York waters (15.4% and 6.1% of total walleye catch; Figure 18). In August 2016, the 2011 year class averaged 23 inches in length. Good production of the 2014 year class in New York waters was first evident in 2015 when 10.3% of the walleye catch in this assessment were age-1 (i.e., 2014 year class fish). In 2016, this year class (age 2) represented 30.6% of the walleye catch. Average length of this year class was 16.3 inches. In 2017, the 2014 year class will be age 3 and most will likely be just over the legally harvestable length of 18 inches. Strong year class production in the Bay of Quinte also occurred in 2015 (OMNRF 2016). Three age-1 fish from the 2015 year class (average length = 12.8 inches) were captured during 2016 netting.

In 2016, walleye total lengths ranged between 12.0 in (306 mm) and 29.3 in (743 mm), and averaged 22.1 in (561.5 mm; Figure 17). Walleye weights ranged from 9.6 oz (272 g) to 11.3 lb (5,135 g) and averaged 5.3 lb (2,384 g).

<u>Smallmouth Bass Abundance Trends, Growth, Condition, Maturity, and Age Composition</u>

Smallmouth bass have provided an important sport fishery in Lake Ontario's eastern basin for decades (Jolliff and LeTendre 1967, Panek 1981, NYDEC 1989, McCullough and Einhouse 1999, McCullough and Einhouse 2004). By the early 2000s, the eastern basin fish community was being impacted by many perturbations including reduced lake productivity, Dreissenid mediated ecosystem changes (e.g., increased water clarity), increased abundance of DCC, and a variety of invasive species (e.g. *Bythotrephes*, *Cercopagis*, round goby). Studies demonstrated that the DCC population was contributing to reduced populations of smallmouth bass and yellow perch at that time (e.g., Adams et al. 1999, NYSDEC 1999, NYSDEC 2001, O'Gorman and Burnett 2001, Lantry et al. 2002), but direct impacts of other system stressors were not well understood. Angler surveys reported reduced smallmouth bass fishing quality in the eastern basin (Eckert 1999, McCullough and Einhouse 1999). By 2001, the smallmouth bass population declined to the lowest level in the data series (Figure 9). DCC management was initiated in 1999 and management plan objectives were met by 2006 (McCullough and Mazzocchi 2014). Meanwhile additional stressors were emerging including Type-E Botulism (early to mid-2000s), Viral Hemorrhagic Septicemia virus (VHSv; 2005 with a major NY outbreak effecting bass in 2006), and *Hemimysis anomola* (bloody red shrimp; 2006).

The index of abundance for Lake Ontario's eastern basin smallmouth bass population was improved during 2005-2013 from the 2000-2004 record lows; however, those levels were lower than expected following achievement of DCC population management objectives. In addition, smallmouth bass have not produced strong year classes relative to those produced in the 1970s and 1980s. In recent years, year classes that appeared improved relative to other recent year class did not persist and 2014-2015 CPUEs declined. Smallmouth bass CPUE in 2016 remained low (5.0 fish per net night) and comparable to (+6.3%) 2014-2015 levels. Factors confounding comparisons of recent to historic data include increased bass growth resulting in accelerated recruitment to assessment gear, and earlier maturation that may be affecting bass longevity. These issues are discussed in detail in the following sections.

*Abundance Trends 1976-2016*

Smallmouth bass CPUE peaked during the 1979-1980 and 1989-1991 periods (1979-1980 average CPUE = 36.9, 1989-1991 average CPUE = 30.1; Table 1, Figure 9), attributable to strong 1973 and 1983 year classes during these respective time periods (Figures 9, 19, 20a, 20b). These strong year classes were evident in gillnet catches through at least age 8 when CPUEs were 9.4 and 4.4, respectively (Chrisman and Eckert 1999; Figures 19, 20b).

Smallmouth bass CPUE declined through the early 1990s and reached record-low levels during 2000-2004 (2000-2004 mean CPUE=4.2; Figures 9, 19, 20a). Relatively high CPUE of young fish indicated production of moderately strong year classes in 1987 and 1988 (Chrisman and Eckert 1999, Eckert 2000, Casselman et al. 2002; Figures 19, 20a, 20b); however, increased CPUE of these year classes at older ages (i.e., ages $\geq$ 5) was not evident (Figures 19, 20b). Unlike the strong 1973 and 1983 year classes, the moderately strong 1987 and 1988 year classes were nearly absent by age 8 (CPUEs 0.4 and 0.5, respectively). Analysis of year class-specific catch curves 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 DCC numbers (Johnson et al. 1999, Johnson et al. 2000). This, combined with DCC diet data, corroborated substantial predation on smallmouth bass (Johnson et al. 1999, Johnson et al. 2000, Lantry et al. 2002).

From 2005 through 2013, average smallmouth bass CPUE (mean CPUE=8.6) was more than 2-fold higher than the 2000-2004 record lows (mean CPUE=4.2). These improved CPUEs, however, were similar to the 1994-1999 time period when catches were well below historic levels (-62.2%), fishing quality was relatively poor (Eckert 1999), and anglers and fishery managers were concerned about the status of the bass population (NYSDEC 1999; Figure 9). The CPUE increase in 2005 is attributed to the 2002 year class, which represented 33.8% of the catch in 2005 (age 3; Figure 20b). CPUE of the 2002 year class peaked in 2005 (CPUE=3.8), then declined, and was nearly absent from the population by age 8 (2010 assessment, CPUE=0.8). The 2005 year class dominated 2008 and 2009 catches (ages 3 and 4, respectively), representing 37.1% and 48.3% of total smallmouth bass catch, respectively. Catch of the 2005 year class declined each year since 2009 and, by 2016 (age 11), CPUE was only 0.2 fish per net night (Figure 20b). The production of poor to weak year classes since 2005 resulted in the low CPUEs observed 2014 through 2016 (i.e., levels only 18.3% higher than during the 2000-2004 time period).

*Growth*

Lake Ontario's eastern basin bass population experienced changes in growth rates over the 1976 to 2016 time period which confound comparisons of "historic" (prior to mid-1990s) data with more recent data, including age-specific CPUE and survival. Prior to the mid-1990s, assessment gill nets did not effectively sample age-2, -3, or -4 smallmouth bass because of their relatively small size (mean lengths-at-age $\leq$ 11.1 in; Figure 21). Bass are not fully vulnerable to assessment nets until approximately 12 in TL. Prior to the mid-1990s, bass reached 12 in TL by approximately age 5 or 6. Evidence of increased growth rates were observed in the mid-1990s which is before first reports of round goby in Lake Ontario (i.e., 1998 in the southwest portion of the lake and 1999 in Bay of Quinte). Increased growth rates at that time were likely due to system changes associated with Dreissenid mussel proliferation and/or compensatory growth associated with a declining bass population (Figure 9). Age-1 bass first appeared in the assessment in 1994 and appeared in low numbers most years since. Beginning in 1997, at least a portion of bass as young as age 3 reached 12 in TL (Figures 21 and 22). By the mid to late 1990s age-specific annual mean TLs were generally above age-specific long-term means for all ages (2-13; Figure 21).

Mean length-at-age continued to increase following establishment of round goby in the system and in bass diets. Unlike early years of this survey, gill nets could effectively sample many age-2 and age-3 bass, and likely all age-4 bass (Figure 21). By 2010, a portion of bass sampled reached 12 in TL by age 2 (Figure 22), and average length of age-3 bass was over 12 in TL in 2010, 2012, and 2014. From the mid-2000s through 2014, mean length-at-age remained at or near record high for all ages 2-10. In 2016, mean length-at-age remained near record high levels for bass ages ≥ 4; however, for several of these age groups mean lengths declined relative to recent years (Figure 21).

Record cold winters (2013/2014 and 2014/2015) followed by below average summer temperatures likely contributed to the substantial decrease in growth observed in young bass. In 2015, mean length-at-age remained at or near record highs for all ages except for age-2 bass, which was the shortest average (7.8 in) since 1992 (7.6 in) and approximately two inches shorter than the previous three years (Figure 21). In 2016, when those bass were caught at age 3, mean length was only 10.4 in, the shortest for age 3 bass since 2005. These bass hatched in 2013 and likely experienced only about four months of good growth before experiencing the record cold winter of 2013/2014, followed by below average summer 2014 temperatures. These fish were then subjected to a second, record cold winter (2014/2015), followed by below average temperatures in summer 2015. Colder water temperatures can slow metabolism, resulting in reduced growth rates. Growth rates of these age-2 bass may have also been impacted by prey availability during the extended period of cold temperatures.

In 2016, smallmouth bass total lengths ranged between 6.9 in (176 mm) and 21.1 in (536 mm), and averaged 12.7 in (322 mm; Figure 17). Bass weights ranged from 3.0 oz (84 g) to 6.3 lb (2,850 g) and averaged 1.6 lb (742 g).

*Condition*

Condition of smallmouth bass in the eastern basin began increasing in the mid-2000s (Figure 23). This coincided with a shift from a diet dominated by crayfish and no round goby, to one dominated by round goby and very low occurrence of crayfish. Smallmouth bass condition varied about the long-term mean from 1976-2005, then increased for all length groups by 2006 (Figure 23). Condition of bass in 2016 remained good and within the range of values observed in recent years (Figure 23). Crane et al. (2015) found a significant increase in smallmouth bass condition following invasion of round goby into lakes Ontario and Erie. Increased condition of bass ≥ age 2 indicates that they are not limited by prey availability.

Mean relative weight varied without trend 1976-2005 and averaged 96.1 (range: 92.1 [1984] - 100.8 [2005]) suggesting that during that time period the bass population was likely in balance with the food supply (Flickinger and Bulow 1993; Figure 24). Each year beginning in 2006, mean relative weight exceeded 105 (2006-2016 average=107.6) indicating that the system could support more fish (Flickinger and Bulow 1993).

In addition to increased growth and condition, an increasing contribution of large smallmouth bass (i.e., ≥ 4 lb) in assessment nets was documented (Figure 25). Prior to 1991, no bass > 4 lbs were caught. The first bass ≥ 4 lbs was caught in 1992 (0.2% of total [n=483] catch). Beginning in 1998, bass ≥ 4 lbs were caught with increasing regularity. In 2016, the proportion of bass caught that weighed ≥ 4 lbs declined from the 2015 high (32.6%) to 13.6% of all smallmouth bass caught (n=184; Figure 25). Bass weighing ≥ 5 lbs were caught each year since 2005 and remained near record high in 2016 (4.9% of all bass caught). Bass ≥ 6 lbs were first caught in the 2005 survey (0.2% of total smallmouth bass caught), and again in 2011. Each year 2011-2016, 0.3-1.1% of bass caught weighed more than 6 lbs. These increases are attributed to good growth and condition (Figures 21, 23-25) and are not due to increased abundance of older aged bass (Figure 19).

*Maturity and Longevity*
Fish populations with increased growth rates tend to mature at earlier ages (e.g., Carlander 1969, 1977, 1997; Heibo et al. 2005). Analysis of percent maturity of male and female bass ages 1-7 sampled prior to (1976-1995) and after (1996-2016) the observed increased growth rates indicated that a higher percentage of bass matured at younger ages in recent years (Figure 26). This began as early as age 2 for both males and females. For example, an average of 28.9% of age-4 females were identified as mature during 1976-1995 compared 62.7% mature during 1996-2016 (Figure 26). For both time periods and sexes, ≥99.3% of the smallmouth bass sampled were mature by age 7. Across the time series, a higher percentage of male bass were mature at age 2-5 than female bass (Figure 26).

Life span is generally shorter where growth is faster (e.g., Carlander 1969, 1977, 1997; Heibo et al. 2005), further confounding population structure evaluations. CPUE of older bass was evaluated to determine if abundance of older bass declined following increased growth rates. During 1976-1995, mean CPUE of age 10+ smallmouth bass was 1.8 (range: 0.4-3.6; Figure 27). Since then (1996-2015), mean CPUE was 67.9% lower (mean CPUE=0.59; range: 0.3-1.1). Increasing growth of older bass (ages 8+) was observed as early as about 1990 (Figure 21) and may have influenced bass life span; however, this also coincides with a period of reduced survival rates that were attributed to DCC predation (Chrisman and Eckert 1998; Lantry et al. 2002). The year classes that reached age 10+ in recent years were impacted by DCC predation, improved growth (Figure 21), and mostly poor year class production (Figure 20a), all of which can contribute to continued relatively low CPUE of bass ages 10+ (Figure 27).

*Age Composition and Year Class Strength*
Age composition of the smallmouth bass catch is influenced by several factors including, assessment net mesh size, size-selective predation by DCC, and year class strength. Through 1994, bass catches were dominated by age-5+ bass (1976-1994 mean CPUE=16.1, representing 73.2% of total bass catch; Figure 19). Catches of bass ≤ age 4 were substantially lower (1976-1994 mean CPUE=5.5 representing an average of 26.8% of total bass catch; Figure 19). Through the 1990s and early 2000s, ecosystem changes, increasing DCC predation and accelerated bass growth rate influenced age-specific CPUE and age composition of bass caught in nets. Since 1995, CPUE of age-5+ bass varied at a lower level than the previous time period, averaging 3.2 and representing 47.7% of the total bass catch (80.2% and 34.9% decreases, respectively). There is no evidence of a strong year class persisting strongly at ages ≥5 since the 1983 year class (Figure 19). CPUE of younger bass (ages ≤ 4) also decreased during 1995-2016 (mean CPUE=3.7) relative to 1976-1994 (mean CPUE=5.5; Figure 19), despite increased vulnerability to capture due to increased growth.

Most recently, size-selective predation by cormorants was likely not having a substantial impact on the bass population because of effective DCC population management and a shift in DCC diets to round goby. Despite reduced predation pressure, CPUE of bass ≤ age 4 was 33.0% below the earlier time period (1976-1994) when bass of the same age were less vulnerable to gill nets due to slower growth rates (Figures 19 and 21). In 2016, despite reduce mean length-at-age of age-3 and age-4 bass and possibly lower vulnerability to capture, CPUE of bass ≤ age 4 improved to 3.2 bass per net night from last year's record low.

I further evaluated age composition of smallmouth bass ≥ 12 in TL because they are both fully vulnerable to assessment nets across the entire 41-year time series and are harvestable in the sport fishery (i.e., minimum harvestable size is 12 in TL). Age structure of bass ≥ 12 in TL changed such that for years prior to the mid-1990s, 98.1%

(1976-1996 mean) of bass ≥ 12 in were age 5 and older (Figure 22). The increased growth rate since the mid-1990s resulted in some bass reaching 12 in TL at a younger age (Figure 21). During 1997-2016, between 50.5% (2009) and 94.2% (2004) of the bass ≥ 12 in TL were age 5 and older (1997-2005 average=82.2%; 2006-2016 average=74.8%). The contribution of younger bass (i.e., ages 2-4) that were 12 in TL increased from an average of 1.9% prior to 1997 to 21.9% since 1997 (1997-2005 average=17.9%; 2006-2016 average=25.2%; Figure 22).

*Discussion – Smallmouth Bass*

Fish communities in Lake Ontario have been impacted by many perturbations that have altered habitat, productivity, food web linkages, and population dynamics. These include water level regulation, phosphorus declines, DCC population increases, and invasive species (e.g., Dreissenid mussels, round goby, *Bythotrephes*, VHSv). Ongoing changes in the Lake Ontario ecosystem confound predictability. Although it is unlikely that the system will support bass abundance at pre-1990s levels, the production of only poor to weak year classes in recent years occurs at a time when conditions appear favorable for good year class production and recruitment.

Predation of bass by DCC in the eastern basin was substantially reduced nearly a decade ago when round goby became the dominant prey item for DCCs and DCC management reduced the number of cormorant feeding days to near the target level (Ross et al. 2003, Johnson et al. 2005, McCullough and Mazzocchi 2014, Johnson et al. 2014). Round goby is now an important and abundant prey item for smallmouth bass. Increased growth and condition indicate that the bass population (ages ≥ 2) is not limited by food availability. Finally, warm summer water temperatures during 2008, and 2010-2013 were expected to produce good to strong year classes given the positive correlation between mean summer (June-August) water temperatures and smallmouth bass recruitment (e.g., Casselman et al. 2002, Einhouse et al. 2002); however, the year class-specific catch curves for these year classes indicate that they are only poor to weak (Figure 20). Below average summer temperatures during 2014 and 2015 likely resulted in two additional years of poor production.

A number of other factors can impact bass recruitment including condition of spawning habitat, predation on bass eggs or fry by round goby or other predators, prey availability for young-of-year bass, and VHSv. Increased *Cladophora* growth in nearshore areas may impact the condition of spawning habitat and consequently bass recruitment; however, impacts are unknown, as are potential impacts of round goby predation. Prey availability for bass from fry to age 1 is unknown and may be impacted, through competition for prey with the invasive macroinvertebrate *Hemimysis* sp. In 2006, bass die-offs in Lake Ontario's main basin and eastern basin and in the St. Lawrence River were attributed to VHSv. It is unclear if VHSv mortality events have occurred since, or will occur in the future, or if VHSv is hindering bass reproductive success.

To better understand eastern basin smallmouth bass population dynamics and manage the sportfishery we need to correct gill net catch data for the change in selectivity by age. Selectivity by size has not changed over the time series; therefore, analysis of size-specific CPUE may improve our ability to compare historic and recent population metrics (i.e., year class strength, abundance, recruitment dynamics, growth, survival, maturity, longevity).

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***Table 1. Stratified mean catch per unit effort data from the 1976-2016 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 | 1988 |
| Lake Sturgeon | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Longnose Gar | 0 | 0 | 0 | 0 | 0.04 | 0 | 0 | 0.04 | 0 | 1.19 | 0.04 | 0 | 0 |
| Bowfin | 0 | 0 | 0 | 0 | 0.02 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| American Eel | 0 | 0 | 0.06 | 0.03 | 0 | 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 | 9.64 |
| 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 | 0.24 |
| 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 | 0 |
| Chain Pickerel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Muskellunge | 0 | 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 | 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 | 0.23 |
| Golden Shiner | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0.04 | 0.02 | 0 | 0 | 0 |
| Spottail Shiner | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.15 | 0 | 0 | 0 | 0 | 0 |
| Quillback | 0 | 0 | 0 | 0.31 | 0.04 | 0.06 | 0 | 0.04 | 0 | 0 | 0.02 | 0 | 0.02 |
| Longnose Sucker | 0 | 0 | 0 | 0 | 0.02 | 0 | 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 | 0.91 |
| 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 | 0.07 |
| Shorthead Redhorse | 0 | 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 | 0.61 |
| 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 | 0.97 |
| Stonecat | 0 | 0.04 | 0.26 | 0.08 | 0 | 0.23 | 0.30 | 0.02 | 0.04 | 0.06 | 0.04 | 0 | 0 |
| Trout-perch | 0 | 0 | 0 | 0 | 0 | 0.15 | 0.15 | 0 | 0.08 | 0 | 0 | 0.08 | 0.15 |
| White Perch | 63 | 136.4 | 74.11 | 86.98 | 26.2 | 44.53 | 25.98 | 34.02 | 20.78 | 12.23 | 13.94 | 11.14 | 4.87 |
| White Bass | 0 | 0 | 0.13 | 0 | 0.02 | 0.06 | 0.26 | 0 | 0.06 | 0.02 | 0.06 | 0.06 | 0.13 |
| 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 | 4.94 |
| Pumpkinseed | 0 | 0.44 | 0.06 | 3.06 | 0.14 | 0.32 | 0.73 | 0.43 | 0.09 | 0.59 | 0.57 | 0.40 | 0.25 |
| Bluegill | 0 | 0 | 0 | 0 | 0 | 0 | 0.04 | 0 | 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 | 15.92 |
| Largemouth Bass | 0 | 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 | 0.02 |
| 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 | 2.19 |
| 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 | 0.80 |
| 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 | 0.45 |
| Round Goby | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 209.4 | 257.1 | 237.8 | 252.8 | 119.7 | 136.4 | 101.2 | 116.8 | 86.50 | 51.38 | 68.30 | 43.98 | 42.42 |

***Table 1 (continued). Stratified mean catch per unit effort data from the 1976-2016 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 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 |
| Lake Sturgeon | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0.02 | 0.06 | 0.04 | 0.10 | 0.02 | 0 |
| Longnose Gar | 0 | 0.08 | 0 | 0 | 0.48 | 0.35 | 0 | 0 | 0.02 | 0.02 | 0.08 | 0 | 0.02 | 0 |
| Bowfin | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| American Eel | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Alewife | 0.59 | 1.29 | 1.27 | 2.26 | 0.18 | 0 | 0.48 | 0.92 | 0 | 0.06 | 0.12 | 0.26 | 0.95 | 0.02 |
| Gizzard Shad | 0.69 | 1.26 | 1.39 | 1.79 | 0.12 | 0.06 | 0 | 0 | 0 | 0.08 | 0.08 | 0.13 | 0 | 0.06 |
| Northern Pike | 0.02 | 0 | 0.15 | 0.04 | 0.10 | 0.06 | 0.04 | 0.04 | 0.08 | 0.06 | 0.06 | 0.08 | 0.07 | 0.19 |
| Chain Pickerel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Muskellunge | 0 | 0 | 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 | 0 | 0 |
| Common Carp | 0.37 | 0.35 | 0.29 | 0.33 | 0.35 | 0.06 | 0.10 | 0.15 | 0.12 | 0.10 | 0.33 | 0.04 | 0 | 0 |
| Golden Shiner | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Spottail Shiner | 0 | 0 | 0 | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Quillback | 0.04 | 0.04 | 0.08 | 0 | 0.04 | 0 | 0 | 0.04 | 0 | 0.04 | 0 | 0 | 0 | 0 |
| Longnose Sucker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Sucker | 0.75 | 3.47 | 0.41 | 0.88 | 1.18 | 0.81 | 1.13 | 2.01 | 1.31 | 1.02 | 1.02 | 0.35 | 0.38 | 0.78 |
| Silver Redhorse | 0.17 | 0.29 | 0.22 | 0.18 | 0 | 0.08 | 0.12 | 0.02 | 0.13 | 0.12 | 0.10 | 0.12 | 0.05 | 0.17 |
| Shorthead Redhorse | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0.02 | 0 |
| Brown Bullhead | 0.84 | 0.66 | 0.86 | 0.87 | 0.35 | 0.35 | 0.06 | 0 | 0.83 | 0.06 | 0.21 | 0.21 | 0.32 | 0.21 |
| Channel Catfish | 2.40 | 3.34 | 1.20 | 1.35 | 1.12 | 0.35 | 0.19 | 0.47 | 1.42 | 0.75 | 0.68 | 0.54 | 0.09 | 0.21 |
| Stonecat | 0.02 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Trout-perch | 0 | 0 | 0.12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Perch | 7.95 | 4.36 | 7.83 | 5.49 | 5.04 | 6.01 | 0.06 | 0.31 | 0.48 | 0.29 | 1.36 | 0.92 | 1.04 | 1.09 |
| White Bass | 0.08 | 0 | 0.10 | 0 | 0.02 | 0 | 0 | 0 | 0 | 0.04 | 0 | 0 | 0 | 0 |
| Rock Bass | 7.53 | 8.08 | 6.86 | 3.09 | 6.99 | 3.99 | 1.41 | 3.79 | 2.33 | 2.13 | 3.08 | 1.47 | 1.22 | 1.10 |
| Pumpkinseed | 0.64 | 0.78 | 0.14 | 0.34 | 0.23 | 0.04 | 0.06 | 0.04 | 0.08 | 0.29 | 0.27 | 0.31 | 0.28 | 0.46 |
| Bluegill | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Smallmouth Bass | 39.05 | 21.72 | 29.4 | 19.13 | 19.91 | 11.99 | 5.01 | 6.98 | 6.03 | 9.36 | 10.68 | 5.01 | 2.99 | 3.76 |
| Largemouth Bass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0 |
| Black Crappie | 0.02 | 0.06 | 0 | 0 | 0.04 | 0 | 0 | 0 | 0 | 0.02 | 0 | 0 | 0 | 0.06 |
| Yellow Perch | 10.06 | 13.61 | 6.97 | 6.72 | 2.78 | 5.87 | 3.68 | 8.76 | 5.53 | 5.01 | 4.47 | 8.58 | 6.37 | 9.65 |
| Walleye | 0.96 | 1.31 | 1.68 | 1.59 | 3.84 | 3.29 | 1.91 | 2.97 | 1.76 | 2.13 | 1.32 | 1.53 | 1.70 | 1.08 |
| Freshwater Drum | 0.53 | 0.62 | 0.34 | 0.43 | 0.52 | 0.74 | 0.63 | 0.23 | 0.41 | 0.25 | 0.50 | 0.25 | 0.20 | 0.23 |
| Round Goby | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total | 72.71 | 61.35 | 59.34 | 44.57 | 43.32 | 34.08 | 14.91 | 26.73 | 20.58 | 21.94 | 24.40 | 19.92 | 15.73 | 19.06 |

***Table 1 (continued). Stratified mean catch per unit effort data from the 1976-2016 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 | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
| Lake Sturgeon | 0.04 | 0.02 | 0.02 | 0.09 | 0.10 | 0 | 0 | 0.08 | 0.02 | 0 | 0.02 | 0 | 0.063 | 0.05 |
| Longnose Gar | 0 | 0.06 | 0.17 | 0.12 | 0.08 | 0.10 | 0.21 | 0.75 | 0.62 | 0.02 | 0.23 | 0.44 | 0.67 | 0 |
| Bowfin | 0 | 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 | 0 |
| Alewife | 0.08 | 0 | 0 | 0.07 | 0.14 | 0.19 | 1.19 | 0 | 0.16 | 0.46 | 0 | 0.31 | 0.47 | 0.02 |
| Gizzard Shad | 0 | 0 | 0 | 0 | 0 | 0 | 0.10 | 0 | 0.12 | 0.19 | 2.08 | 0.32 | 1.09 | 0.70 |
| Northern Pike | 0.15 | 0.17 | 0.19 | 0.08 | 0.06 | 0.23 | 0.09 | 0.10 | 0.02 | 0.02 | 0.12 | 0.12 | 0.02 | 0.02 |
| Chain Pickerel | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.06 | 0 | 0 | 0 |
| Muskellunge | 0 | 0.02 | 0.02 | 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 | 0 | 0.00 |
| Common Carp | 0.02 | 0.15 | 0.14 | 0.11 | 0.02 | 0.05 | 0.10 | 0.02 | 0.02 | 0 | 0.15 | 0.11 | 0.05 | 0.08 |
| Golden Shiner | 0 | 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 | 0 |
| Quillback | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.08 | 0.02 | 0.02 | 0.03 |
| Longnose Sucker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Sucker | 1.66 | 0.41 | 1.03 | 0.72 | 0.573 | 0.65 | 1.31 | 0.48 | 0.25 | 2.35 | 0.19 | 0.16 | 0.57 | 0.22 |
| Silver Redhorse | 0.10 | 0.42 | 0.33 | 0.02 | 0.02 | 0.08 | 0.07 | 0.04 | 0 | 0.06 | 0.06 | 0 | 0 | 0.05 |
| Shorthead Redhorse | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Brown Bullhead | 0.40 | 0.35 | 0.48 | 0.31 | 0.54 | 2.12 | 0.81 | 1.48 | 0.42 | 0.82 | 1.97 | 1.54 | 0.46 | 0.60 |
| Channel Catfish | 0.12 | 0.79 | 0.81 | 0.15 | 0.12 | 0.57 | 0.54 | 0.42 | 0.17 | 0.21 | 0.42 | 0.07 | 0.31 | 0.13 |
| Stonecat | 0 | 0 | 0.06 | 0.02 | 0 | 0 | 0 | 0.04 | 0.02 | 0.02 | 0 | 0 | 0 | 0 |
| Trout-perch | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| White Perch | 0.42 | 1.18 | 1.94 | 0.92 | 0.81 | 7.75 | 3.02 | 6.22 | 3.72 | 1.04 | 6.41 | 7.87 | 3.69 | 3.55 |
| White Bass | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Rock Bass | 1.84 | 2.09 | 2.70 | 2.43 | 0.70 | 3.27 | 2.52 | 1.54 | 1.31 | 0.75 | 1.21 | 1.00 | 1.06 | 1.43 |
| Pumpkinseed | 0.46 | 0.52 | 0.50 | 1.15 | 0.21 | 0.10 | 0.28 | 0.04 | 0.21 | 0.29 | 0.38 | 0.02 | 0.04 | 0.03 |
| Bluegill | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Smallmouth Bass | 5.43 | 3.84 | 11.33 | 10.45 | 6.39 | 9.27 | 9.81 | 7.90 | 6.09 | 8.12 | 7.65 | 5.01 | 4.36 | 4.98 |
| Largemouth Bass | 0 | 0.02 | 0.02 | 0.02 | 0 | 0 | 0.03 | 0.02 | 0 | 0 | 0.02 | 0 | 0 | 0 |
| Black Crappie | 0 | 0.02 | 0.06 | 0 | 0.04 | 0.05 | 0.03 | 0.04 | 0.04 | 0.02 | 0.06 | 0.02 | 0.00 | 0 |
| Yellow Perch | 9.82 | 6.74 | 8.93 | 9.13 | 13.95 | 16.91 | 7.37 | 16.31 | 15.29 | 14.99 | 10.32 | 1.70 | 0.82 | 3.15 |
| Walleye | 2.12 | 1.69 | 2.38 | 1.94 | 1.33 | 2.33 | 2.65 | 1.91 | 1.97 | 2.38 | 1.34 | 1.55 | 0.97 | 1.28 |
| Freshwater Drum | 0.27 | 0.60 | 0.19 | 0.32 | 0.23 | 0.26 | 0.36 | 0.08 | 0.19 | 0.19 | 0.29 | 0.34 | 0.26 | 0.16 |
| Round Goby | 0 | 0 | 0.04 | 0.10 | 0.26 | 0.42 | 0.95 | 0.36 | 0.08 | 0.07 | 0.02 | 0 | 0 | 0.06 |
| Total | 22.92 | 19.1 | 31.36 | 28.16 | 25.6 | 44.36 | 31.44 | 37.84 | 30.73 | 32.02 | 33.09 | 20.62 | 14.92 | 16.52 |

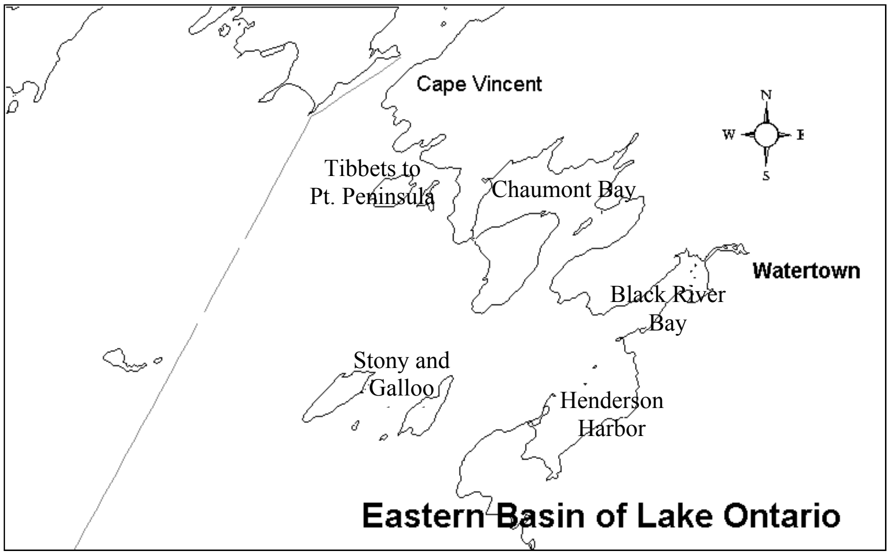


***Figure 1. Map of New York waters of Lake Ontario's eastern basin showing five area strata used in the 1980-2016 warmwater assessment.***

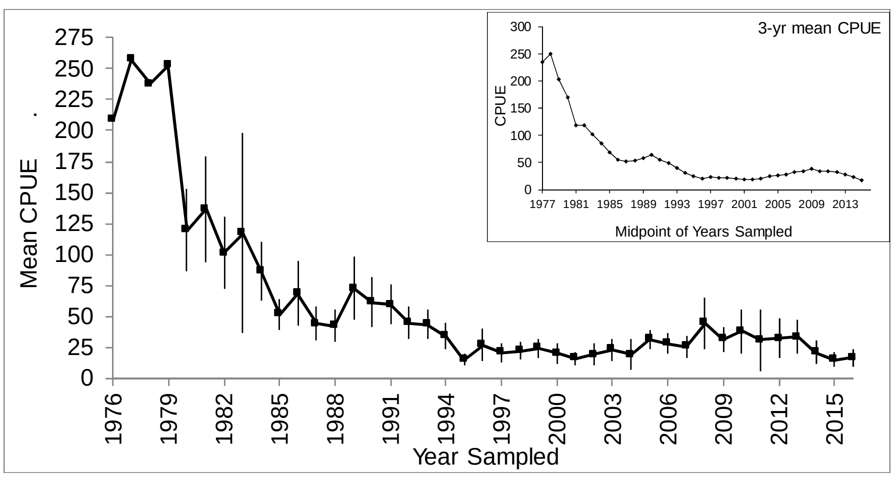


***Figure 2. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for all warmwater fish from the 1976-2016 assessments.***

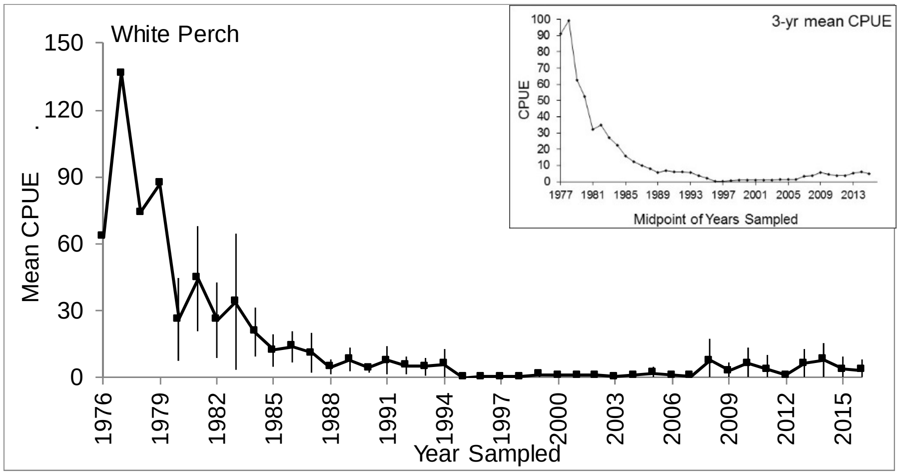


***Figure 3. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for white perch, 1976-2016.***

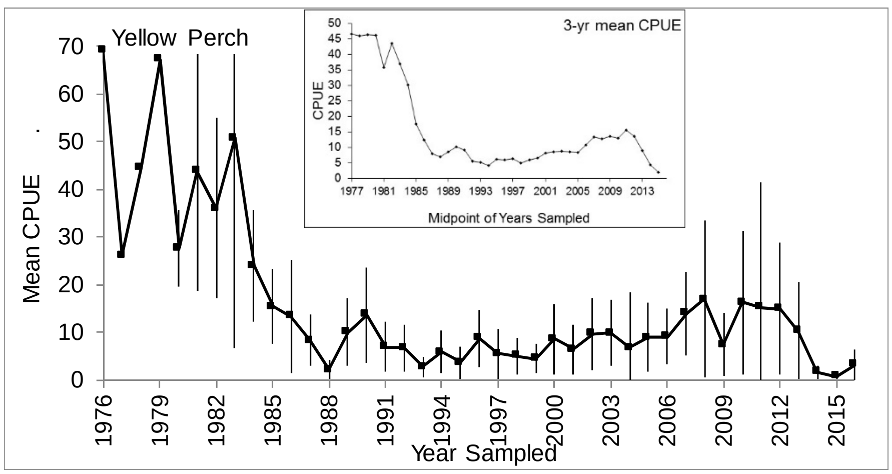


***Figure 4. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for yellow perch, 1976-2016.***

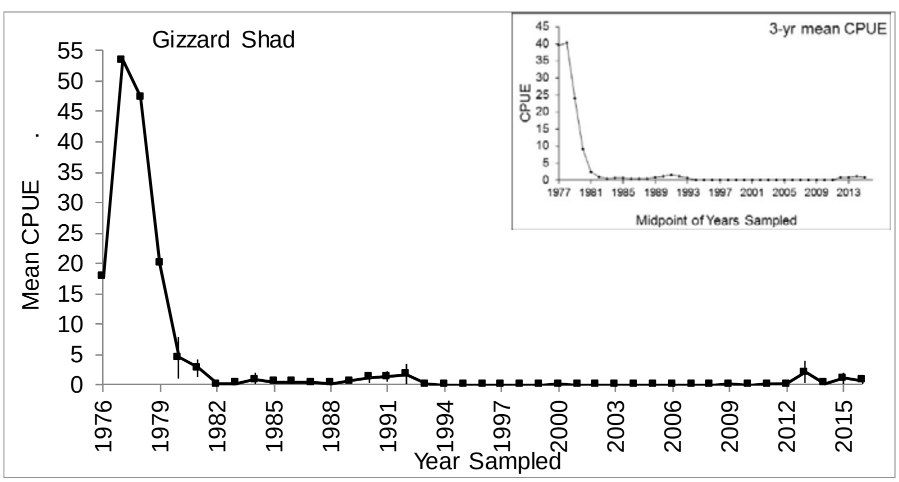


***Figure 5. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for gizzard shad, 1976-2016.***

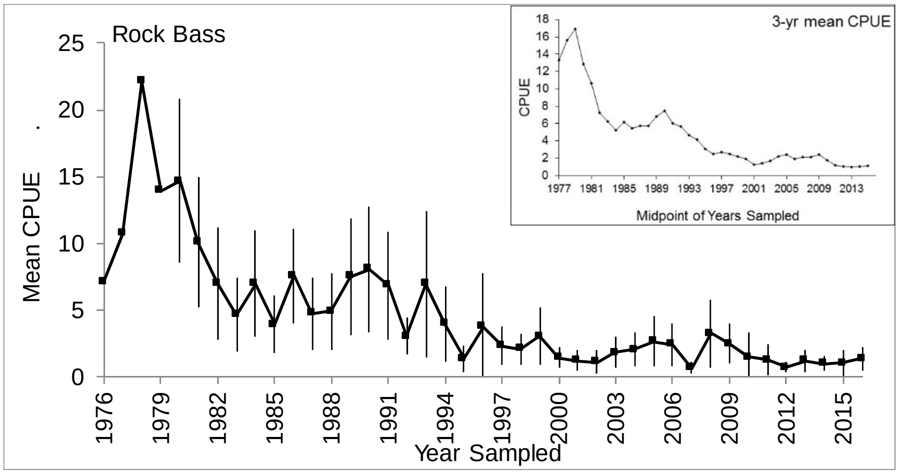


***Figure 6. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for rock bass, 1976-2016.***

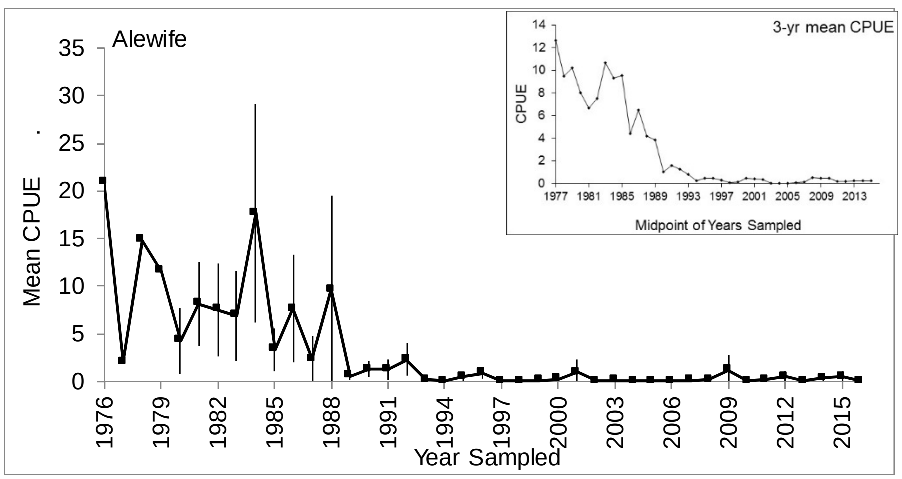


***Figure 7. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for alewife, 1976-2016.***

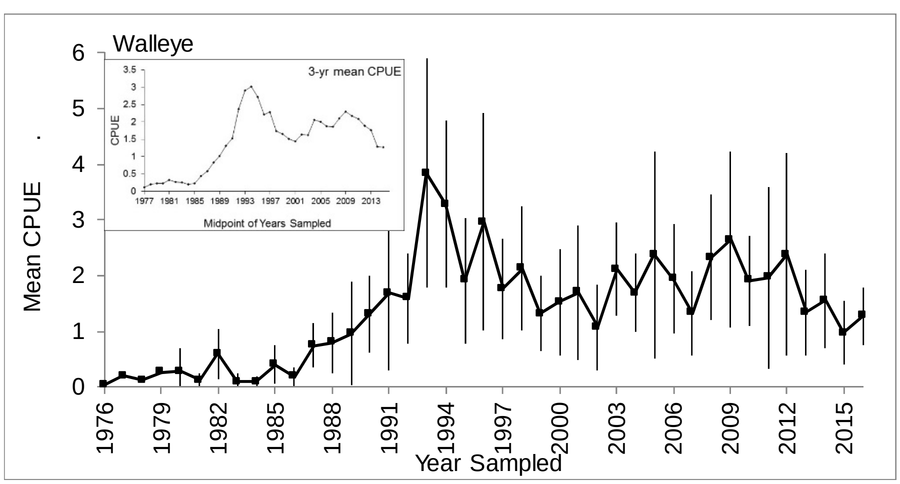


***Figure 8. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for walleye, 1976-2016.***

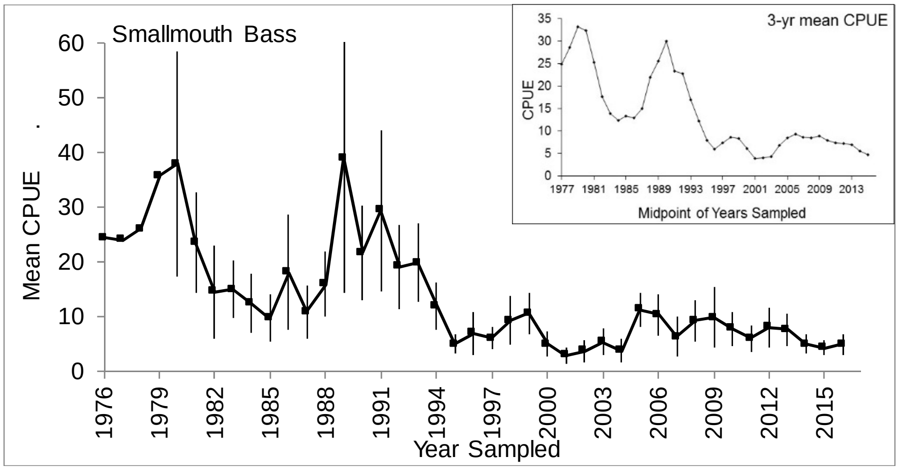


***Figure 9. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for smallmouth bass, 1976-2016.***

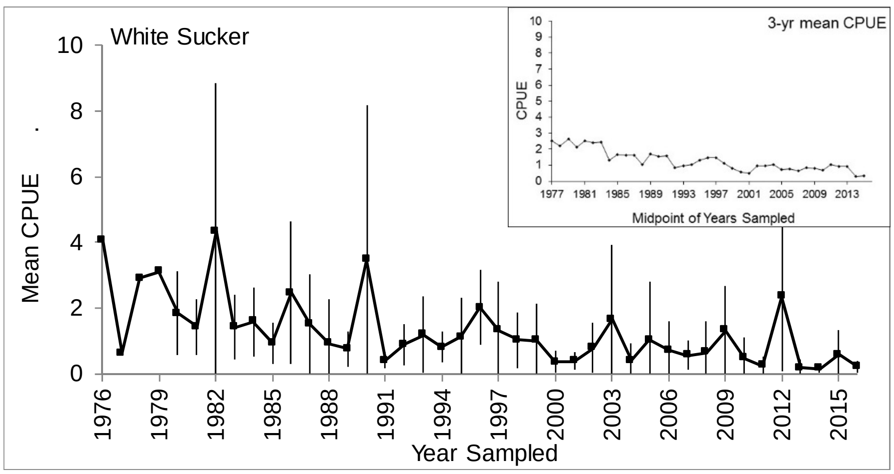


***Figure 10. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for white sucker, 1976-2016.***

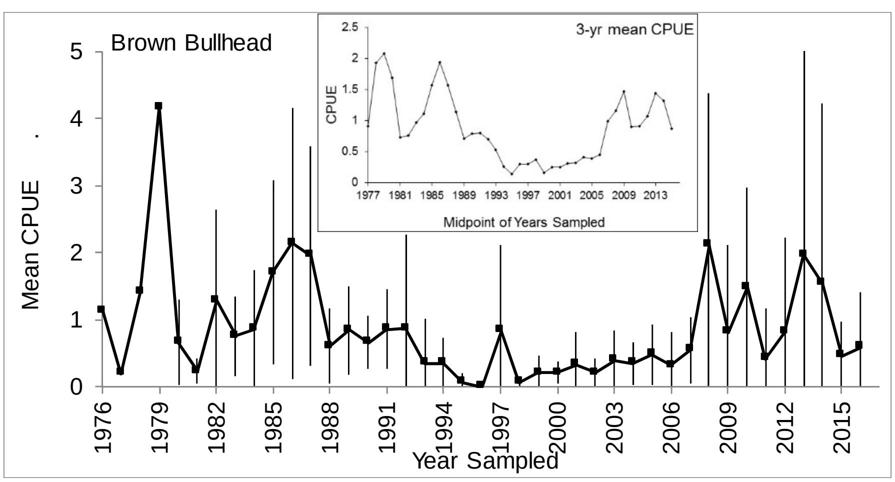


***Figure 11. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for brown bullhead, 1976-2016.***

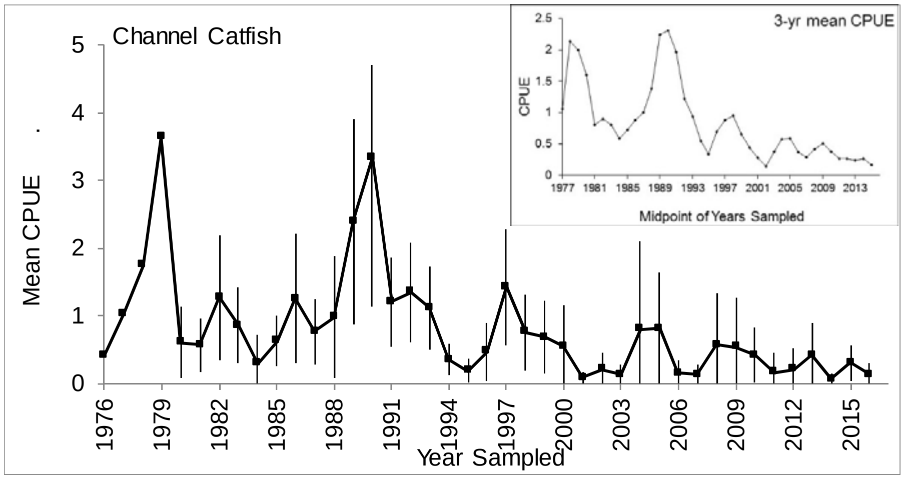


***Figure 12. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for channel catfish, 1976-2016.***

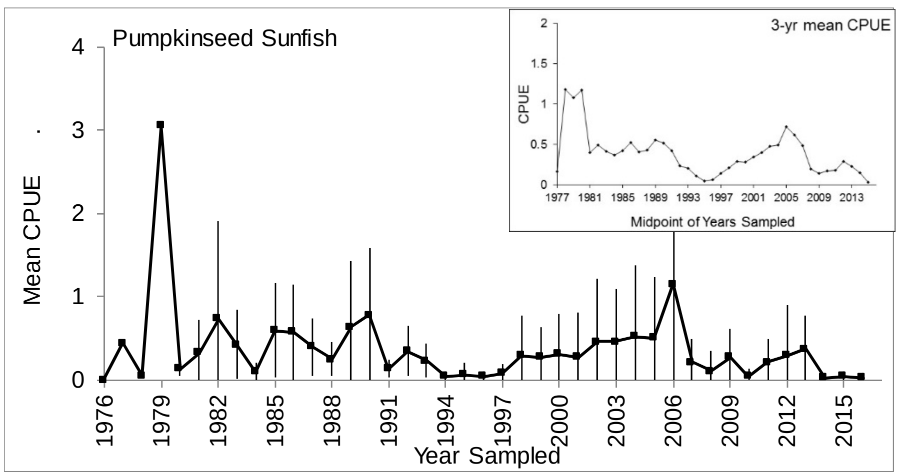


***Figure 13. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for pumpkinseed sunfish, 1976-2016.***

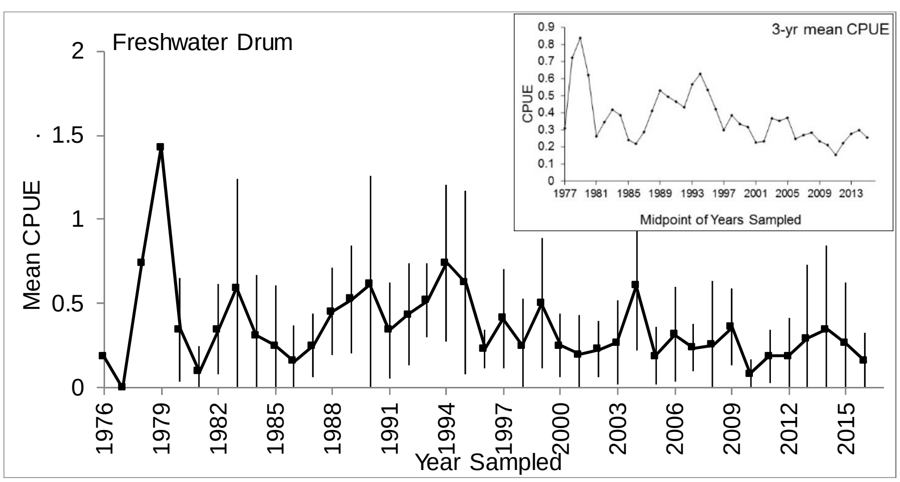


***Figure 14. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for freshwater drum, 1976-2016.***

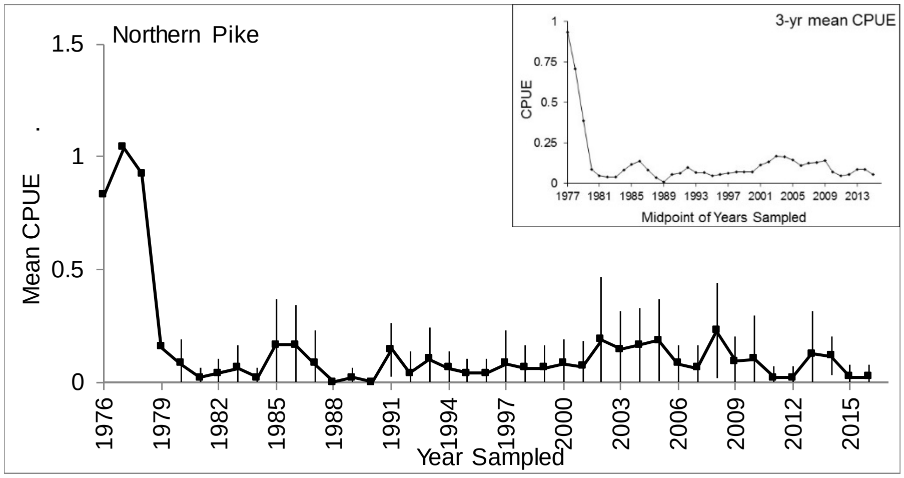


***Figure 15. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for northern pike, 1976-2016.***

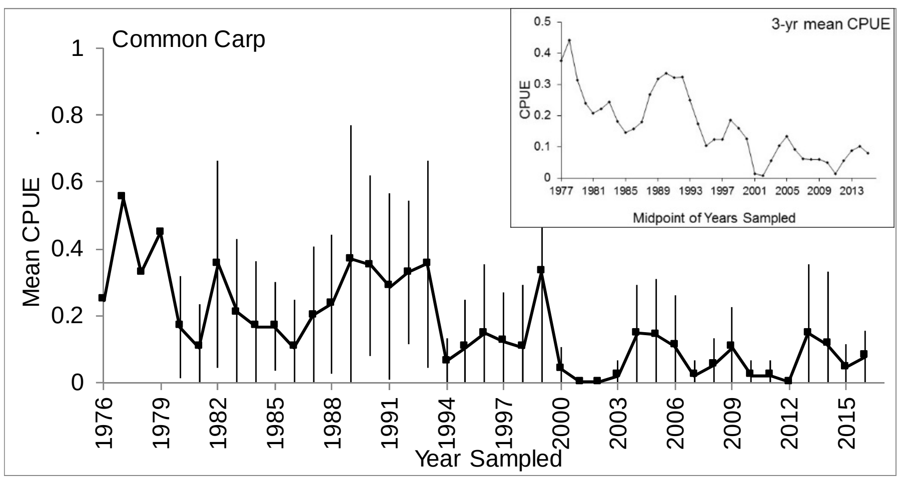


***Figure 16. Stratified mean catch per 450 ft gill net gang (CPUE) and 95% confidence intervals for common carp, 1976-2016.***

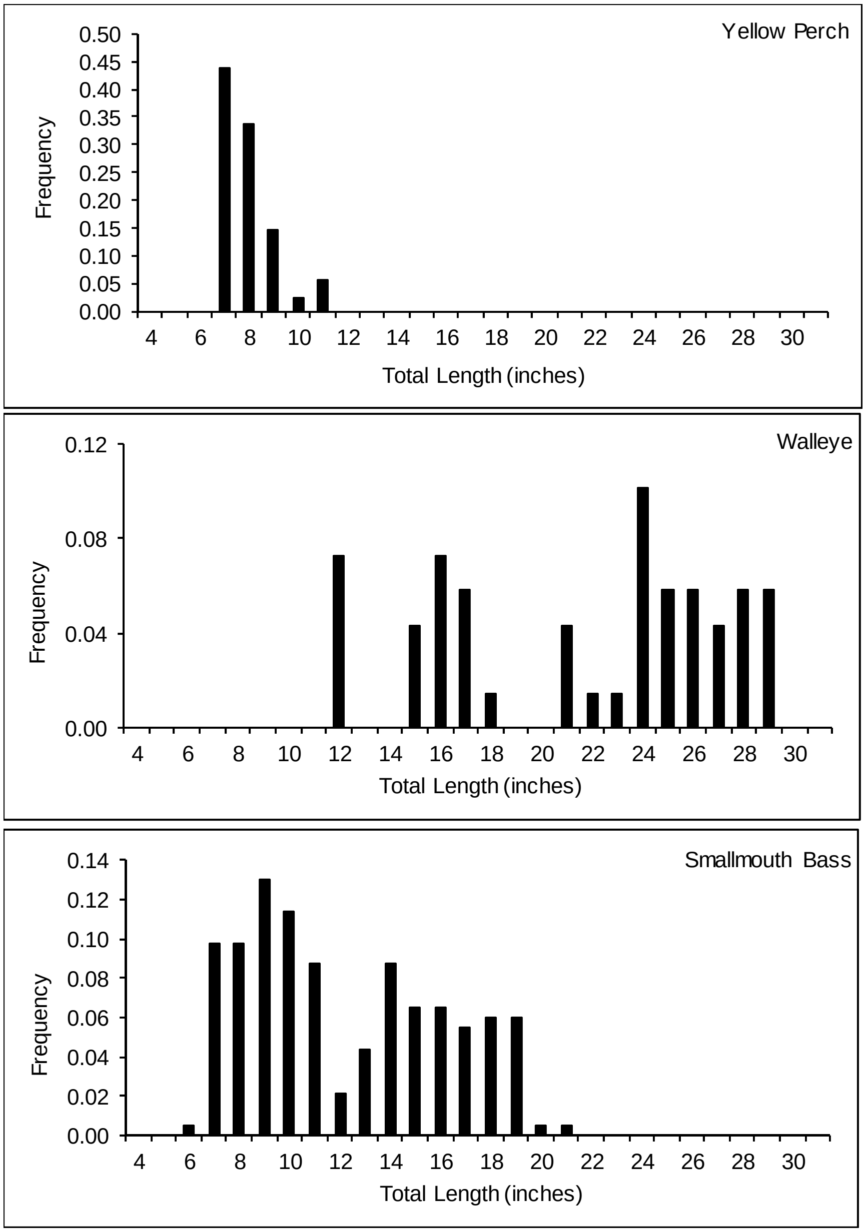


***Figure 17. Length frequency distribution of yellow perch, walleye, and smallmouth bass collected during the warmwater assessment in 2016.***

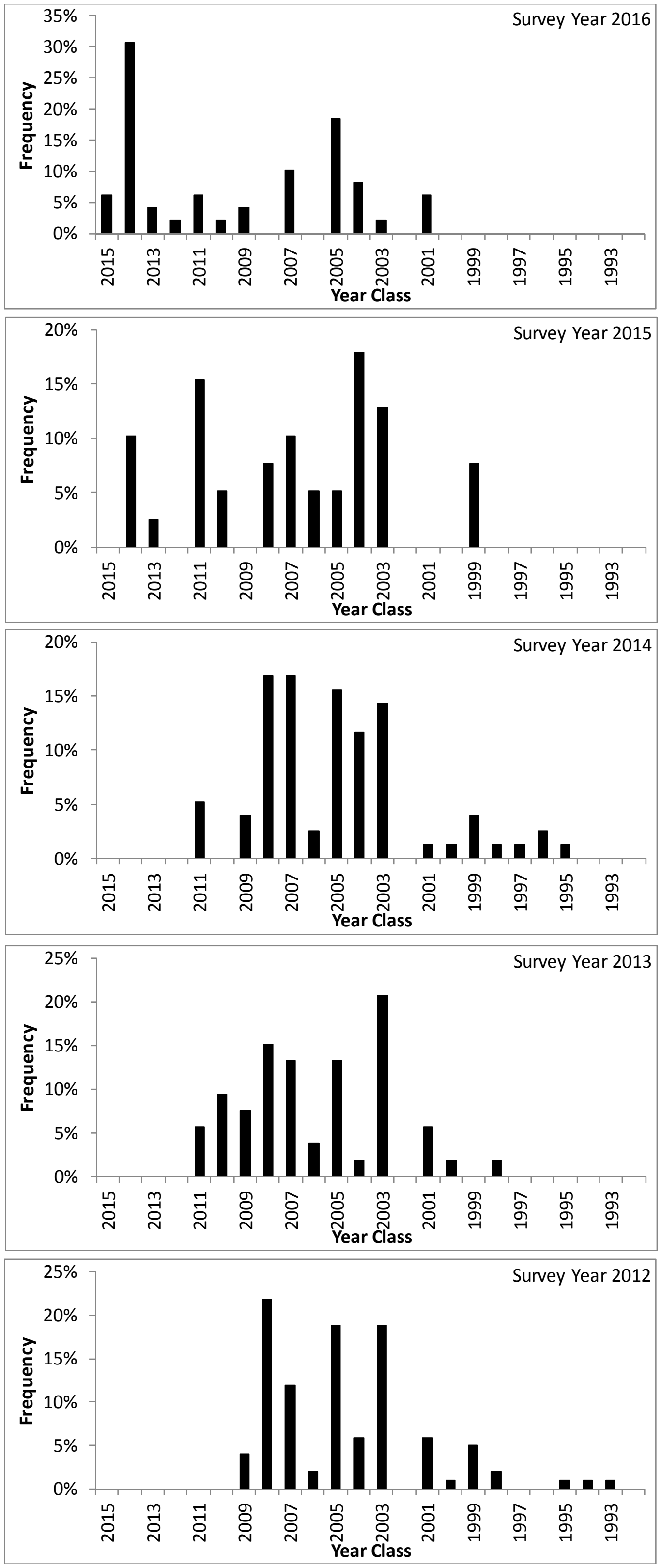


***Figure 18. Year class frequency distribution of walleye collected during the warmwater assessment in 2012-2016.***

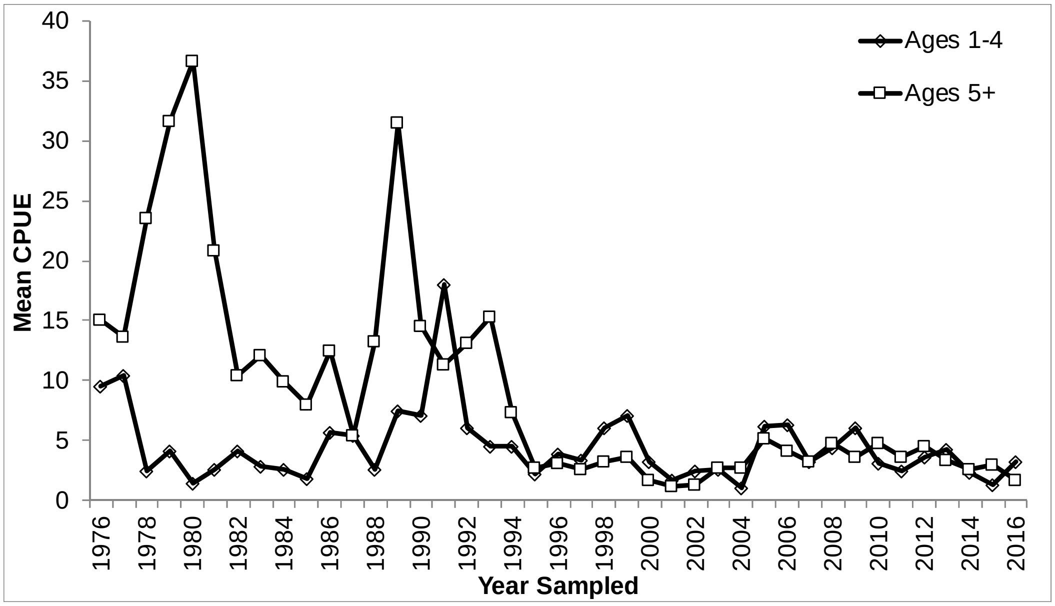


***Figure 19. Stratified mean catch per 450 ft gill net gang (CPUE) of smallmouth bass ages ≤ 4 and ages ≥ 5, 1976-2016. Note: Increased growth and changes in net catchability confound inter-annual comparisons of age-specific CPUE.***

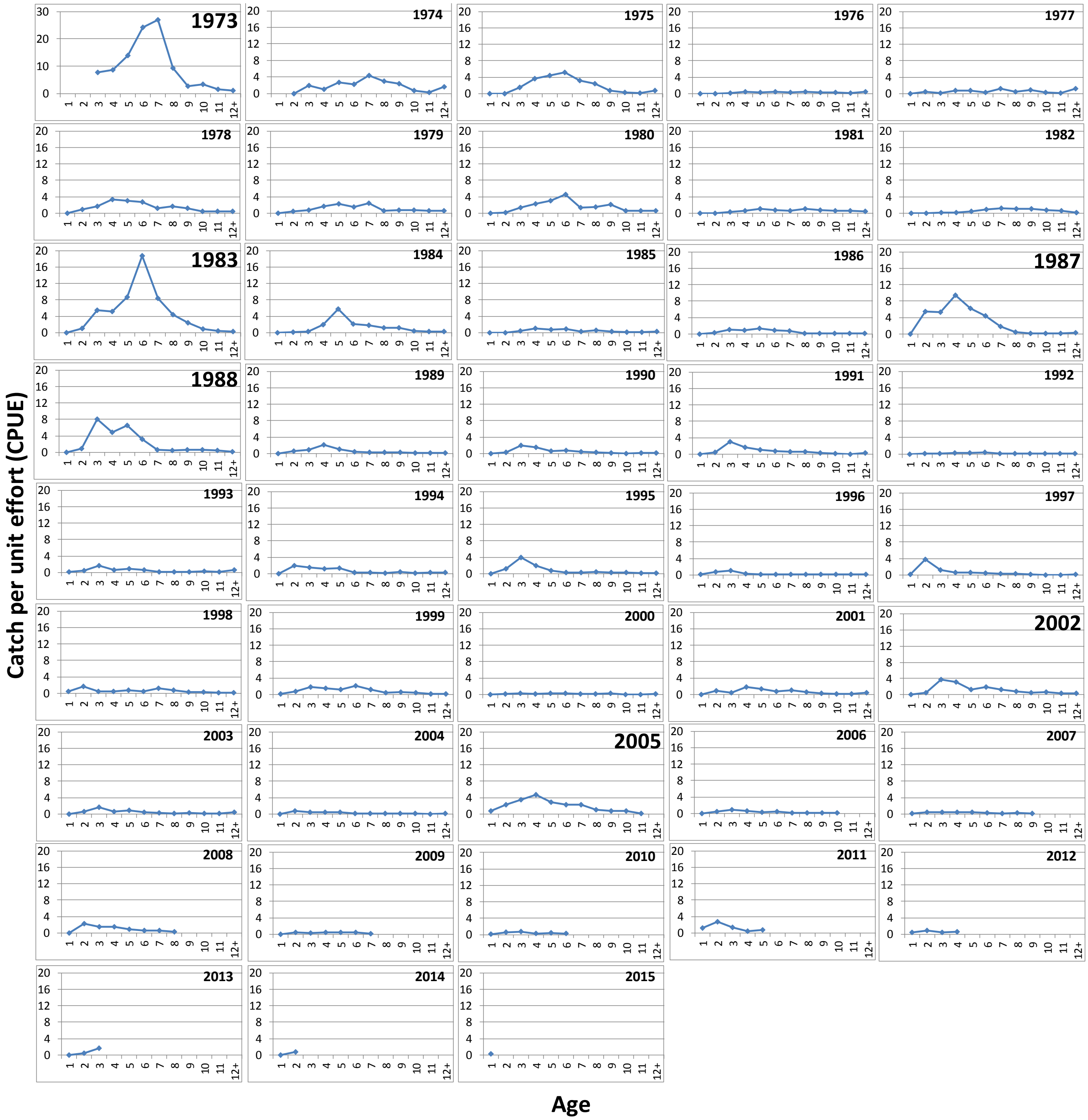


***Figure 20a. Smallmouth bass year class-specific catch curves (CPUE by age), 1973-2015 year classes. Note the difference in y-axis scale for the 1973 year class vs. the y-axis scale 1974-2015 year classes.***

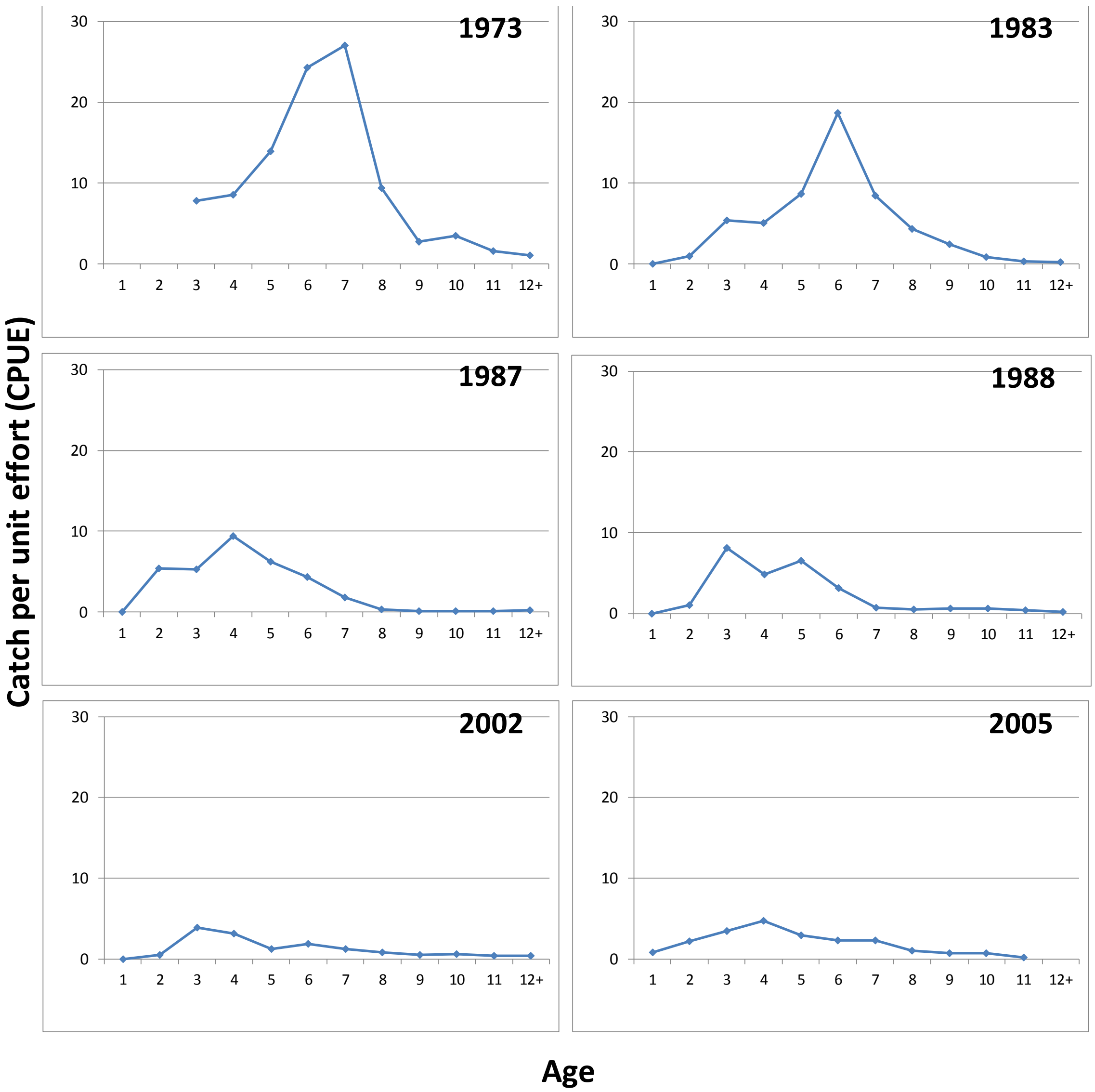


*Figure 20b. Smallmouth bass year class-specific catch curves (CPUE by age) for the 1973, 1983, 1987, 1988, 2002, and 2005 year classes.*

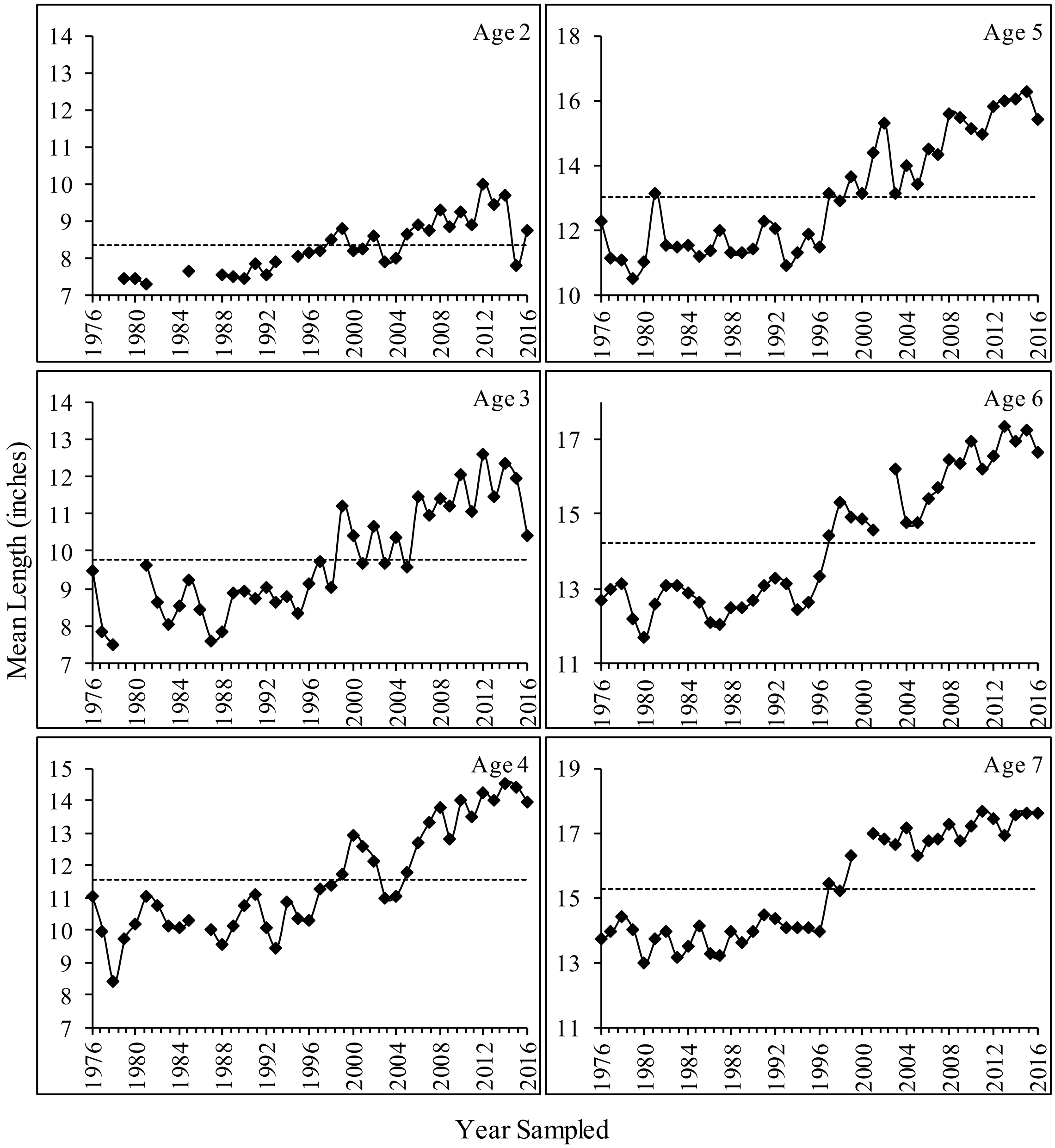


***Figure 21. Mean length at age (age 2-13) by year sampled (1976-2016) for smallmouth bass collected during the warmwater assessment (continued on next page). Dotted lines represent longterm mean lengths.***

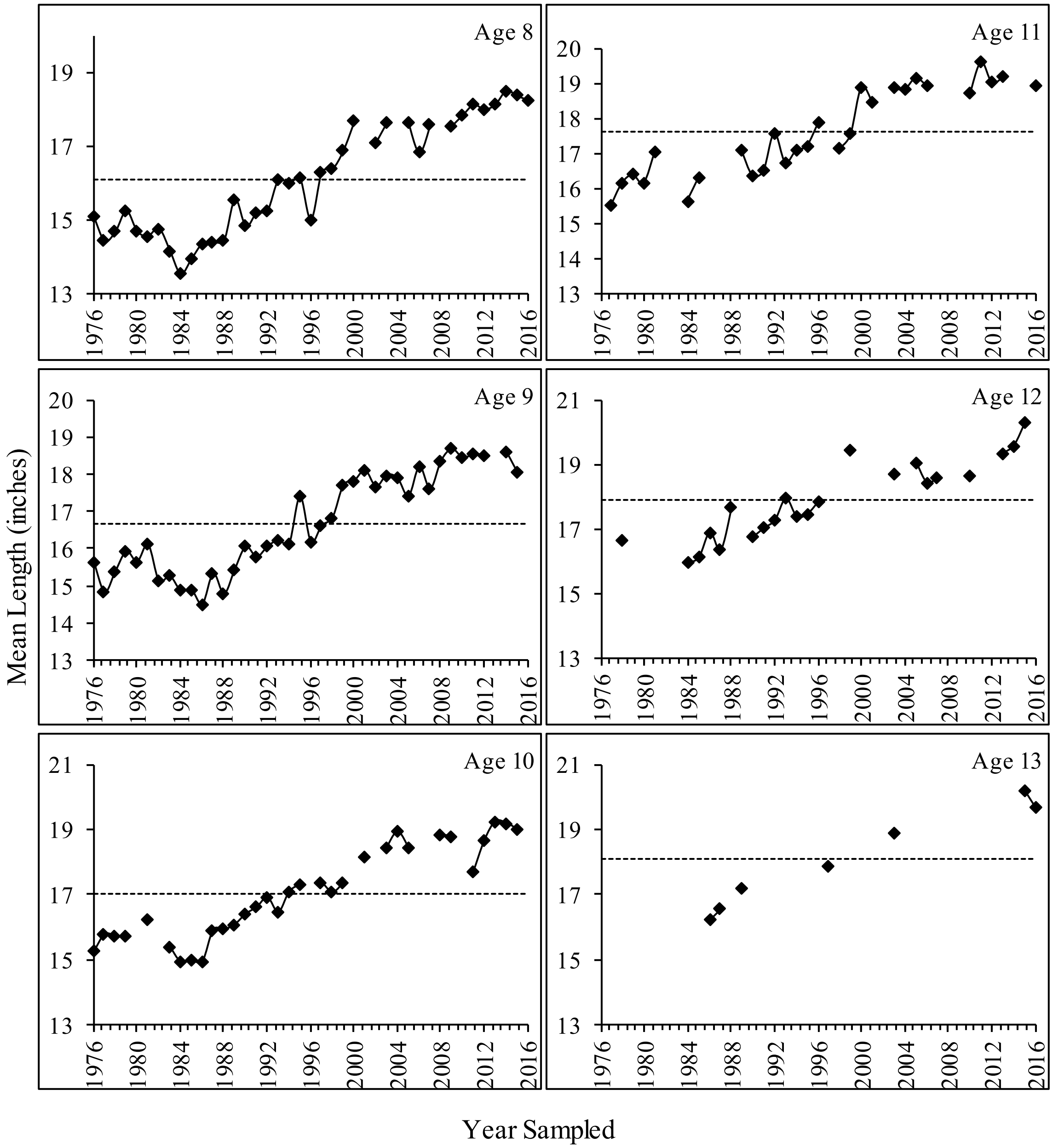


***Figure 21 (continued). Mean length at age (age 2-13) by year sampled (1976-2016) for smallmouth bass collected during the warmwater assessment. Dotted lines represent the longterm mean lengths.***

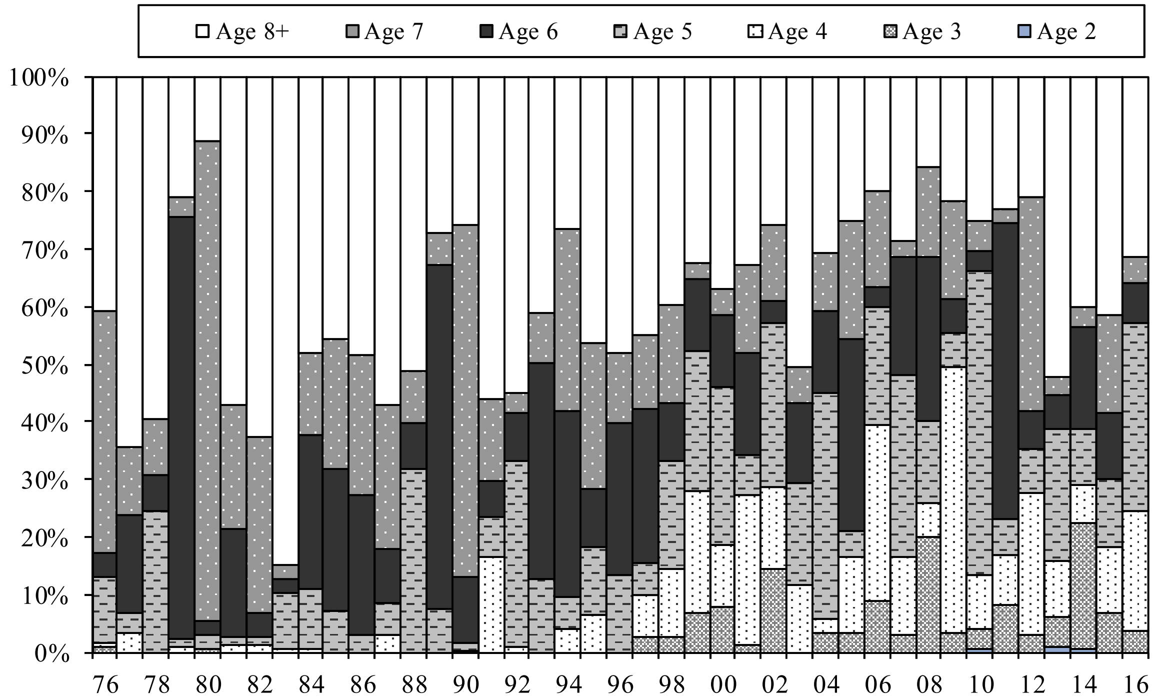


***Figure 22. Age composition of smallmouth bass ≥ 12 inches in the warmwater assessment (1976-2016).***

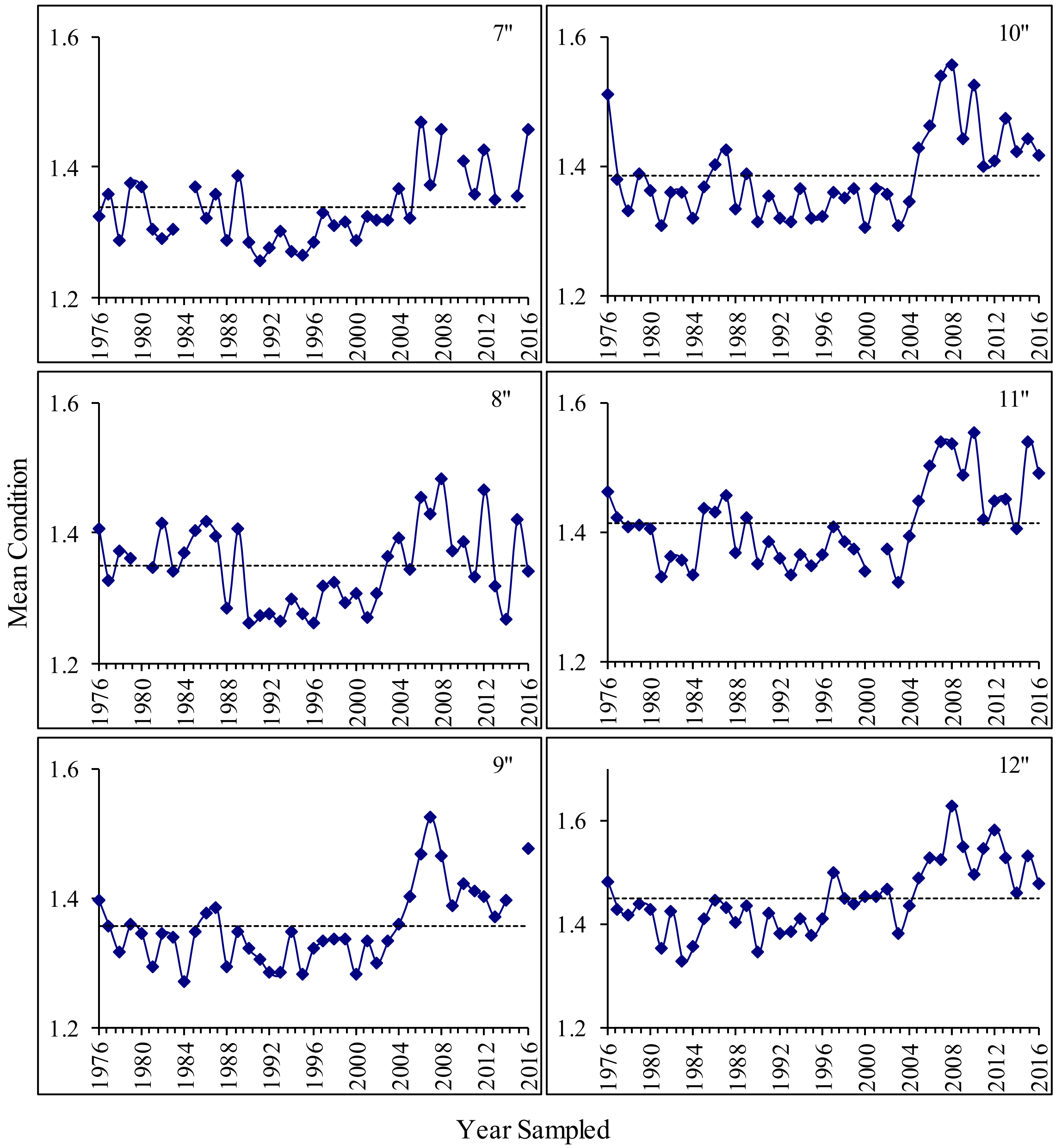


***Figure 23. Mean condition (7-18 inch increments) by year sampled (1976-2016) for smallmouth bass collected during the warmwater assessment. Dashed line represents the long-term mean condition for the respective length increment.***

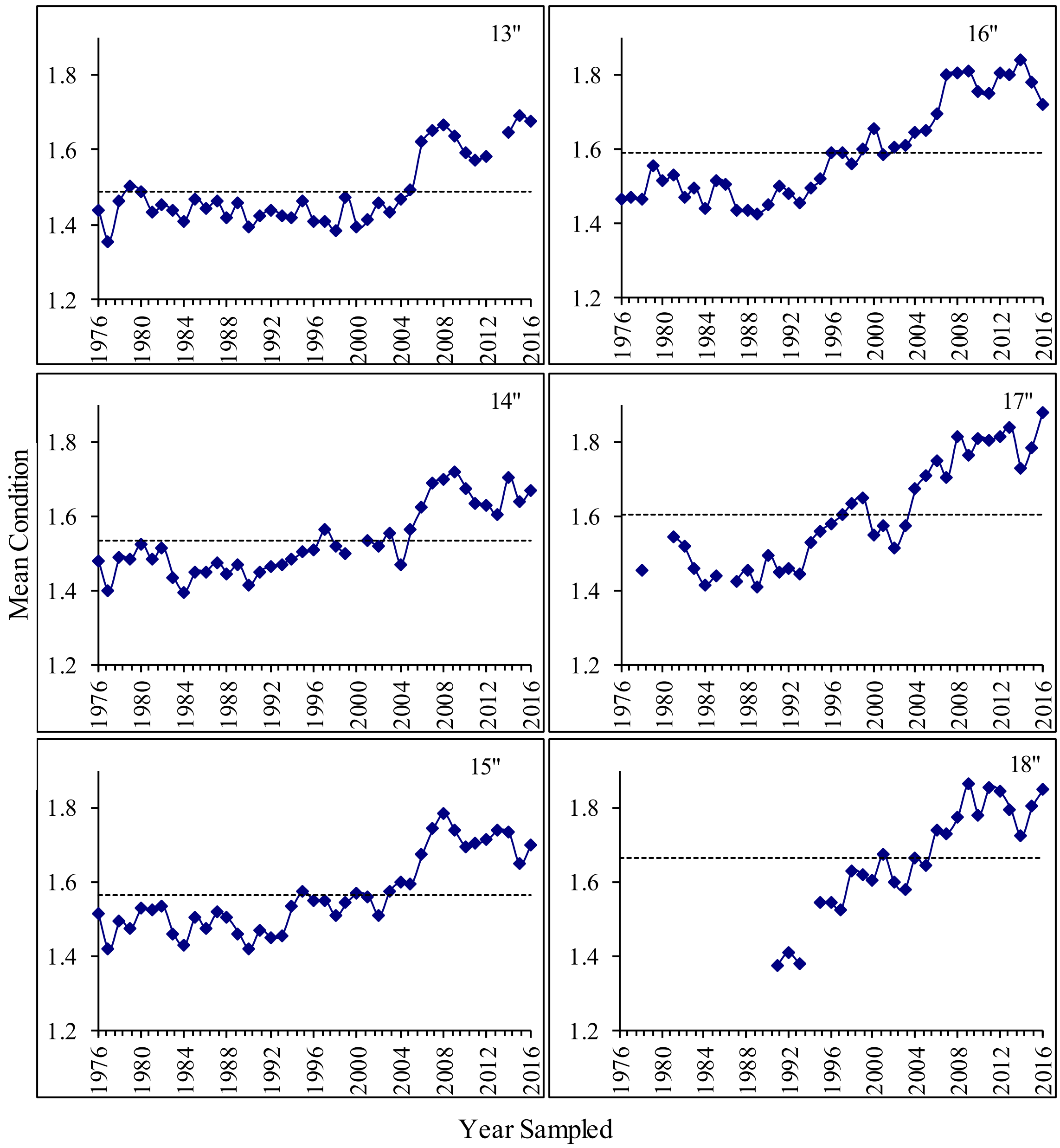


***Figure 23 (continued). Mean condition (7-18 inch increments) by year sampled (1976-2016) for smallmouth bass collected during the warmwater assessment. Dashed line represents the long-term mean condition for the respective length increment.***

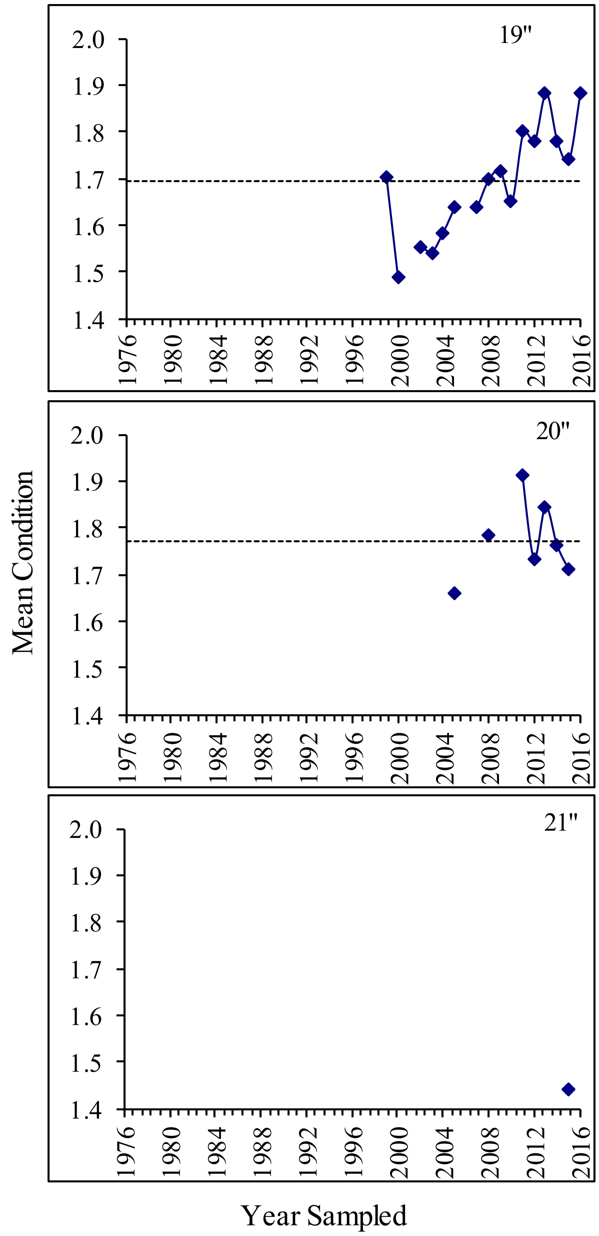


***Figure 23 (continued). Mean condition (7-18 inch increments) by year sampled (1976-2016) for smallmouth bass collected during the warmwater assessment. Dashed line represents the long-term mean condition for the respective length increment.***

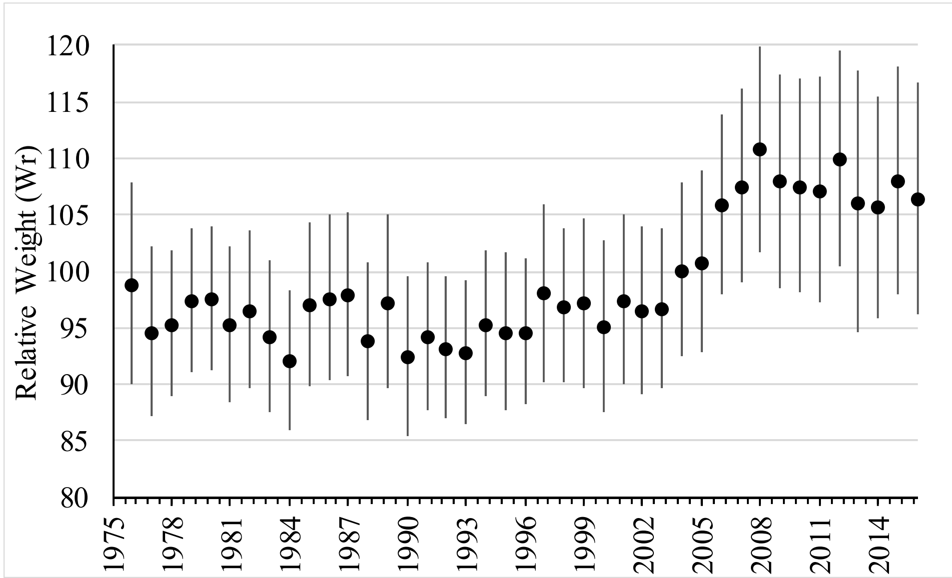


***Figure 24. Mean relative weight of smallmouth bass caught in the warmwater assessment (1976-2016) (±1 standard deviation).***

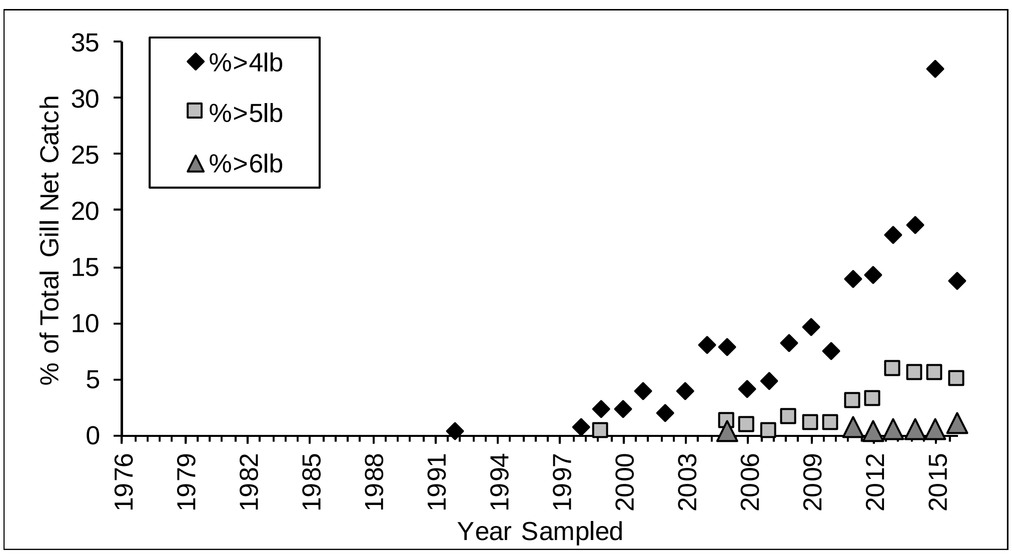


***Figure 25. Percentage of total smallmouth bass catch during the warmwater assessment (1976-2016 catches) that were >4lb, >5lb, and >6lb.***

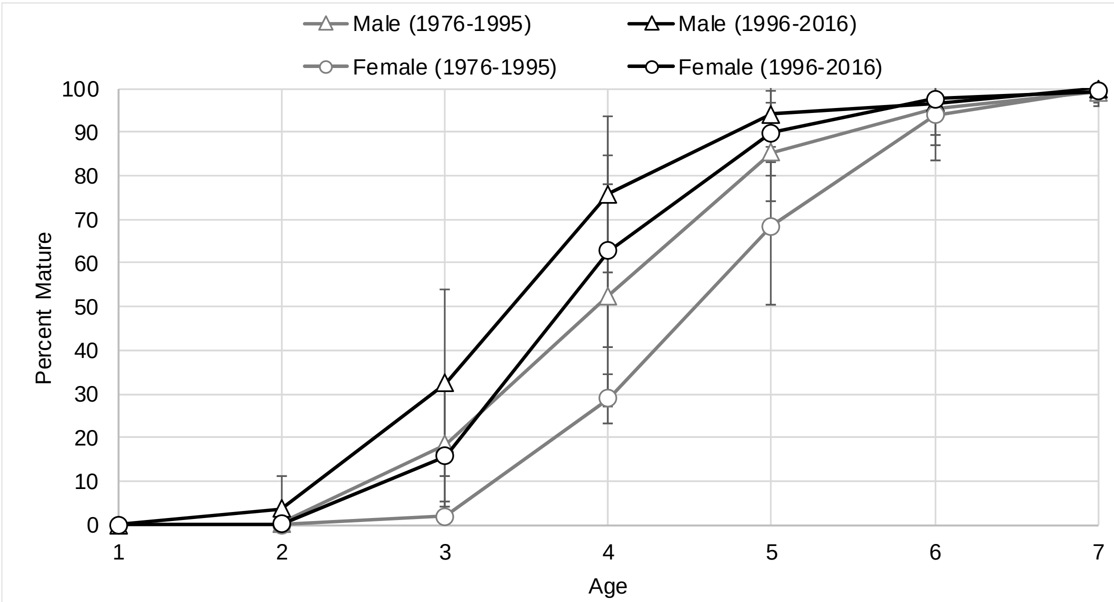


***Figure 26. Average (± 1 standard deviation) percent maturity of age-1 to age-7 male and female smallmouth bass sampled during survey years 1976-1995 and 1996-2016.***

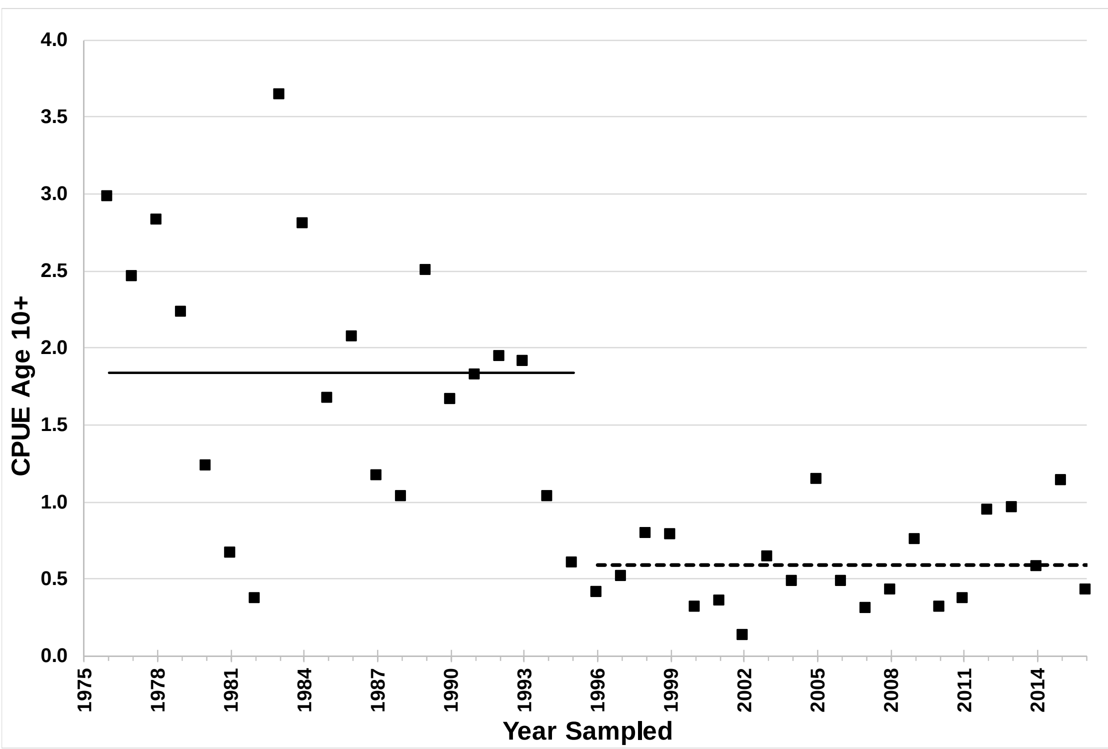


***Figure 27. Stratified mean catch per 450 ft gill net gang (CPUE) of smallmouth bass ages 10+, 1976-2016 sample years. Solid line is the 1976-1995 average CPUE of age 10+ bass. Dashed line is the 1996-2016 average CPUE of age 10+ bass.***

# Lake Trout Rehabilitation in Lake Ontario, 2016

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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. The first-year survival index for the 2014 year class of stocked lake trout (age 2 in 2016) was the highest observed since 1990. The catch per unit effort of adult lake trout in gill nets increased each year from 2008-2014, recovering from historic lows recorded during 2005-2007. Adult abundances in 2015 and 2016 were similar and about 20% below the 2014 peak, but similar to the 1999-2004 mean, which at the time appeared to be the new stable abundance following the 1993 stocking cuts. The 2015 rate of wounding by sea lamprey* (Petromyzon marinus) *on lake trout caught in gill nets (1.40 A1 wounds per 100 lake trout) was below target (2 wounds per 100 lake trout). Estimates from the NYSDEC fishing boat survey indicated 2016 angler catch and harvest rates were more than 7.5 times higher than the lows observed in 2007. Condition values for an adult lake trout, indexed in September from the predicted weight for a 700mm lake trout from annual length-weight regressions and Fulton's K for age-6 males, were each at the second highest level observed for the 1983-2016 time series. However, July-August condition of juvenile lake trout indexed from the predicted weight of a 400 mm individual and Fulton's K for age-2 fish were among the lowest values recorded for the 1979-2016 time series. 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 stabilized during 2009-2016. Twenty two cohorts of naturally produced lake trout have been collected since 1994 with the largest catches occurring during 2014- 2016.*

## 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], U.S. Geological Survey [USGS], U.S. Fish and Wildlife Service [USFWS], and Ontario Ministry of Natural Resources and Forestry [OMNRF]) developed the Joint Plan for Rehabilitation of Lake Trout in Lake Ontario (Schneider et al. 1983, 1997) which guided restoration efforts and evaluation through 2014. A revised document, A Management Strategy for the Restoration of Lake Trout in Lake Ontario, 2014 Update (Lantry et al. 2014), will guide future efforts. The present report documents progress towards restoration by reporting on management plan targets and measures through 2016.

The data associated with this report have not received final approval by the U.S. Geological Survey (USGS) and are currently under review. The Great Lakes Science Center is committed to complying with the Office of Management and Budget data release requirements and providing the public with high quality scientific data. We plan to make all USGS research vessel data collected between 1958 and 2016 publicly available from the GLSC website later in 2017.

The anticipated citation will be http://doi.org/10.5066/F75M63X0. Please direct any immediate questions to our Information Technology Specialist, Scott Nelson, at snelson@usgs.gov. All USGS sampling and handling of fish during research are carried out in accordance with guidelines for the care and use of fishes by the American Fisheries Society (http://fisheries.org/docs/wp/Guidelines-for-Use-of-Fishes.pdf). Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

## Methods

Adult Gill Net Survey

During September 1983-2016, adult lake trout were collected with gill nets at random transects within each of 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 2016, USGS R/V *Kaho* and NYSDEC R/V *Seth Green* fished standard monofilament 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 the 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 two of those 12 sites, Pultneyville and Oswego, northeast winds occurring after nets were deployed pushed warm water in towards shore and as a result their shallowest nets experienced temperatures rising above the range inhabited by lake trout. Because of this the shallowest 2 sets at Pultneyville and the shallowest set at Oswego were not used in calculating abundance indices. At two sites in the eastern basin, three nets were fished in waters from 23 to 48 m due to thermocline depth.

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 depth based strata, representing 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 (Elrod et al. 1995). 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 and Prindle 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), and 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 ≥433 mm. 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). Results from the two examinations indicated that at some point between the early 1980s and the mid-1990s, age-related factors began to influence fecundity. 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. 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 1982-2016. 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 2017). The survey uses boat trips as the primary unit of effort. Boat counts are made at boat access locations and interviews are based on trips completed during April 15 - September 30, 1985-2016.

Juvenile Trawl Survey

From mid-July to early-August, 1980-2016, 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 generally 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. In 2013, effort was reduced because no lake trout from the 2011 year class were stocked in U.S. waters during 2012 (Lantry and Lantry 2013) and thus no U.S. stocked age-2 lake trout were present in 2013. Effort returned to routine levels in 2014. In 2016, trawling was conducted at 14 locations during July 7 - 15. 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.

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. Survival was assessed at age-2 because the trends in index 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 the CWL strain or the Niagara River stocking location which were the factors that necessitated catch adjustment. Catches of the 1995 through 2014 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 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 an annual U.S. target of 1.25 million yearlings. 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, fishery managers reduced the lake trout stocking target to 500,000 yearlings because of a predator-prey imbalance in Lake Ontario, and following recommendations from an international panel of scientists and extensive public review. Annual stockings were near the revised target level in 18 of 24 years during 1993-2016 (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 (WRNFH) in Vermont. In 2010, 94% of the stocked lake trout were raised at WRNFH and 6% were raised at NYSDEC Bath Fish Hatchery. All lake

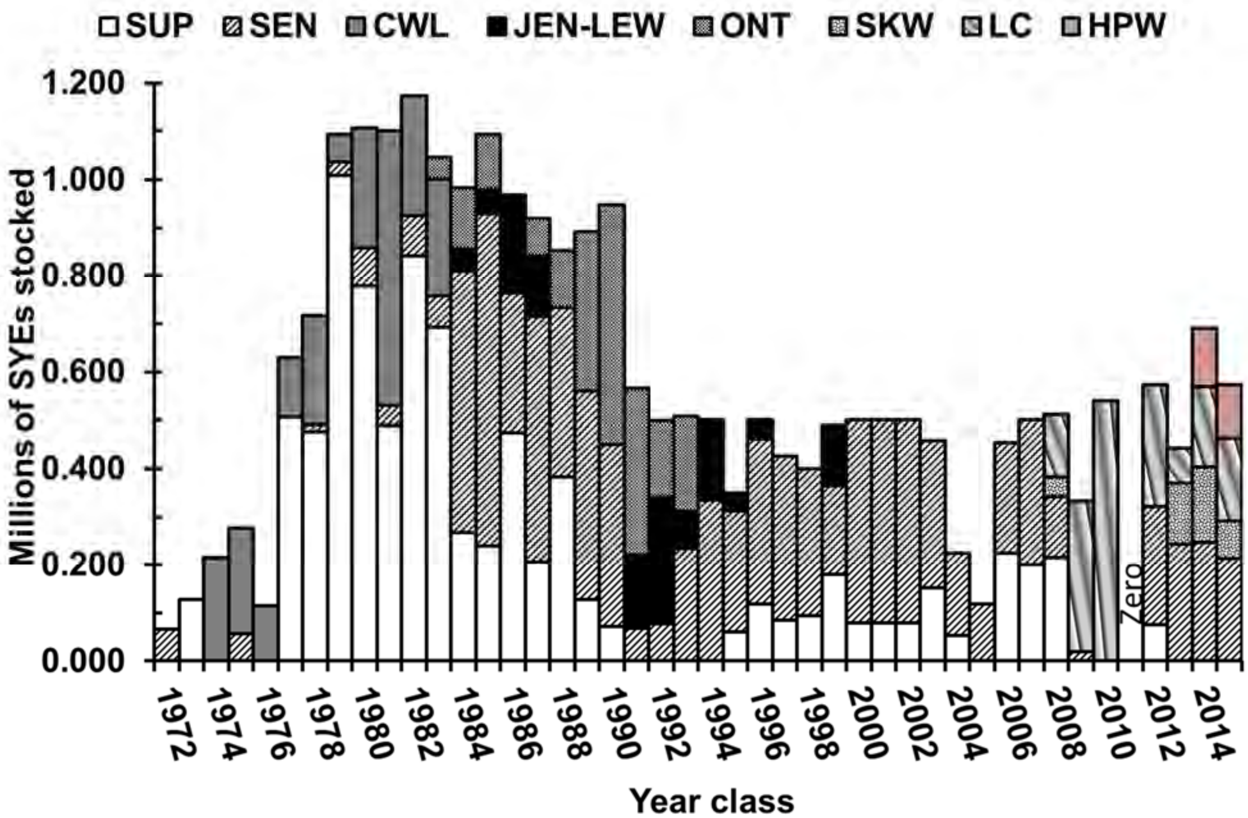


***Figure 1. Total spring yearling equivalents (SYE) for lake trout strains (strain descriptions for ONT, JEN-LEW, CWL, SEN, LC, SUP, SKW, HPW appear in Appendix 1) stocked in U.S. waters of Lake Ontario for the 1972 – 2015 year classes. SYE = 1 spring yearling or 2.4 fall fingerlings (Elrod et al. 1988). No lake trout from the 2011 year class were stocked in 2012.***

trout from stockings in 2009 and 2011 were raised at the USFWS WRNFH. In late August 2011, flooding of WRNFH from the adjacent White River during tropical storm Irene led to the USFWS decision to depopulate the hatchery over serious concerns of raceway contamination 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. Combined production of the 2012 year class at ANFH and ENFH resulted in stocking of nearly 123,000 fall fingerlings and over 520,000 spring yearlings. During 2014, combined production of the 2013 year class at ANFH and ENFH resulted in stockings of approximately 442,000 spring yearlings. That same year, fish managers increased the lake trout stocking target to 800,000 spring yearling equivalents (Lantry et al. 2014). Combined production of the 2014 year class at ANFH and ENFH resulted in stocking of nearly 528,000 fall fingerlings and 521,000 spring yearlings (Connerton 2017). Combined ANFH and ENFH production of the 2015 year class fish resulted in stocking of nearly 454,000 fall fingerlings 384,000 spring yearlings (Connerton 2017). No fall fingerling lake trout were stocked in 2016.

Survival of stocked fish to age-2

The first-year survival index 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). The index declined further for the 1990 year class and continued to decline for the 1991-1996 year classes. The average index value for 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 for the 1993 – 2009 year classes, fluctuating by greater than 40-fold with no general trend apparent. The survival indices for the 2010, 2012 and 2013 year classes were high compared to the 1995-2009 year-classes. No lake trout

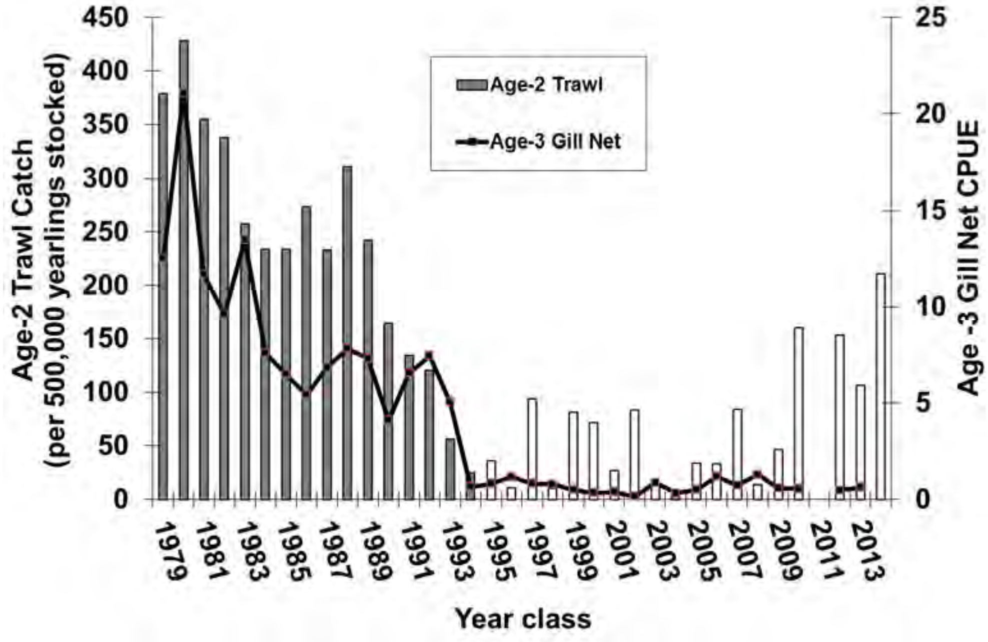


***Figure 2. Survival indices lake trout stocked in U.S. waters of Lake Ontario (no 2011 year-class lake trout were stocked into U. S. waters in 2012). Survival was indexed at age 2 as the total catch from bottom trawls (BTR) fished in July-August per 500,000 fish stocked (Note: White bars represent 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).***

from the 2011 year-class were stocked in U. S. waters during 2012 and thus no U.S. stocked age-2 lake trout were present/captured in 2014. The survival index for the 2014 year-class was the highest observed since the 1989 year-class and higher than any other year-class since the early 1990's reductions in stocking.

Abundance of age-3 and older Lake Trout

A total of 694 lake trout were captured in the 51 nets used to calculate abundance indices for the September 2016 gill net survey, resulting in a total CPUE of mature adults of 11.04 (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 9.1% and 10.7% 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 of the 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 1990s. After the 1998-1999 decline, the CPUE for mature lake trout remained relatively stable during 1999-2004 (mean = 11.1) appearing to reflect a new stable equilibrium established subsequent to the stocking reductions in 1993, but then abundance declined further (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 each year during 2008-2014. Adult abundance in 2016 (CPUE: 11.0) was similar to the 2015 (CPUE: 11.5) value and to the 1999-2004 average. Similar to the catch of age-2 lake trout 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 2016 (CPUE: 2.2).

Schneider et al. (1997) established a target

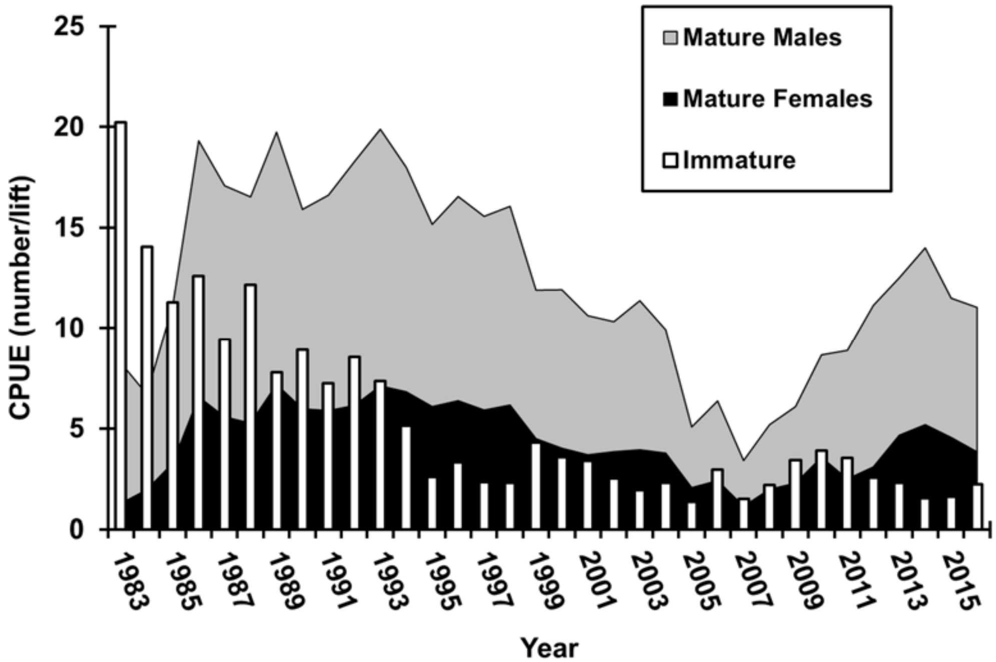


***Figure 3. Abundance of mature (generally males ≥ age 5 and females ≥ age 6) and immature (sexes combined) lake trout calculated from catches made with gill nets set in U.S. waters of Lake Ontario, during September 1983-2016. CPUE (number/lift) was calculated based on four strata representing net position in relation to depth of the sets.***

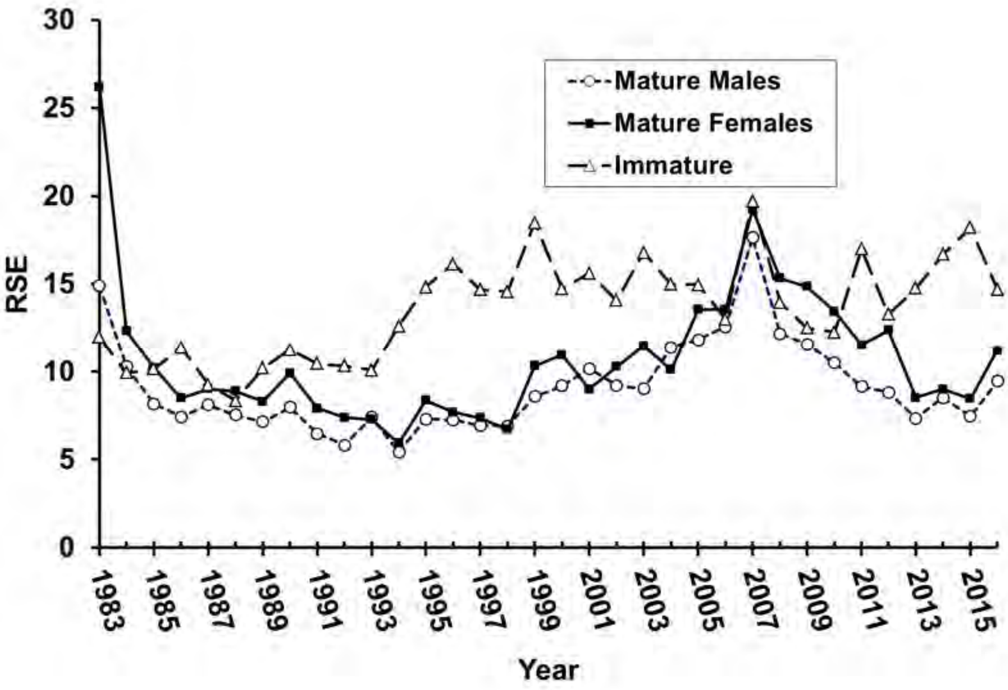


***Figure 4. Relative standard error (RSE = {SE / Mean}*100) of the annual CPUE for mature and immature (sexes combined) lake trout caught with gill nets set in U.S. waters of Lake Ontario, during September 1983 – 2016.***

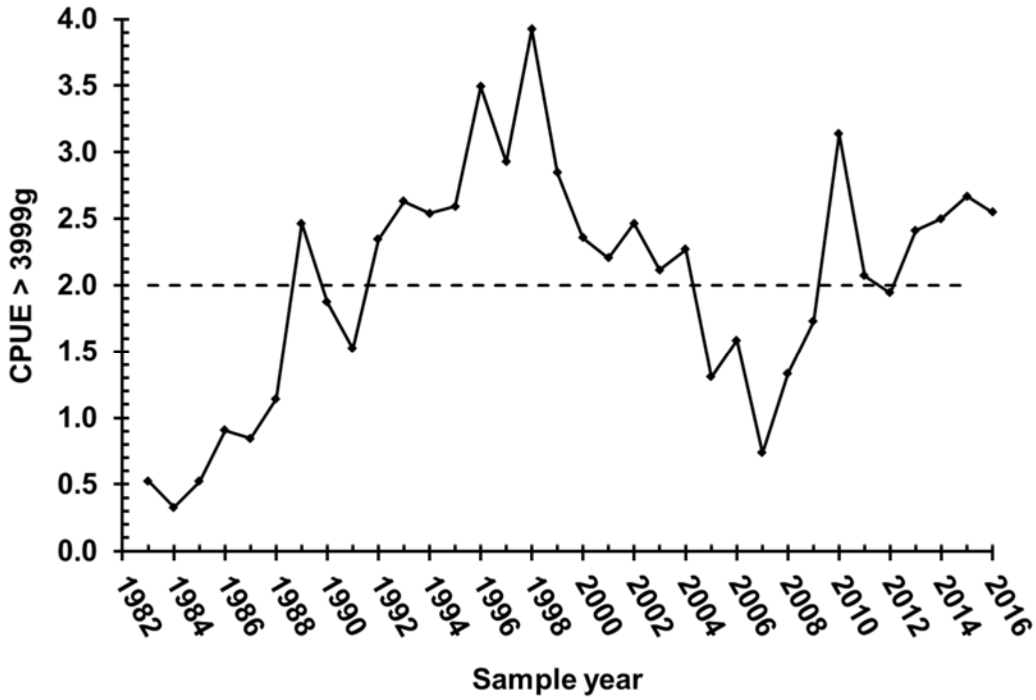


***Figure 5 Abundance of mature female lake trout >4000g calculated from catches made with gill nets set in U.S. waters of Lake Ontario, during September 1983-2016. The dashed line represents the target CPUE from Schneider et al. (1997).***

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 that 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. As the adult population abundance increased during 2008-2014, the CPUE of mature females ≥ 4,000 g also increased and during 2010-2016 CPUEs have remained near or above target.

Angler Catch and Harvest

Fishing regulations, lake trout population size, and availability of other trout and salmon species influenced angler harvest through time. Since 1988, lake trout harvest was limited by a slot size limit designed to increase the number and ages of spawning adults. In 1992, the regulation permitted a limit of three lake trout harvested outside of the protected length interval of 635 to 762 mm (25 to 30 in). 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 635 to 762 mm slot.

Annual catch and harvest of lake trout from U.S. waters of Lake Ontario (Figure 6) declined over 84% from 1991 to the early-2000s (Lantry and Eckert 2017). Catch and harvest declined further from the early to the mid-2000s, coinciding with the lake trout population decline (Figure 3) 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 2017). 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 2017). Harvest at that time was more than 97% below the 1991 estimate. After 2007, however, catch and harvest rates increased for six consecutive years. Rates have remained relatively stable since 2013. The 2016 catch and harvest rates were more than 7.5 times higher than the lows observed in 2007 (Lantry and Eckert 2017). In 2016, angler catch (36,336 fish) and harvest (18,426 fish) were more than

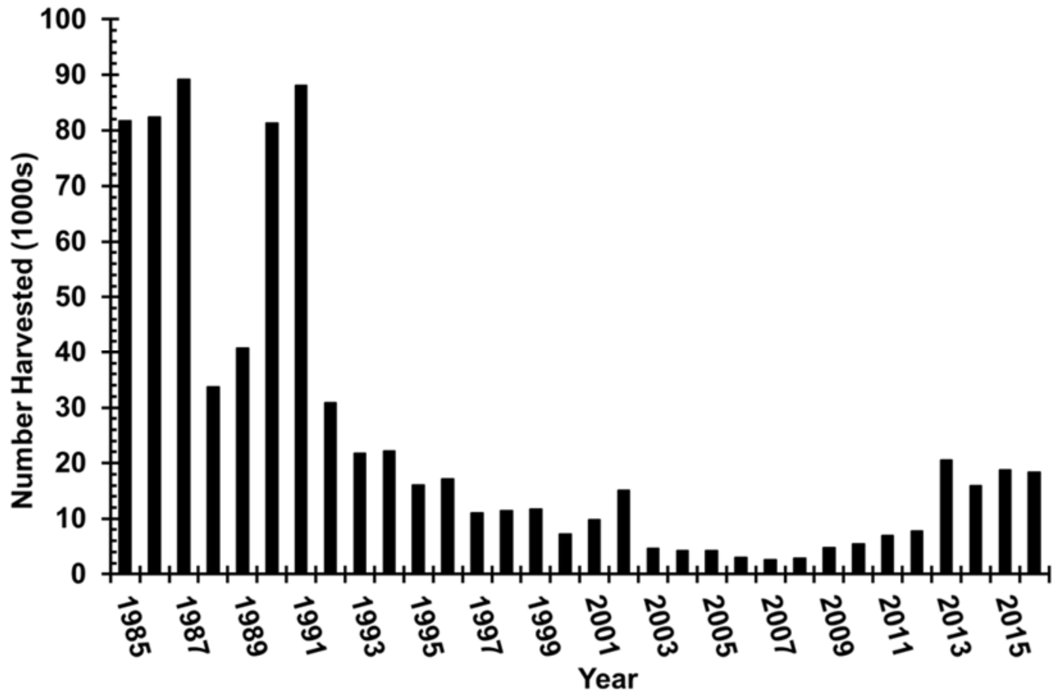


***Figure 6. Estimated numbers of lake trout harvested by boat anglers from U.S. waters of Lake Ontario, during April 15 – September 30, 1985 – 2016 (Lantry and Eckert 2017). Beginning with the 2012 report, all harvest values have been reported reflecting a 5.5 month sampling interval. Prior reports were based on a 6 month sampling interval (April 1 – September 30).***

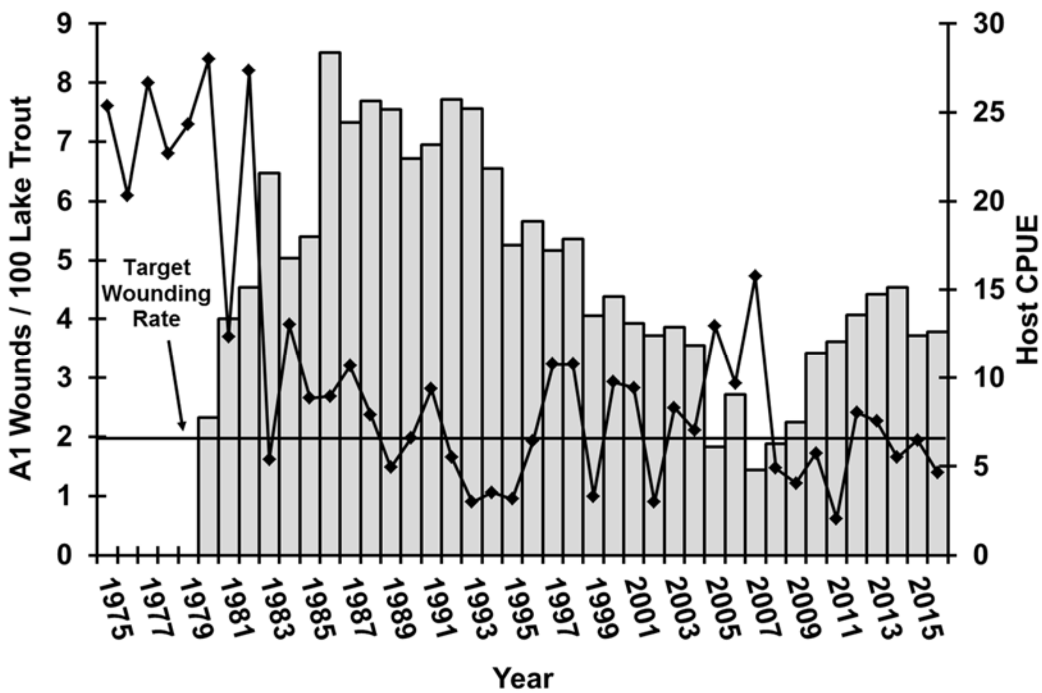


***Figure 7. Wounding rates (A1 wounds per 100 lake trout, line) inflicted by sea lamprey on lake trout ≥ 433 mm (17.1 in) TL and the gill net CPUE of lake trout hosts (≥ 433 mm TL, bars) collected from Lake Ontario in fall, 1975 – 2016.***

1.7- and 2-fold higher than the respective previous 10-year averages. These increases follow the October 2006 regulation change, and coincide with an increase in lake trout abundance and anecdotal reports of anglers targeting lake trout more frequently during 2013-2016.

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 well 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). While the rate was slightly above target again in 2012 (2.41) and 2013 (2.26), it fell once again below target in 2014 (1.65), 2015 (1.94) and 2016 (1.40).

Adult Survival

Survival of Seneca strain lake trout (ages 7 to 11) was 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 and 2003-2007 cohorts as all fish stocked during that period received coded wire tags. Population survival was not calculated for the 1978-1982 and 1996-2002 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 most recent completely tagged year class (2003) sampled at ages 7-11 was above target. The SEN strain survival and the population survival for the 2004 and 2005 year classes are above target and are identical because the stockings for both year classes were predominantly SEN. Stockings for both of those year classes were also far below the 500K target with all 224K of the 2004 year class being stocked at one site in the eastern basin and all 118K of the 2005 year class released at one site in the western part of the lake. The stockings for the 2006 and 2007 year classes were near the 500K target and more evenly distributed between SEN and SUP-like strains. The CPUEs although were only high enough to calculate SEN survival separately from total population values and for both year classes both survival values were above targets.

***Table 1. Annual survival of various strains (strain descriptions appear in Appendix 1) of lake trout, U.S. waters of Lake Ontario, 1985-2016. 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 | 0.84 | - | - | - | - | |
| 2000 | 7-11 | 0.90 | - | - | - | - | |
| 2001 | 7-11 | 0.73 | - | - | - | - | |
| 2003 | 7-11 | 0.72 | - | 0.53 | - | - | 0.68 |
| 2004 | 7-11 | 0.78 | | | | | 0.78 |
| 2005 | 7-11 | 0.85 | - | - | - | - | 0.85 |
| 2006 | 7-10 | 0.79 | - | - | - | - | 0.76 |
| 2007 | 7-9 | 0.85 | - | - | - | - | 0.73 |

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 the highest values observed for the time series (2010-2012 mean =3734.0 g). 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. While both predicted weight and condition remained generally at a high level during 2007-2015, a declining trend from 2011 to 2015 was apparent. That trend reversed in 2016 with the second highest condition and Fulton's K values recorded since the time series began in 1983.

Predicted weights of 400-mm lake trout, based on bottom trawl catches of 250-500 mm fish, and Fulton's K for an age-2 lake trout changed between the late 1990s and early 2000s (Figure 9). The mean predicted weight during 1999-2016 declined by 15.4g below the 1979-1998 mean, paralleling declines in native benthic prey resources (Weidel et al. 2014). Predicted weight increased for a brief period during 2005-2008 paralleling increases in round goby (*Neogobius melanostomus)* abundance (Weidel et al. 2014) which are now common in lake trout diets. Condition of immature fish fell again in 2009 (591.3 g, 1.3 lb.) and in most years during 2010-2016, remained at values that were among the lowest for the time series.

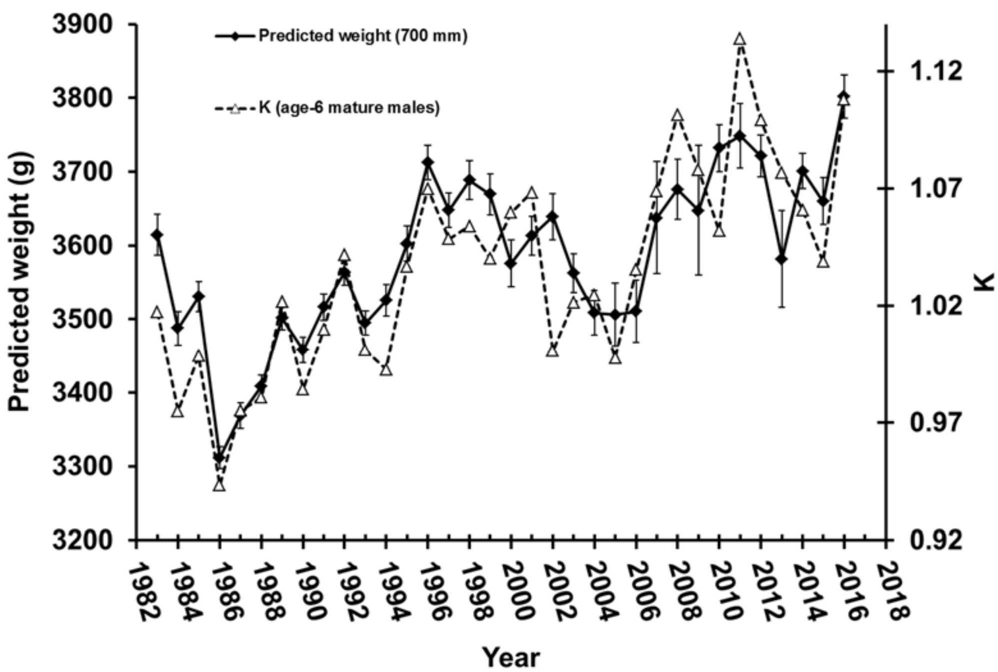


***Figure 8. Lake Ontario lake trout condition (K) for age-6 mature males and predicted weight at 700-mm (27.6 in) TL from weight-length regressions calculated from all fish collected during each annual gill net survey, September 1983 – 2016. Error bars represent the regression confidence limits for each annual value.***

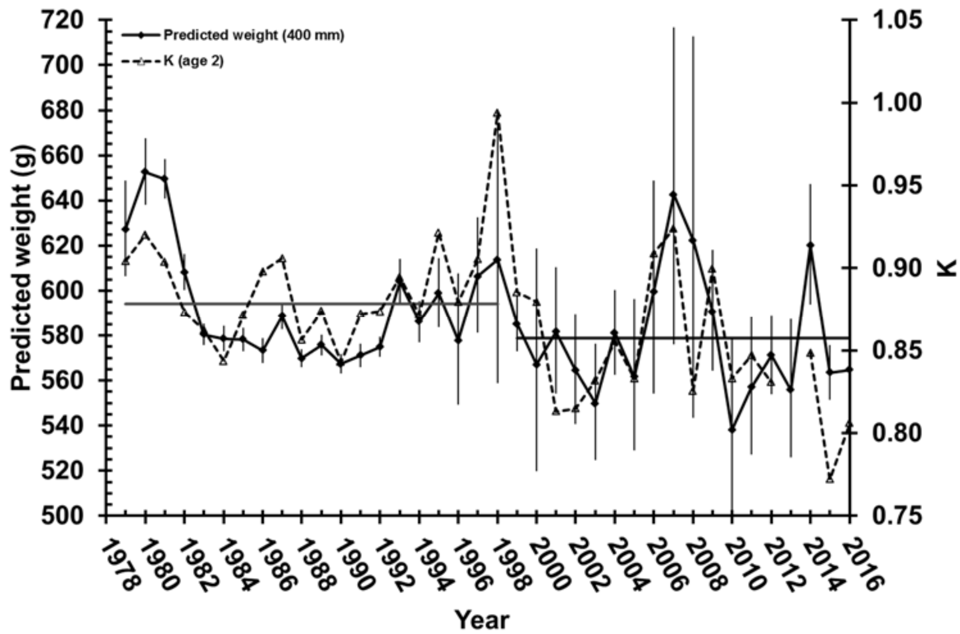


***Figure 9. Lake Ontario lake trout condition (K) for age-2 coded wire tagged fish and predicted weight at 400-mm (15.8 in) TL from annual weight-length regressions calculated from fish 250 mm-500 mm (9.8 to 19.7 in). All lake trout were sampled from bottom trawls, July -August 1978 – 2016. The horizontal lines represent the mean predicted weights during 1979-1998 and during 1999-2016. Sample sizes for regressions were ≥ 39 except for 1997, 2000, 2005, 2006, 2007, 2008 and 2013 (n = 13, 15, 19, 11, 14, 20 and 12, respectively). Error bars represent the regression confidence limits for each annual value.***

<u>Reproductive Potential</u>

Temporal patterns in the egg deposition index (Figure 10) differed considerably from temporal abundance patterns in the CPUE of all mature females (Figure 3). The CPUE of all 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. Trends more closely agreed between the egg deposition index and the CPUE of mature females ≥ 4,000 g than between the index and the CPUE of all females, reflecting the effects of population age structure on fecundity. 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 between 1997 and 2003 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.

In 2013-2016 egg deposition indices were similar to 2001-2004 values and, for the first time, included contributions from Klondike strain (SKW) lake trout from the 2008 year class (see Appendix 1 from strain descriptions).

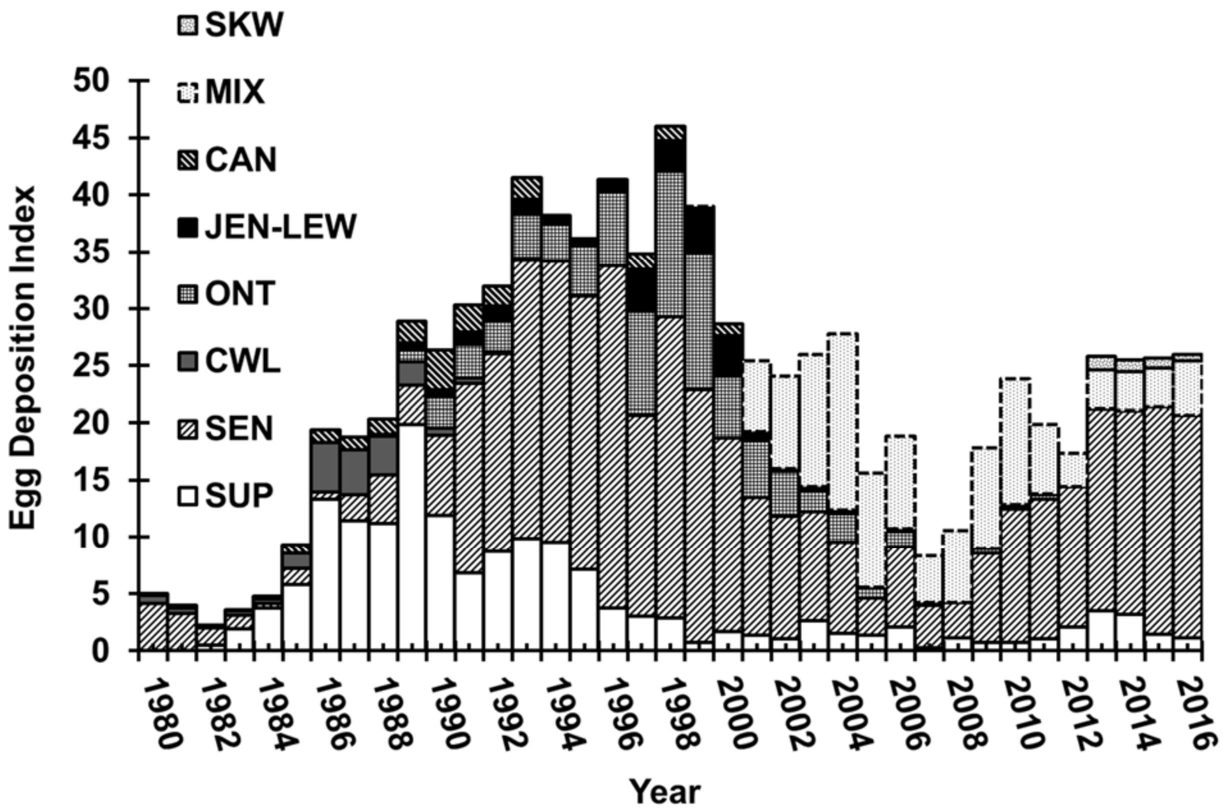


***Figure 10. Egg deposition indices by strain (strain descriptions for ONT, JEN-LEW, CWL, SEN, SUP and SKW appear in Appendix 1) for lake trout in U.S. waters of Lake Ontario during 1980-2016. CAN represents a mix of the strains stocked by OMNRF and MIX represents values for untagged females stocked since 1997 for which strain could not be determined.***

Natural Reproduction

Evidence of survival of naturally produced lake trout past the summer/fall fingerling stage occurred in each year during 1993-2014 (Figure 11) except 2008, representing production of 22 year classes. Numbers caught represent the entire annual bottom trawl catch from four surveys occurring during April-October 1979-2014 (for a description of the surveys see O'Gorman et al. 2000 and Owens et al. 2003). In 2015 the June bottom trawl survey was discontinued, so total trawl effort decreased. Catch was not corrected for effort due to the low catch in most years and a relatively constant level of effort expended within the depth range (20m - 100m) where age-0 to age-2 naturally reproduced lake trout are most often encountered in Lake Ontario for most years. Low numbers of small (<100 mm, 3.9 in), wild fish captured during 1997-2012 may have been due in part to a change in our trawl gear that was necessary to avoid abundant dreissenid mussels. The wild yearlings captured in 2010-2016 were the first wild yearlings caught since 2005. The three largest catches of the 22-year time-series occurred during 2014-2016 with 47 age-1 (93-186 mm, 3.7-7.3 in) and 70 age-2 wild lake trout (176-291 mm, 6.9-11.5 in) caught in 2014; 24 age-1 (94-147 mm, 3.7-5.8 in) and 48 age-2 (167-262 mm, 6.6-10.3 in) caught in 2015; and 21 age-1 (87-169 mm, 3.4-6.6 in) and 30 age-2 (178-245 mm, 7.0-9.6 in) caught in 2016.

The distribution of catches of wild fish suggests that lake trout are reproducing throughout New York waters of Lake Ontario with the greatest

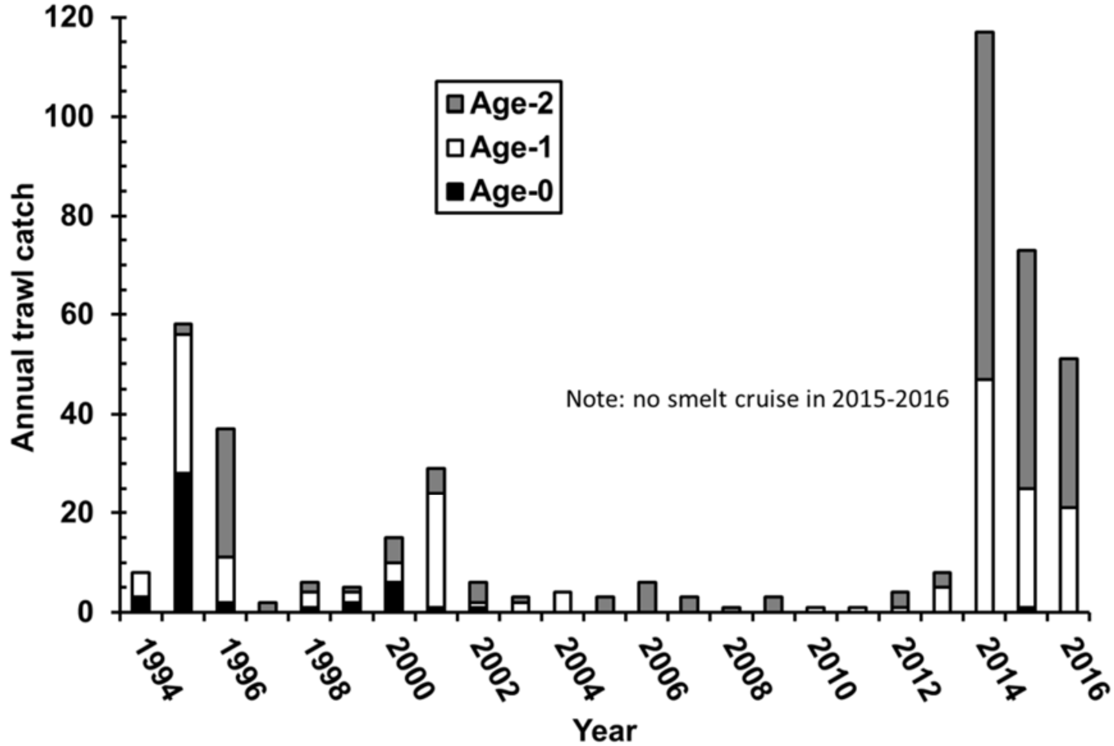


***Figure 11. Numbers and ages of naturally produced (wild) lake trout captured with bottom trawls in Lake Ontario by NYSDEC and USGS, 1994-2016. During 1980-1993, only one naturally produced lake trout was captured with bottom trawls.***

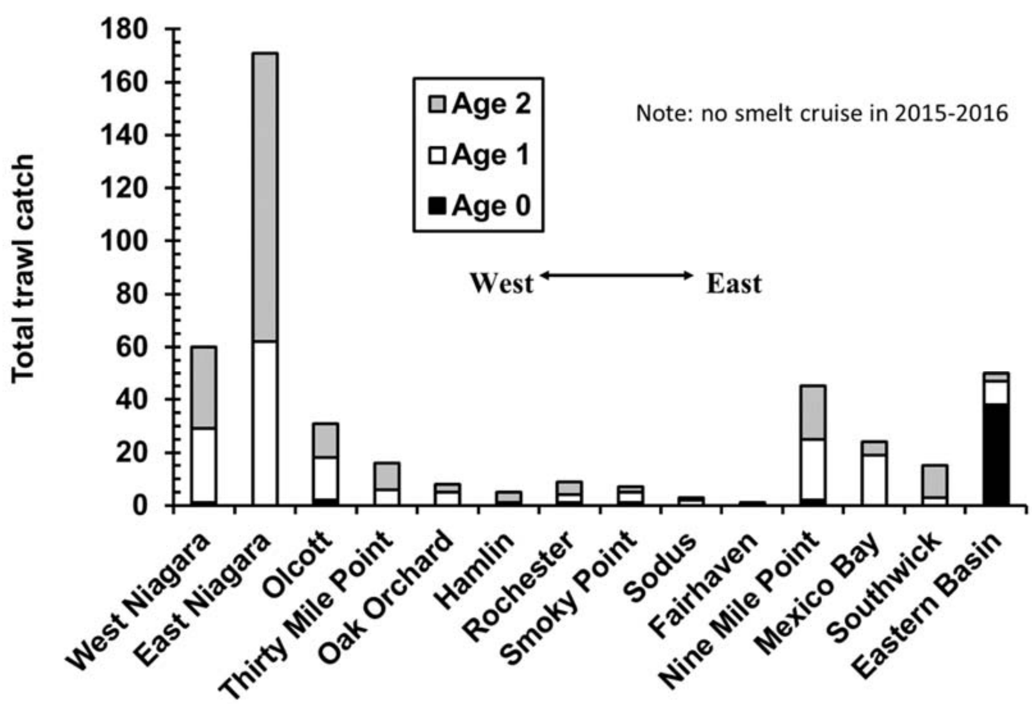


***Figure 12. Numbers of wild lake trout (age 0 to 2) captured with bottom trawls at various locations in Lake Ontario by NYSDEC and USGS, 1994 – 2016. (Note: east and west Niagara are only sampled once per year whereas the other locations are usually sampled four times per year.***

concentration coming off the Niagara Bar area at the mouth of the Niagara River (Figure 12). Catches from at least 22 cohorts of wild lake trout since 1994 and survival of those year classes to older ages demonstrates the feasibility of lake trout rehabilitation in Lake Ontario (Schneider et al. 1997). Although recent large catches of wild lake trout are encouraging, achieving the goal of a self-sustaining population requires consistent production of relatively large wild year classes and survival of those fish to reproductive ages.

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**Appendix 1.**

<u>Strain Descriptions</u>
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 to supplement broodstocks 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 and 2012 year classes). 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 is no longer be available as a source of eggs for future Great Lakes stockings. The Apostle Island strain was derived from a remnant "lean" Superior stock restored through stocking efforts, was phased out of production at USFWS Iron River National Fish Hatchery (IRNFH) and is no longer be available as a source of eggs for future Great Lakes stockings.

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 have been held at the USFWS Sullivan Creek National Fish Hatchery and USFWS Iron River National Fish Hatchery. The USFWS Berkshire National Fish Hatchery developed a SKW brood stock to supply fertilized eggs to ANFH for rearing and stocking into Lake Ontario.

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).

HPW - "Lean" lake trout strain originated from a self-sustaining remnant population located in Parry Sound on the Canadian side of Georgian Bay in Lake Huron. A captive HPW broodstock is maintained at the USFWS Sullivan Creek National Fish Hatchery and is the source of eggs for HPW reared at USFWS Alleghany National Fish Hatchery in Warren, Pennsylvania for stocking into Lake Ontario. The first HPW lake trout stocking into Lake Ontario occurred in fall 2014.

*For further discussion of the origin of strains used in Lake Ontario Lake Trout Restoration see Krueger et al. (1983), Visscher, L. 1983, and Page et al. 2003.*

## Thousand Islands Warmwater Fisheries Assessment

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Warmwater fisheries 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 fisheries 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 fisheries assessment is applied to this project in keeping with NYS Bureau of Fisheries administrative structure, but several species of interest would normally be considered coolwater fishes (e.g. northern pike [*Esox lucius*], wWalleye [*Sander vitreus*] [Eaton et al. 1995]). Sampling was conducted 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 ($\alpha$= .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

<u>Environmental conditions</u>
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 to 79°F (26°C) in 1979. Bottom temperatures are generally within 2°F (1°C) of surface temperatures. Surface temperature in 2016 was fairly typical of recent years at 73-75°F (23-24°C). Bottom temperature at 50 ft (15 m) was 72°F (22°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 2016, transparency was high with Secchi depth at 50 ft (15.2m) (Table 1).

<u>Catch composition</u>
A total of 37 species have been represented in

Thousand Islands gill net sampling between 1977 and 2015 (Table 2). These nets were not designed to catch small-bodied species so that cyprinids, other than carp, are rarely captured. Total annual catch (for 32 net sets) has historically ranged from 847 fish in 2012 to 2,080 fish in 1988. Diversity has ranged from 13 species in 1995 to 19 species (six times). Total catch in 2016 was a low at 824 individuals (adjusted to multifilament standard); diversity was a record high, with 20 species represented (Table 2) thanks to the presence of several rarely sampled species such as Lake Sturgeon (*Acipenseur fulvescens*) and muskellunge (*Esox masquinongy*). 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 in all but one year (2013) since. Historically, 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 (Figure 1). In recent years, abundance of pumpkinseed punfish and brown bullhead have declined, leaving northern pike, rock bass, smallmouth bass, yellow perch, walleye and white sucker (*Catostomous commersonii*) as the predominant group. In 2016, alewife (*Alosa pseudoharengus*) and brown bullhead were unusually abundant; in addition to yellow perch, rock bass, and smallmouth bass they made up over 90% of the catch (Figure 1).

<u>Primary recreational fishery targets</u>

*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 varied at relatively high levels until 2012. Abundance then declined, reaching a near record low in 2015. In 2016 abundance increased substantially, suggesting the 2015 value may have been a sampling anomaly. The trend in smallmouth bass abundance is complicated by a disproportionate representation of younger fish since 2006. Abundance of age-5 and older fish in the sample, which have historically constituted the bulk of the catch, has remained relatively low in recent years, while the abundance of age-3 and age-4 fish has increased (Figure 3). Younger bass, ages 3-4, have generally been more abundant since 2006 relative to earlier years (Figure 4). This may indicate increased abundance of these fish, but more likely reflects a change in catchability of young bass due to increased growth rates.

Age 5 and 6 bass, 2009 and 2010 year classes, were much less abundant than expected in 2015 but these year classes were somewhat above average abundance in 2016 (Figure 4). This anomaly may be related to the small sample size (n=60) of smallmouth bass in 2015. During the 10 year period, 2007 through 2016, seven year classes (2004-2010) could be followed from ages 3 through 6. The 2009 year class was fairly average strength for year classes sampled 2007-2016, the 2010 year class was moderately weak. Overall the 2004 year class was the weakest detected during this period; the 2005 year class was the strongest (Table 4).

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).

Smallmouth bass growth changed little between 1977 and 1998. Thereafter growth increased, possibly a density dependent effect (McCullough 2012), resulting in an overall increasing trend in size of age-5 bass from 1977 to 2004 (regression slope = 0.98, $r^2$ = 0.30). Bass are now generally reaching legal size, 12" (305 mm), before age-5. Since Round Goby establishment in 2005, mean total length at age 5 has increased more quickly (linear regression slope = +7.76, $r^2$ = 0.87, Figure 5). In 2014 age-5 bass averaged a record 15.7 inches (399 mm) and was essentially unchanged in 2015. In 2016 mean length at age 5 declined slightly to 15.0 in (381 mm) (Figure 5). It is too soon to determine whether this is a new trend or a temporary fluctuation. 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 have been 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 again generally declined and has tended to vary 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 have been less abundant recently, particularly at ages 3 and 4 (Figure 7). Older fish have thus far shown little decline, suggesting that survival of recruited fish has improved relative to earlier years (Figure 7). Sample size for northern pike has declined to the point that determination of year class strength has become impractical.

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). Overall there has been a declining trend. Although the change in growth (mean total length at age-4) of northern pike after the establishment of round goby has been less notable than that of other St. Lawrence River piscivorous fishes, growth of pike may be improving (1977-2005 linear regression slope = -2.04, $r^2$ = 0.24; 2005-2016 linear regression slope= 1.54, $r^2$= 0.06).

*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 perchyellow perch abundance tended to increase, but to only a fraction of its previous level. After 1999, yellow perch catch generally declined, falling to its lowest recorded (adjusted) level in 2005. Catches increased somewhat in 2006 and remained at this level through 2008. Abundance then declined to a record low in 2012 and has remained low since (Figure 9).

Although overall abundance has declined the bulk of perch in the sample have consistently been ages 3-5 (Figure 10). There have been several reasonably strong yellow perch year classes detected during the 2007-2016 period. Of the seven year classes (2004-2010) followed for ages 2-6, the 2004 year class was strongest and the 2009 year class was the weakest (Table 4).

Growth rate of age-4 yellow perch has generally increased over the survey period (Figure 11). Growth was relatively stable 1977-2004 (linear regression slope=0.03, $r^2$=0.001). Increased growth since 2005 may be attributable to the availability of round goby as forage (linear regression slope = 4.06, $r^2$=0.06, Figure 11). Total length of age-4 perch reached a record high of 218 mm (8.6 inches) in 2013, but has since declined.

*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 catches have been substantially more abundant to date (excepting an apparently anomalous low catch in 2012; Figure 12). As in Lake Ontario's eastern basin, walleye is the only sportfish species that increased in abundance since the inception of this assessment (Lantry 2010).

<u>Other species of interest</u>

*Sturgeon.* Lake sturgeon 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. Three sturgeon were sampled in 2016, the most ever captured in a single year of assessment netting. Two of three fish caught were confirmed to have been stocked. All 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) and in the St. Lawrence River at Ogdensburg (1996-2000, 2013-2015). Natural spawning has been observed in the upper St. Lawrence River (LaPan et al. 1997), however, and is thought to be a major source of recruitment to this population.

*River Herrings.* Alewife were frequently captured during the 1970s and 1980s, and were detected at very low levels from 1989 through 2006. The catch rate in 2009 was the highest yet recorded, declined close to the background level by 2014, and increased substantially in 2015-16 (Figure 13). Like salmonids, many of the alewife in the river probably strayed 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*) have been captured occasionally. 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). Only 11 muskellunge have been caught since 1977, including one in 2015 and one in 2016. 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 have been at or near recod low abundance since 2014(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 this assessment 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. Brown bullhead were at record low abundance in 2015, but increased to a more moderate, though still low level in 2016. Channel catfish have been sampled regularly throughout the survey period. Through 2009 they had generally been present at substantially lower abundance than brown bullhead, but with the decline in bullhead in recent years (Figure 15) the two species were about equally abundant from 2011 to 2015. In 2016 brown bullhead were somewhat more abundant than channel catfish.

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 historically been the most common sunfishes in Thousand Island gillnet sampling and 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). From 2000 through 2011 rock bass generally increased while pumpkinseed decreased in abundance. Rock bass have been in a general decline since 2012, but remained an order of magnitude more abundant than Pumpkinseed in 2016.

Both bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) are captured regularly. Typically they are caught in low numbers (fewer than 10 individuals), 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*) were found in low numbers through 2003; none have been caught since.

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***Table 1. Water temperature and Scchi depth.***

| Sample Year | Water Temperature Range °C (°F) | Secchi Depth m (ft) | Sample Year | Water Temperature Range °C (°F) | Secchi Depth m (ft) |
|---|---|---|---|---|---|
| 1977 | 22-23 (72-73) | | 1997 | 20-22 (68-72) | 4.3 (14) |
| 1978 | 21-22 (70-72) | | 1998 | 22-24 (72-75) | 8.0 (27) |
| 1979 | 25-26 (77-79) | | 1999 | 23-24 (74-76) | 16.8 (55) |
| 1980 | 20-22 (68-72) | | 2000 | 21-22 (70-71) | 13.4 (44) |
| 1981 | 20-22 (68-72) | | 2001 | 20-24 (68-75) | 6.2 (20) |
| 1982 | 18-19 (64-66) | | 2002 | 21-23 (70-73) | 7.3 (24) |
| 1983 | 22-23 (72-73) | | 2003 | 21-24 (69-76) | 6.5 (21) |
| 1984 | 19-21 (66-70) | | 2004 | 21-22 (69-71) | 8.1 (26.5) |
| 1985 | 20-21 (68-70) | | 2005 | 22-24 (72-75) | 11 (36) |
| 1986 | 19-21 (66-70) | | 2006 | 22-24 (72-75) | 8.8 (29) |
| 1987 | 19-21 (66-70) | | 2007 | 21-22 (69-72) | 7.8 (22.5) |
| 1988 | 22-24 (72-75) | | 2008 | 20-24 (68-75) | 10.4 (34) |
| 1989 | 19-22 (66-72) | | 2009 | 21-23 (69-73) | 9.5 (31) |
| 1990 | 22-24 (72-75) | | 2010 | 23-25 (74-77) | 6.0 (20) |
| 1991 | 23-23 (73-73) | | 2011 | 23-24 (74-76) | 8.8 (29) |
| 1992 | 18-19 (64-66) | | 2012 | 23-25 (73-75) | 9.3 (30.5) |
| 1993 | 21-24 (70-75) | | 2013 | 23-25 (73-75) | 6.5 (21.3) |
| 1994 | 21-24 (70-75) | | 2014 | 20-22 (68-71) | 12.0 (39.5) |
| 1995 | 22-24 (72-75) | | 2015 | 20-22 (69-71) | 8.0 (26.3) |
| 1996 | 21-21 (70-70) | 8.8 (29) | 2016 | 23-24 (73-75) | 15.2 (50) |

***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 | 1997 | 36.4 | 17 | 1,165 |
| 1978 | 59.7 | 16 | 955 | 1998 | 32.6 | 17 | 1,044 |
| 1979 | 57.7 | 12 | 923 | 1999 | 44.9 | 19 | 1,437 |
| 1980 | 47.5 | 13 | 760 | 2000 | 30.0 | 18 | 959 |
| 1981 | 38.1 | 14 | 610 | 2001 | 29.1 | 17 | 932 |
| 1982 | 41.5 | 17 | 1,328 | 2002 | 34.9 | 16 | 1,077 |
| 1983 | 39.0 | 16 | 1,249 | 2003 | 35.5 | 18 | 1,137 |
| 1984 | 39.7 | 18 | 1,271 | 2004 | 30.3a | 15 | 970a |
| 1985 | 40.4 | 17 | 1,292 | 2005 | 27.5a | 16 | 880a |
| 1986 | 50.7 | 12 | 1,622 | 2006 | 41.9a | 15 | 1,352a |
| 1987 | 51.9 | 17 | 1,661 | 2007 | 40.4a | 18 | 1,293a |
| 1988 | 65.0 | 19 | 2,080 | 2008 | 39.1a | 14 | 1,196a |
| 1989 | 45.3 | 19 | 1,450 | 2009 | 36.7a | 16 | 1,160a |
| 1990 | 49.2 | 19 | 1,574 | 2010 | 36.2a | 18 | 1,158a |
| 1991 | 41.5 | 18 | 1,328 | 2011 | 37.9a | 16 | 1,214a |
| 1992 | 31.7 | 19 | 1,014 | 2012 | 26.5a | 19 | 847a |
| 1993 | 38.6 | 15 | 1,235 | 2013 | 31.8a | 17 | 1,017a |
| 1994 | 35.1 | 16 | 1,123 | 2014 | 23.6a | 18 | 755a |
| 1995 | 37.4 | 13 | 1,197 | 2015 | 23.5a | 13 | 752a |
| 1996 | 36.7 | 17 | 1,174 | 2016 | 25.8a | 20 | 824a |

* 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 | 1977 | 1978 | 1979 | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 | 1989 | 1990 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake Sturgeon | 0 | 0 | 0 | 0 | 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 |
| Common 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 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 |
| Common 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 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lake Sturgeon | .03 | 0 | 0 | 0 | .03 | 0 | 0 | 0 | 0 | 0 | 0 | .09 | | |
| Longnose Gar | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Bowfin | .03 | 0 | 0 | 0 | 0 | .03 | 0 | .03 | .03 | .03 | 0 | .03 | | |
| Alewife | .09 | .03 | 2.25 | .59 | 8.78 | 2.13 | 2.56 | .50 | .41 | .13 | 3.59 | 2.47 | | |
| Gizzard Shad | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Coho Salmon | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Brown Trout | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Lake Trout | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .03 | 0 | 0 | | |
| Rainbow Smelt | 0 | 0 | .06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Northern Pike | 1.63 | 1.84 | 2.06 | 1.34 | 1.38 | 2.34 | 1.44 | 2.19 | 2.0 | 1.53 | 1.13 | .94 | | |
| Muskellunge | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .03 | .03 | | |
| Common Carp | .12 | .19 | .16 | .19 | .09 | .06 | .16 | .16 | .22 | .03 | .06 | .06 | | |
| Rudd | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .22 | 0 | 0 | 0 | 0 | | |
| Golden Shiner | 0 | 0 | .03 | 0 | .03 | .03 | .03 | 0 | 0 | 0 | 0 | .13 | | |
| Fallfish | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .03 | .06 | 1 | 0 | .09 | | |
| Longnose Sucker | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| White Sucker | 1.10 | 1.16 | .88 | .81 | .63 | .34 | .69 | .53 | .78 | .31 | .31 | .44 | | |
| Silver Redhorse | .03 | .06 | .03 | .03 | .03 | .19 | .03 | .03 | .03 | .41 | 0 | .03 | | |
| Shorthead Redhorse | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Greater Redhorse | 0 | 0 | 0 | 0 | .16 | 0 | 0 | 0 | .03 | .03 | 0 | 0 | | |
| Brown Bullhead | 1.53 | 2.47 | 1.22 | .81 | 1.56 | .72 | .75 | .97 | .50 | .19 | .09 | 1.34 | | |
| Yellow Bullhead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .03 | 0 | 0 | 0 | 0 | | |
| Channel Catfish | .38 | .44 | .25 | .31 | .84 | 1.06 | 0.03 | .31 | .34 | .31 | .13 | .22 | | |
| Stonecat | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Burbot | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| White Perch | 0 | .03 | 0 | 0 | 0 | 0 | 0 | 0 | 0.13 | 0 | 0 | 0 | | |
| White Bass | 0 | .03 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| Rock Bass | 8.23** | 11.3* | 9.03* | 8.87* | 8.82* | 10.46* | 11.63* | 5.47* | 10.72* | 6.48* | 7.00* | 5.41* | | |
| Pumpkinseed | 1.88 | 2.41 | .97 | .88 | .81 | .72 | .69 | .47 | .94 | .09 | .09 | .25 | | |
| Bluegill | .06 | .03 | .13 | .06 | 0 | .06 | .09 | .25 | .09 | .03 | 0 | .06 | | |
| Smallmouth Bass | 4.75 | 7.84 | 5.13 | 6.69 | 4.19 | 7.5 | 5.0 | 8.91 | 6.41 | 4.59 | 1.88 | 5.25 | | |
| Largemouth Bass | 0 | 0 | .19 | 0 | 0 | .03 | 0 | .31 | .06 | 0 | 0 | .13 | | |
| Black Crappie | 0 | 0 | 0 | 0 | 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* | 8.31* | 7.75* | 8.18* | 7.94* | | |
| Walleye | .75 | .81 | 1.34 | .84 | 1.03 | .84 | 1.06 | .47 | .81 | 1.22 | 1.22 | .69 | | |
| Freshwater Drum | .06 | 0 | .13 | 0 | 0 | 0 | .09 | .06 | 0.03 | 0 | 0 | 0 | | |
| Round Goby | 0 | 0 | .09 | .53 | .19 | .16 | .75 | .06 | 0 | .37 | .13 | .16 | | |

***Table 4. Smallmouth bass and yellow perch relative year class strengths (abundance of year class$_x$ relative to mean abundance of all year classes tested).***

| Species | Period | Ages | Year Class | Abundance (Σ N) | Proportion of Mean Abundance |
|---|---|---|---|---|---|
| SMB | 2007-2016 | 3-6 | 2004 | 69 | 0.44 |
| | | | 2005 | 257 | 1.64 |
| | | | 2006 | 155 | 0.99 |
| | | | 2007 | 122 | 0.78 |
| | | | 2008 | 226 | 1.44 |
| | | | 2009 | 150 | 0.96 |
| | | | 2010 | 120 | 0.76 |
| | | | **mean** | **157** | |
| | | | | | |
| YP | 2007-2016 | 3-6 | 2004 | 1540 | 1.54 |
| | | | 2005 | 1201 | 1.2 |
| | | | 2006 | 749 | 0.75 |
| | | | 2007 | 1119 | 1.12 |
| | | | 2008 | 1242 | 1.24 |
| | | | 2009 | 470 | 0.47 |
| | | | 2010 | 681 | 0.68 |
| | | | **mean** | **1000** | |

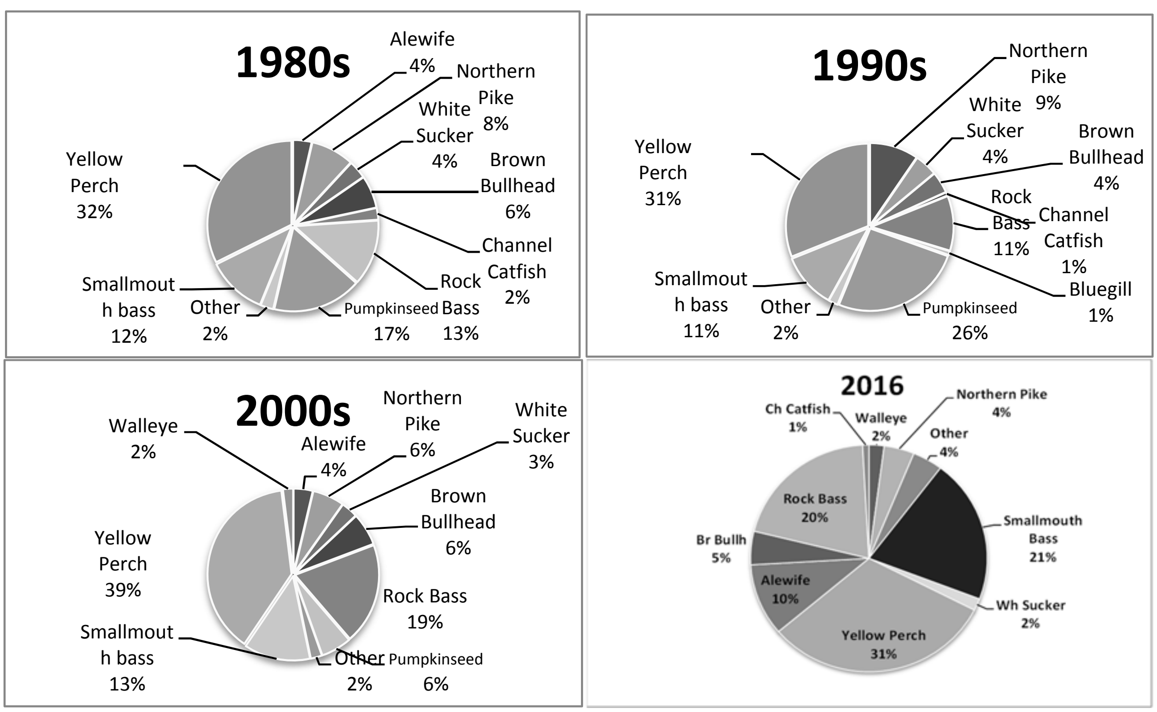


***Figure 1. Composition of the warm/coolwater fisheries assessment sample from mid- depths of the St. Lawrence River Thousand Islands area.***

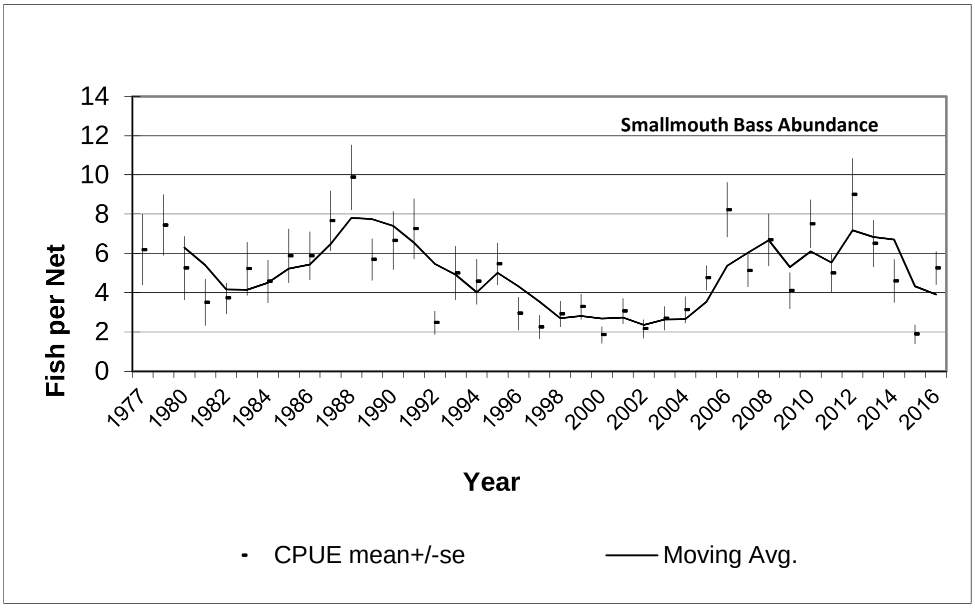


***Figure 2. Smallmouth bass abundance index in the St. Lawrence River Thousand Islands area (Catch per Unit Effort +/- SE and 3-year moving average).***

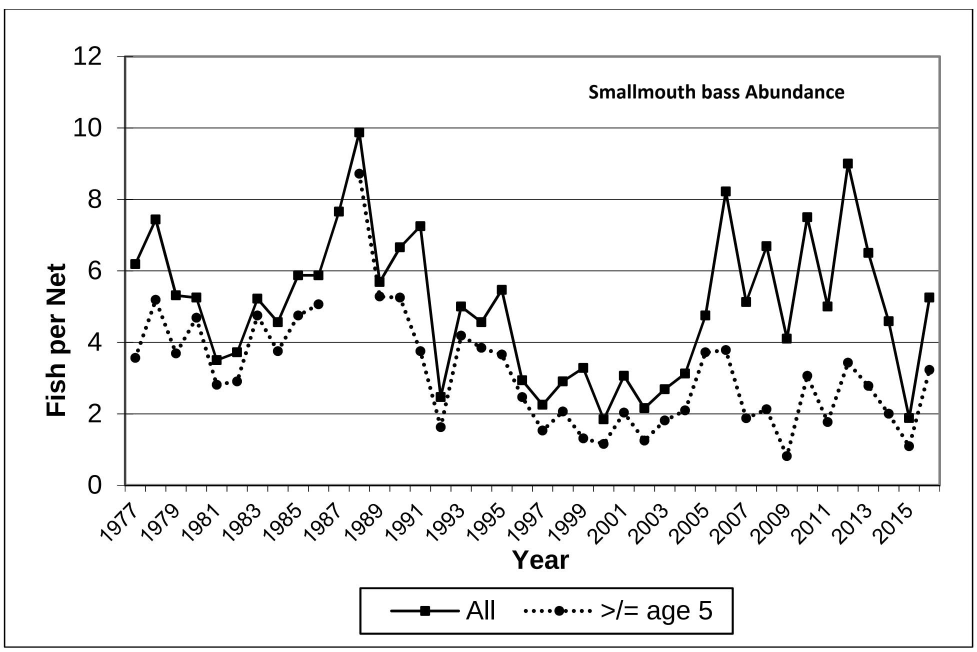


***Figure 3. Smallmouth bass abundance index in the St. Lawrence River Thousand Islands area (all bass sampled and bass greater than or equal to age 5).***

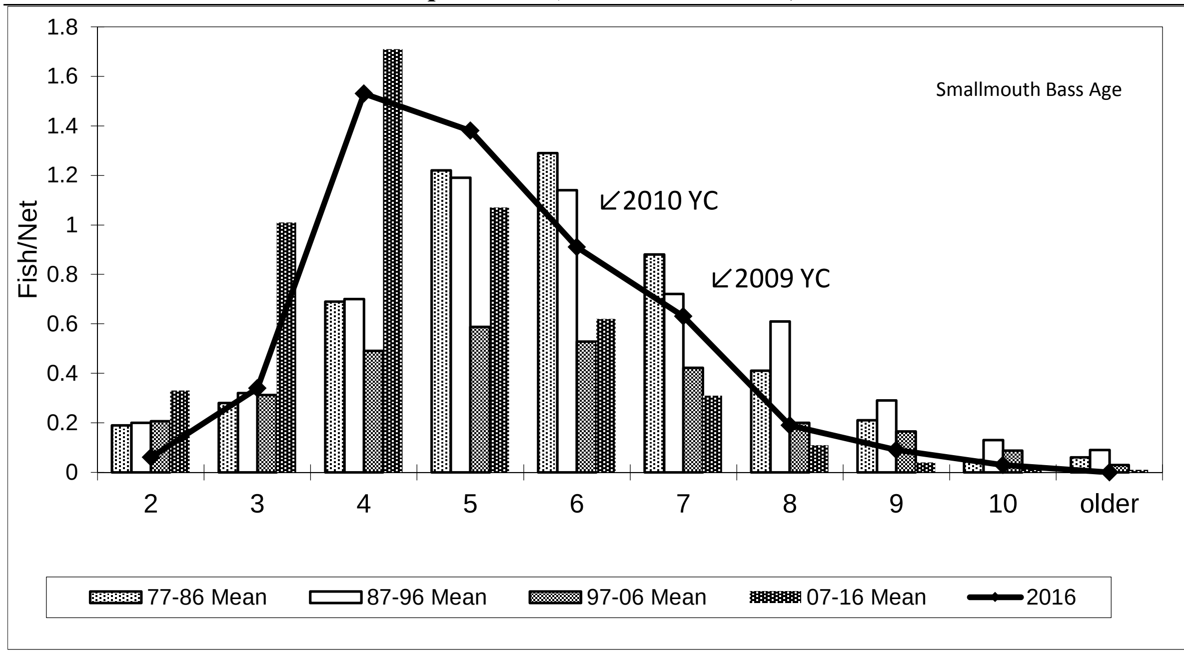


***Figure 4. Smallmouth bass age distribution in the St. Lawrence River Thousand Islands area.***

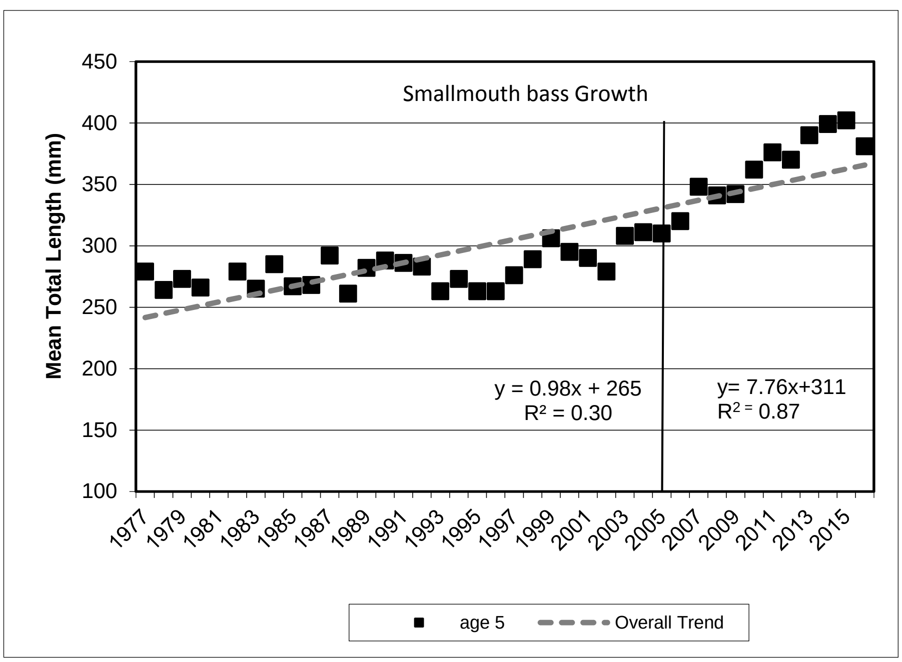


***Figure 5. Mean total length of smallmouth bass at age 5 in the St. Lawrence River Thousand Islands area. Vertical line indicates establishment of abundant round goby-2005.***

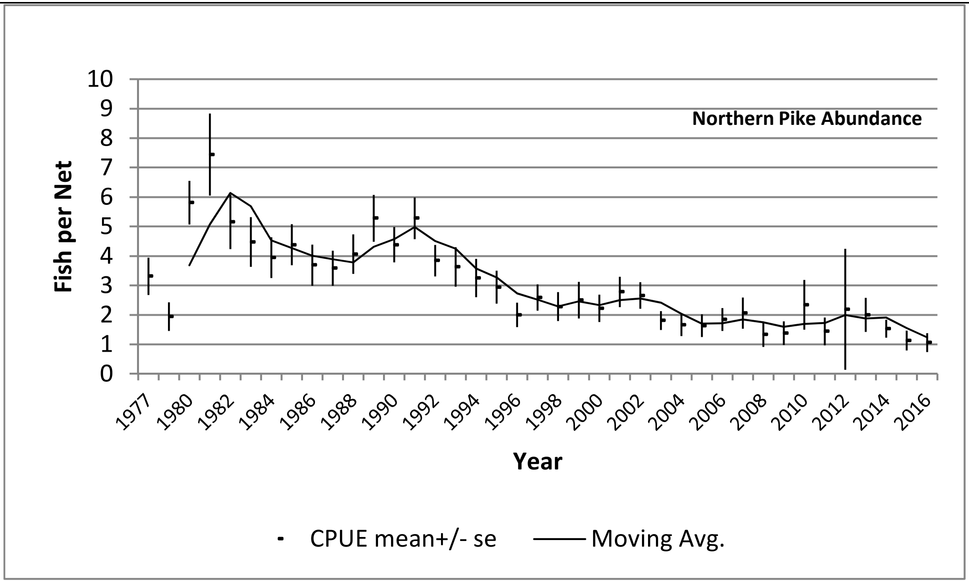


*Figure 6. Northern pike abundance index in the St. Lawrence River Thousand Islands area. (Catch per Unit Effort +/- SE and 3-year moving average).*

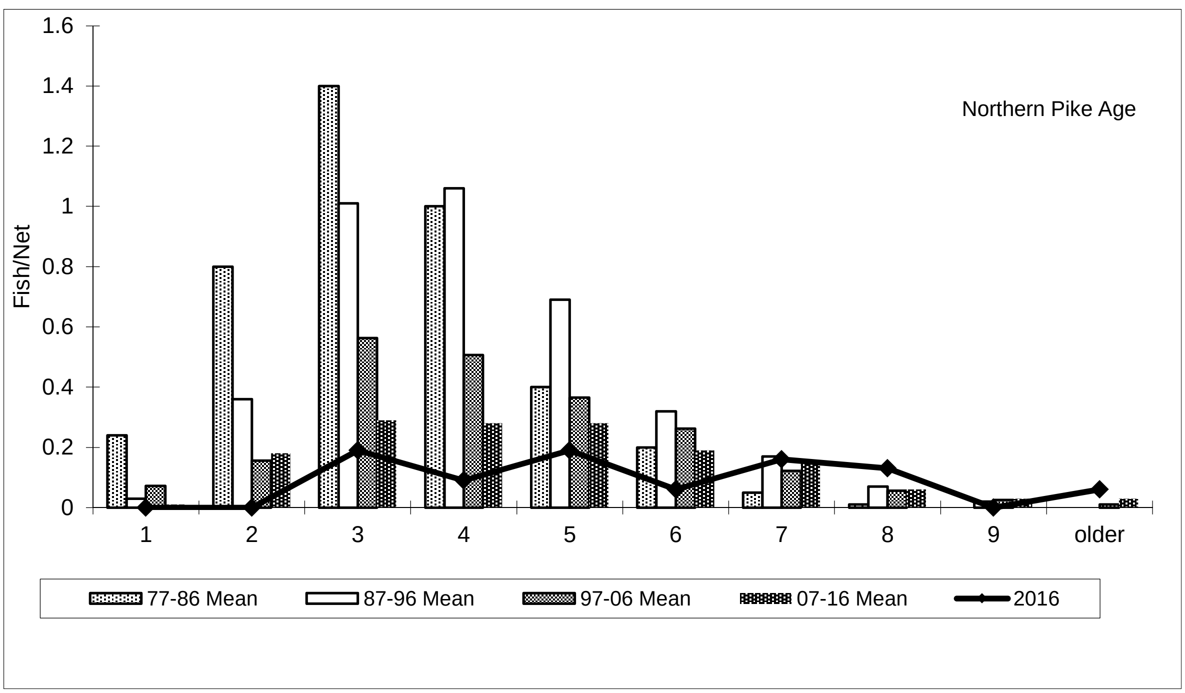


*Figure 7. Northern pike age distribution in the St. Lawrence River Thousand Islands area.*

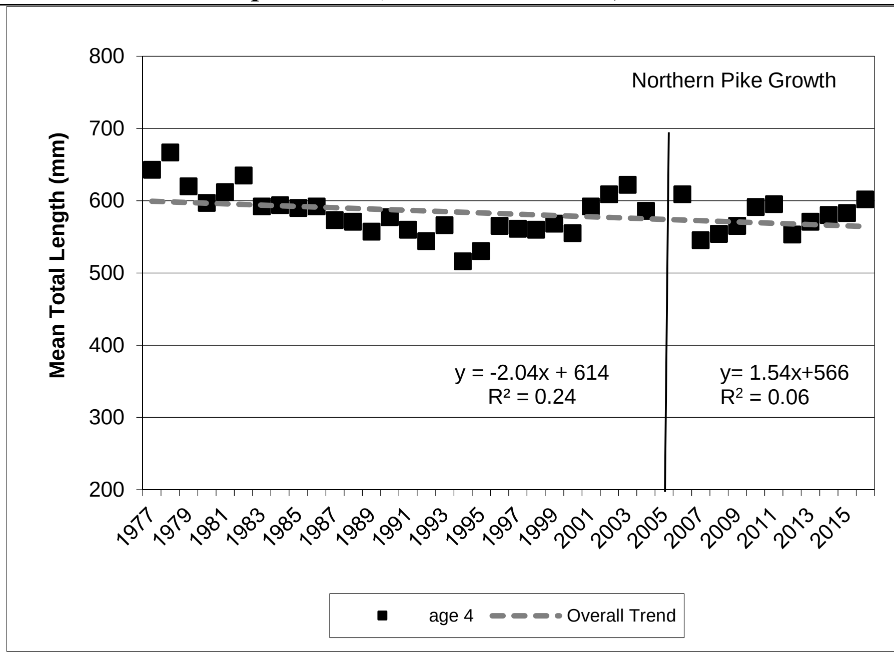


***Figure 8. Mean total length of northern pike at age 4 in the St. Lawrence River Thousand Islands area. Vertical line indicates establishment of abundant Round Goby-2005.***

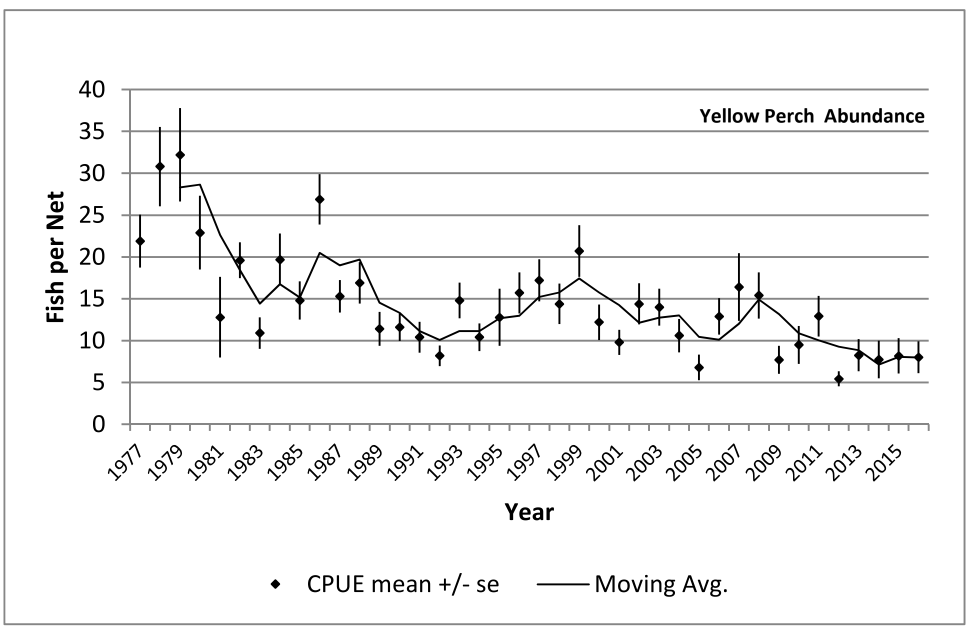


***Figure 9. Yellow perch abundance index in the St. Lawrence River Thousand Islands area. (Catch per Unit Effort +/- SE and 3-year moving average).***

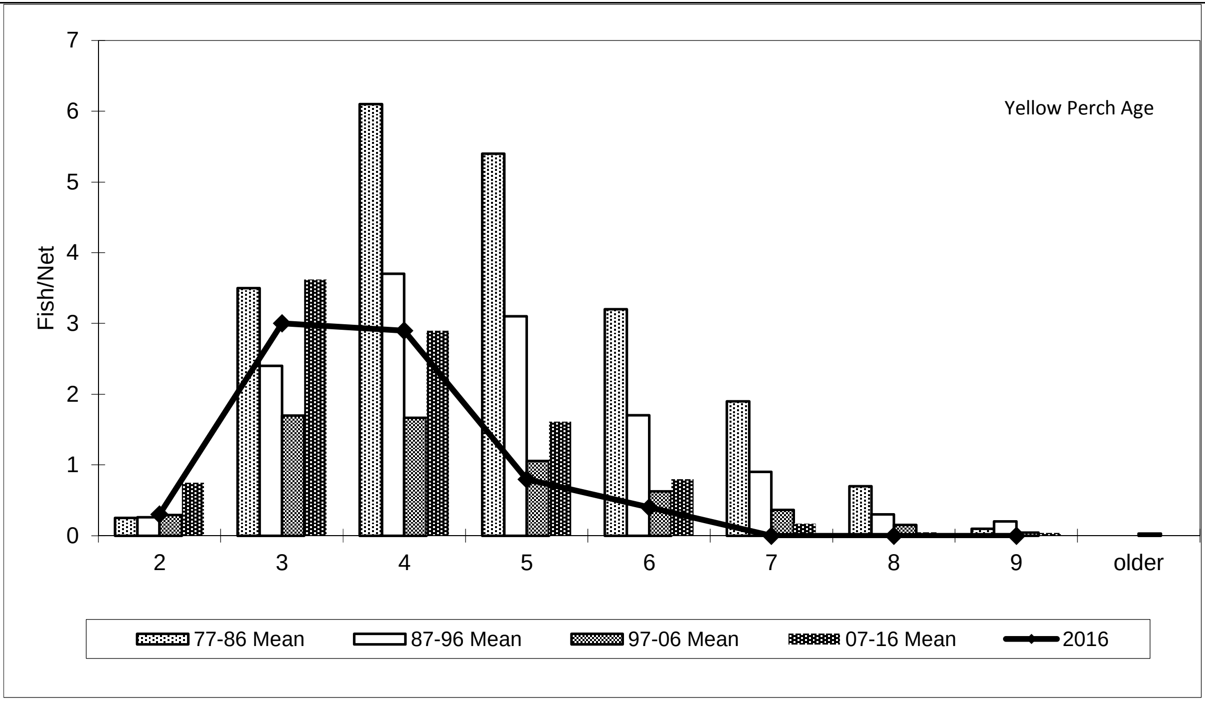


***Figure 10. Yellow perch age distribution in the St. Lawrence River Thousand Islands area.***

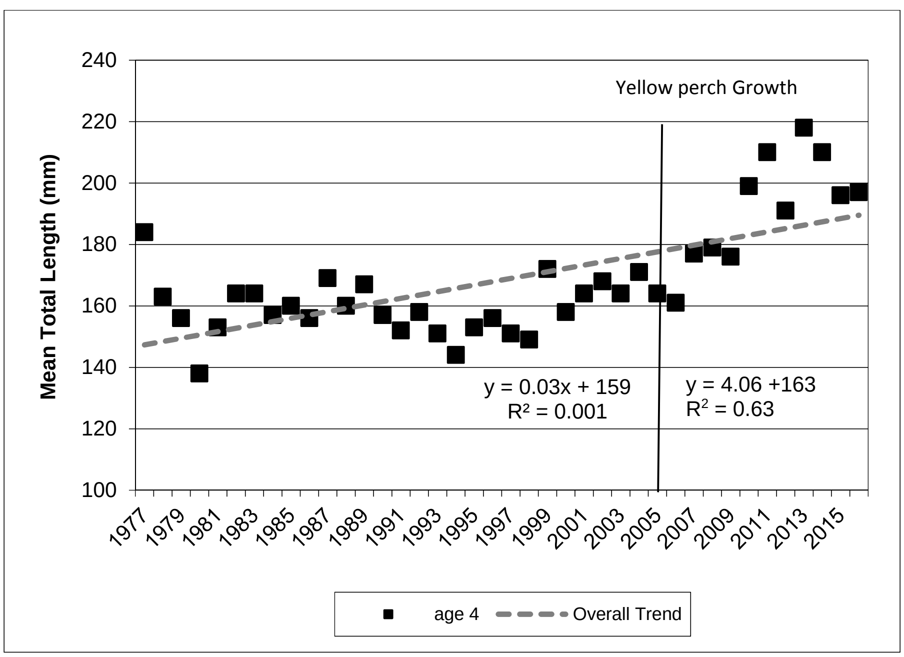


***Figure 11. Mean total length at age 4 for Yellow perch in the St. Lawrence River Thousand Islands area. Vertical line indicates establishment of abundant round goby-2005.***

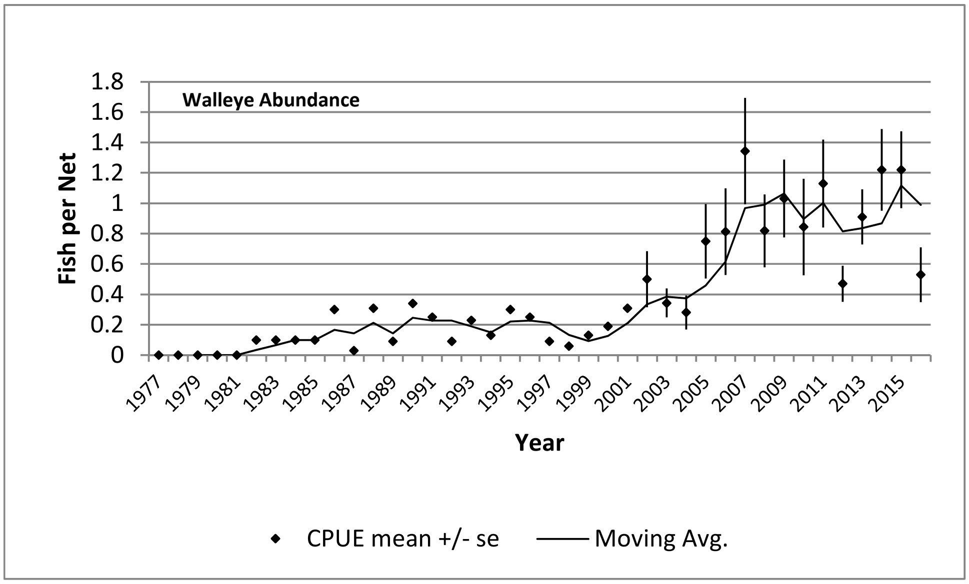


***Figure 12. Walleye abundance index in the St. Lawrence River Thousand Islands area.***

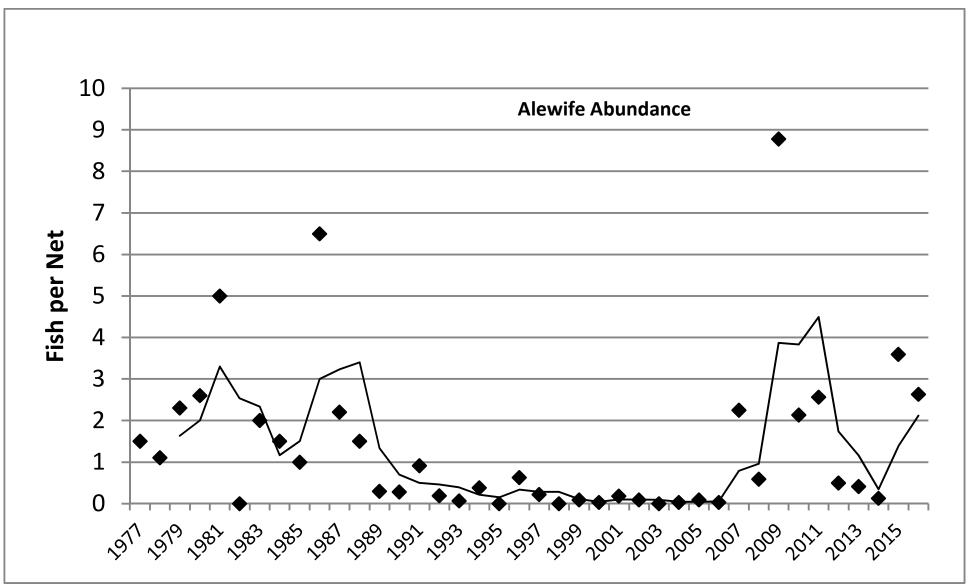


***Figure 13. Abundance index for Alewife in the St. Lawrence River Thousand Islands area (with 3-year moving average).***

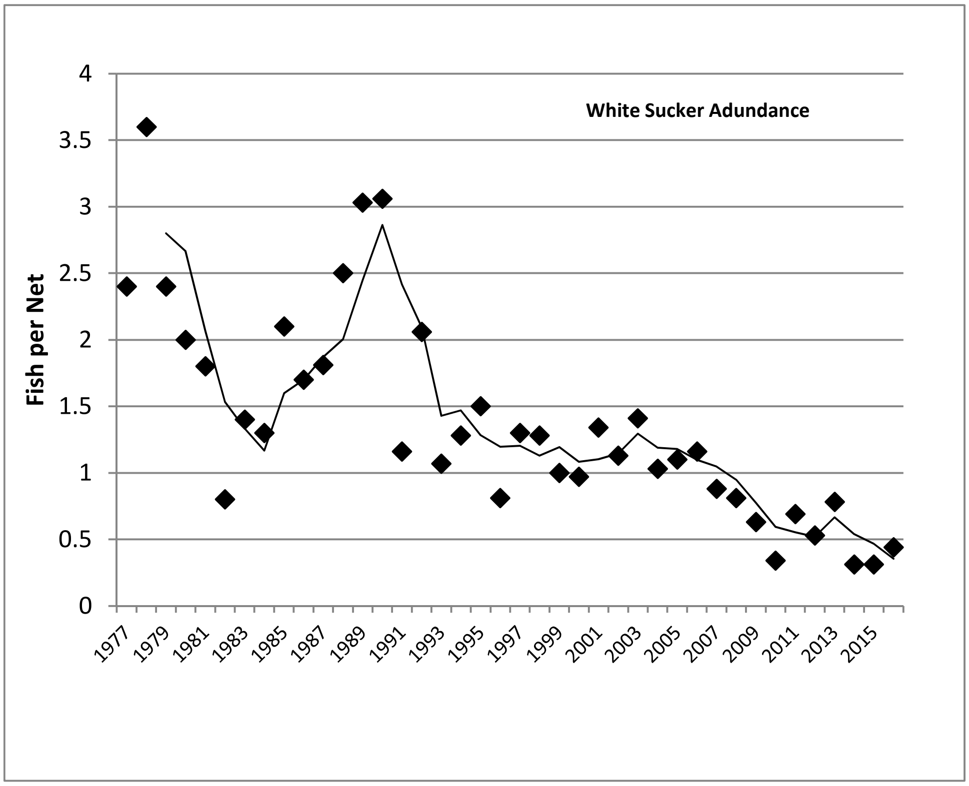


***Figure 14. Abundance index for white sucker in the St. Lawrence River Thousand Islands area (with 3-yr moving average).***

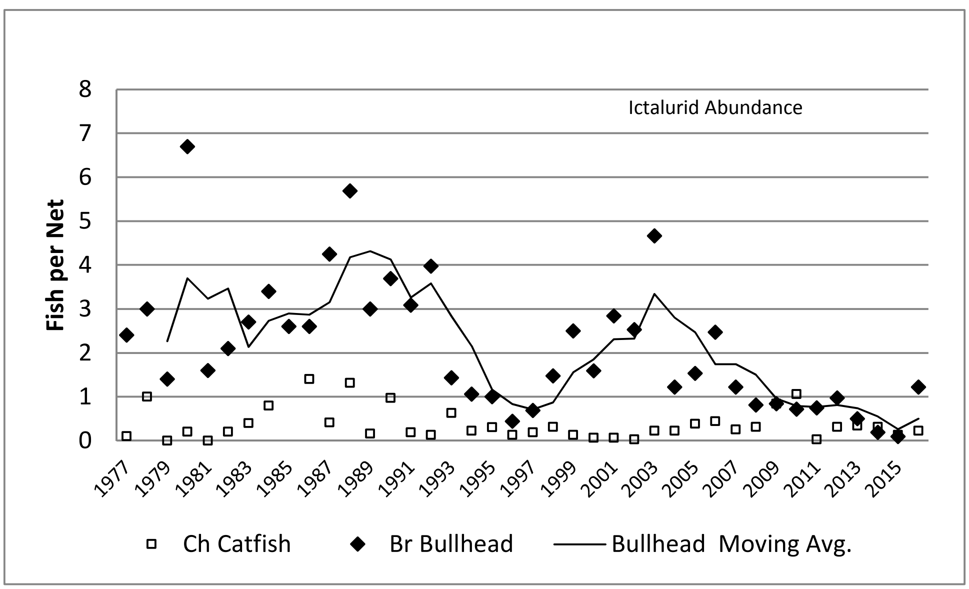


***Figure 15. Abundance index for brown bullhead and channel catfish in the St. Lawrence River Thousand Islands area.***

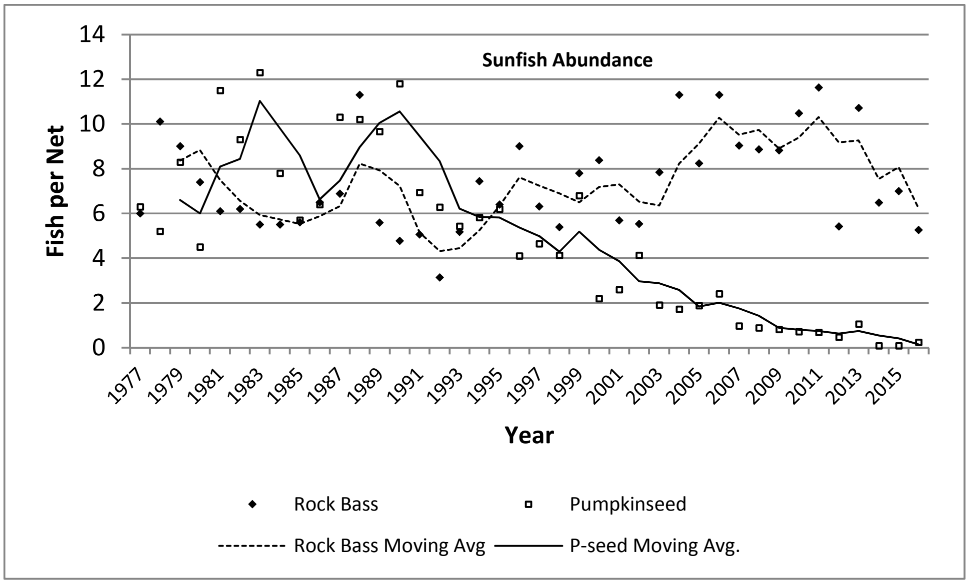


***Figure 16. Abundance index for rock bass and pumpkinseed sunfish in the St. Lawrence River Thousand Islands area (with 3-year moving averages).***

## 2016 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 and Forestry (OMNRF) 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 (Klindt 2006). 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 18.6 hours (SD=0.48) 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 2016 Lake St. Lawrence assessment was conducted from 12 to 15 September. Surface water temperatures ranged from 70 to 72$^{o}$F (21.1-22.2$^{o}$C). A sample of 629 fish comprising 19 species was collected (Table 1). The catch was dominated by yellow perch (37.0%), rock bass (19.2%) and smallmouth bass (9.2%).

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 depicts species that comprise 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 poorly represented in earlier surveys now make up even smaller proportions of the overall assemblage. Largemouth bass, while not depicted in the figure, had a record catch (N=38) in 2016, which may illustrate a changing system. Largemouth bass were just over 6% of the total catch.

Total CUE decreased by 1.5% from 19.97 fish in 2015 to 19.66 in 2016. While total catch declined for the fourth consecutive year, 2016 is above the long-term average of 18.7 (Figure 2). Total CUE is generally driven by fluctuations in yellow perch catch.

Yellow perch CUE decreased by 18% from 8.9 in 2015 to 7.3 in 2016 (Figure 3). From 2008-2012, the perch catch experienced large annual fluctuations. Since 2012 the population has been relatively stable. Predation from Double-crested Cormorant (*Phalacrocorax auritus*; DCC) has been documented to influence yellow perch numbers in Lake St. Lawrence in the past (Klindt and Gordon 2013). DCC diet data are no longer available for Lake St. Lawrence, however, cormorant predation will continue to influence the fish community as it has in the Thousand Islands (McCullough and Gordon 2013) and Lake Ontario (Lantry et al. 1999).

The majority of perch collected ranged from 6-7”, with few perch <6” and a high proportion of fish >9” (27.0%, Figure 4). From 2006 to 2016, perch >9” have comprised 19.8-33.9% of the catch. Age-4 yellow perch comprised the majority of fish collected in 2016 (Figure 5). The ten year average CUE at age indicates that 2016 had a higher than average catch for age-4 fish. Few perch over age-7 are caught in assessment nets.

Growth rates of yellow perch were determined by year class for fish ages 2-6 years. The slope of the regression line of log transformed mean length at age for each year class is illustrated in Figure 6. A minimum of four data points is needed to plot an individual year class to decrease variability. Although variability remains high within the series ($r^2$=0.47), an increasing growth rate trend remains apparent for the entire data series. A more recent short term trend (2000-2011 year classes) implies that growth rate is stabilizing. 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 forage.

Smallmouth bass CUE was relatively stable from 1998-2004, fluctuated substantially from 2005 to 2013, and remained stable from 2014 to present. Smallmouth bass CUE (1.8) was below the long term average of 2.3 in 2016 (Figure 7). Unlike the previous two years, the length frequency distribution shows several distinct peaks distributed throughout (Figure 8). The proportion of bass <12 inches (54%) is the highest since 1990. Age-1 &2 bass were well represented and were well above the 10 year average, suggesting potentially strong year classes (Figure 9). The strong 2011 year class detected at age- 3 in 2014 and age-4 in 2015 was not well represented at age-5 in 2016. The average 10 year age frequency distribution demonstrates consistent, relatively low catches of age-5 fish. Predicting year class strength of smallmouth bass has been difficult in this assessment as small fish are 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 10. The relationship is weak ($r^2$=0.15), however, it depicts an overall increase in growth rate. Data for the 1998, 1999 and 2001 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 10 to demonstrate a similar trend of increasing growth. When considering only the 2002-2011 year classes, it appears that growth rate may be stabilizing.

Walleye CUE (0.91) increased 8% in 2016 and remains below to the long term average of 1.4 fish/net night (Figure 11). Overall catch has been in decline since 2009 in spite of the appearance of a very strong 2007 year class. The length-frequency distribution of the walleye catch (Figure 12) has two distinct peaks at 14 and 28 inches. Catch was not dominated by any particular age class, however, age-5 fish (2011year class) are well represented (Figure 13). Older walleye age-8 to 10 were relatively common for this assessment which accounts for the peak at 28 inches. Walleye in Lake St. Lawrence tend to fully recruit to our gear as age 2 fish (11-12”) as shown by the 10 year average age frequency. High catches of young of year or age 1 fish don’t necessarily persist in the catch at older ages. All walleye to date have been aged using scales which may have led to some inconsistencies in reporting age of older fish. Future surveys may incorporate otoliths as aging structures since many researchers report improved accuracy (Beamish and McFarlaine 1987).

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. Northern pike CUE (0.28) in 2016 remained low, consistent with a declining trend since 2001 (Figure 14). Total length of northern pike sampled ranged from 11.0-32.1 in (Figure 15). Fish age-1, 3, 7, 8 and 10 were represented in the catch (Figure 16).

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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, 1983-2016.***

| | **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, 1983-2016 (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, 1983-2016 (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, 1983-2016 (continued).***

| | **Year** | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | LT Avg. |
|---|---|---|---|---|---|---|---|---|---|
| **SPECIES** | **# Nets** | 32 | 32 | 32 | 32 | 32 | 32 | 32 | |
| Lake Sturgeon | | 0.06 | 0.03 | x | x | x | x | x | 0.01 |
| Bowfin | | 0.03 | x | x | 0.03 | x | 0.03 | x | 0.01 |
| Alewife | | x | 0.03 | 0.09 | x | 0.03 | x | 0.31 | 0.18 |
| Gizzard Shad | | 0.06 | 0.03 | 0.63 | 0.44 | x | 0.03 | 0.56 | 0.13 |
| Rainbow Trout | | x | x | x | x | x | x | x | 0.00 |
| Brown Trout | | x | x | x | x | x | x | x | 0.01 |
| Lake Trout | | x | x | x | x | x | x | x | 0.00 |
| Rainbow Smelt | | x | x | x | x | x | x | x | 0.00 |
| Northern Pike | | 0.28 | 0.31 | 0.19 | 0.28 | 0.09 | 0.13 | 0.28 | 0.44 |
| Muskellunge | | x | 0.03 | x | x | x | x | x | 0.00 |
| Lake Chub | | x | x | x | x | x | x | x | 0.00 |
| Carp | | 0.19 | 0.16 | 0.41 | 0.25 | 0.09 | 0.25 | 0.13 | 0.58 |
| Golden Shiner | | x | x | 0.03 | x | x | x | x | 0.00 |
| Fallfish | | 0.19 | 0.19 | 0.16 | 0.47 | 0.16 | 0.25 | 0.22 | 0.15 |
| White Sucker | | 0.44 | 0.53 | 1.22 | 0.72 | 0.59 | 0.41 | 0.88 | 0.81 |
| Silver Redhorse | | 0.19 | 0.63 | 0.44 | 0.38 | 0.25 | 0.31 | 0.22 | 0.43 |
| Shorthead | | x | x | x | 0.03 | x | 0.03 | x | 0.02 |
| Greater Redhorse | | 0.06 | 0.03 | x | 0.03 | 0.03 | x | 0.03 | 0.01 |
| Yellow Bullhead | | x | x | x | x | x | x | x | 0.00 |
| Brown Bullhead | | 0.16 | 0.22 | 0.66 | 0.31 | 0.78 | 0.25 | 0.34 | 0.94 |
| Channel Catfish | | 0.03 | 0.09 | 0.09 | 0.09 | 0.06 | 0.06 | x | 0.07 |
| White Perch | | 0.41 | 1.03 | 1.75 | 2.16 | 3.41 | 1.59 | 1.25 | 0.92 |
| White Bass | | x | x | x | x | x | x | x | 0.02 |
| Rock Bass | | 8.03 | 3.41 | 5.16 | 3.97 | 5.22 | 3.50 | 3.78 | 2.96 |
| Pumpkinseed | | 0.19 | 0.09 | 0.16 | 0.38 | 0.16 | 0.56 | 0.22 | 0.37 |
| Bluegill | | x | x | x | x | x | 0.09 | 0.09 | 0.01 |
| Smallmouth Bass | | 2.22 | 1.34 | 2.66 | 3.09 | 1.97 | 2.25 | 1.81 | 2.26 |
| Largemouth Bass | | 0.22 | 0.22 | 0.69 | 0.09 | 0.03 | 0.44 | 1.18 | 0.08 |
| Black Crappie | | x | x | x | 0.03 | x | 0.03 | 0.13 | 0.04 |
| Yellow Perch | | 18.78 | 9.03 | 16.69 | 7.94 | 7.50 | 8.88 | 7.28 | 6.74 |
| Walleye | | 2.75 | 1.81 | 2.09 | 2.06 | 1.38 | 0.84 | 0.91 | 1.43 |
| Freshwater Drum | | 0.03 | x | 0.03 | 0.03 | x | 0.03 | 0.03 | 0.03 |
| **TOTAL CATCH** | | 34.25 | 19.34 | 33.16 | 22.93 | 21.78 | 19.97 | 19.66 | 18.66 |

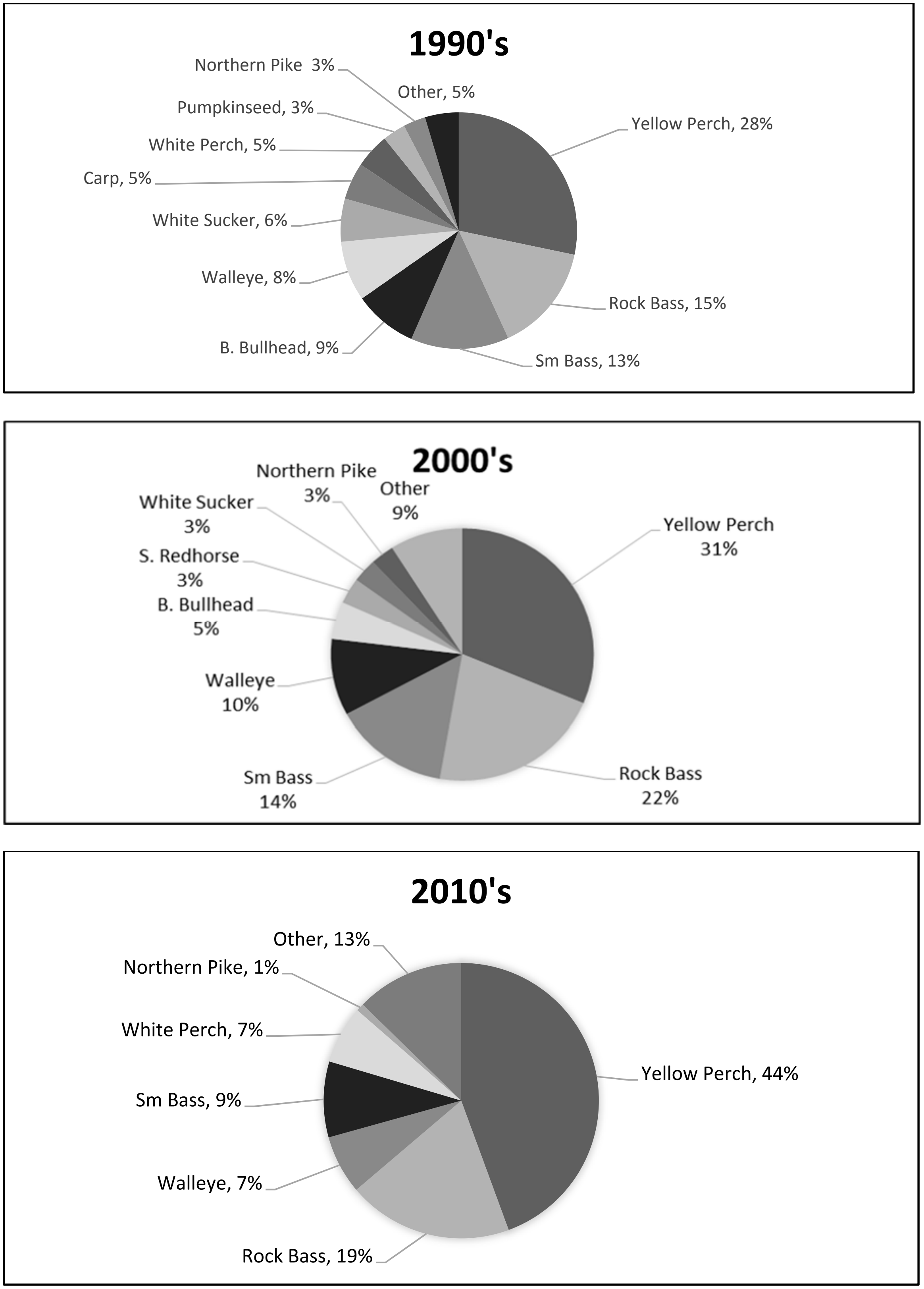


***Figure 1. Composition of the Lake St. Lawrence fish community sampled by gill nets and presented by decade.***

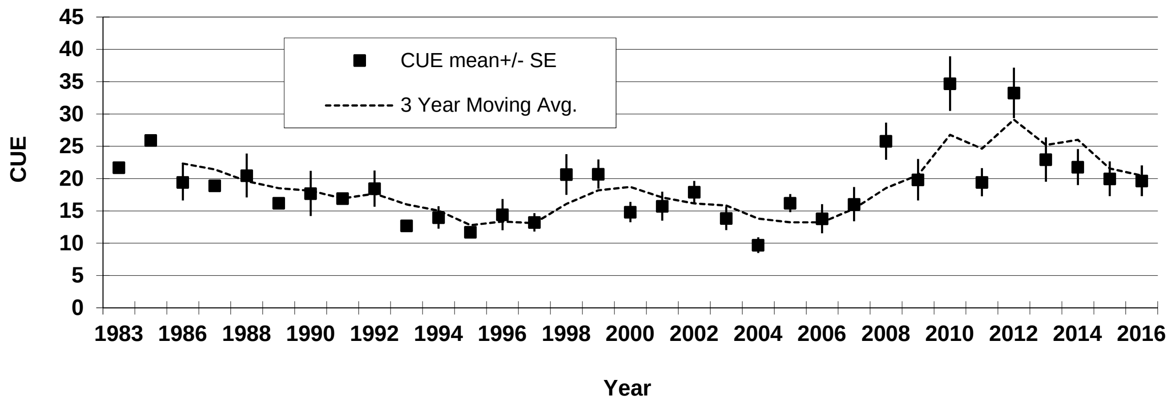


*Figure 2. Total catch per gill net night (CUE) for Lake St. Lawrence, 1983-2016.*

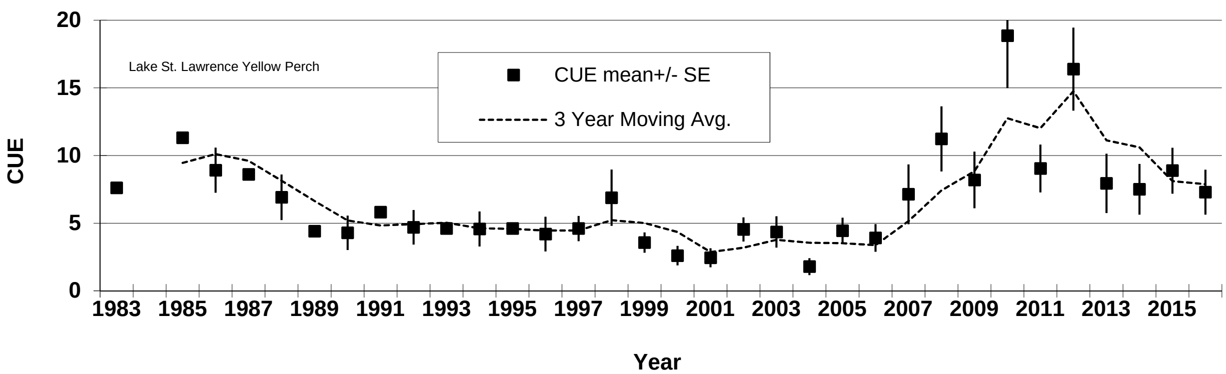


*Figure 3. Yellow perch total catch per gill net night (CUE) for Lake St. Lawrence, 1983-2016.*

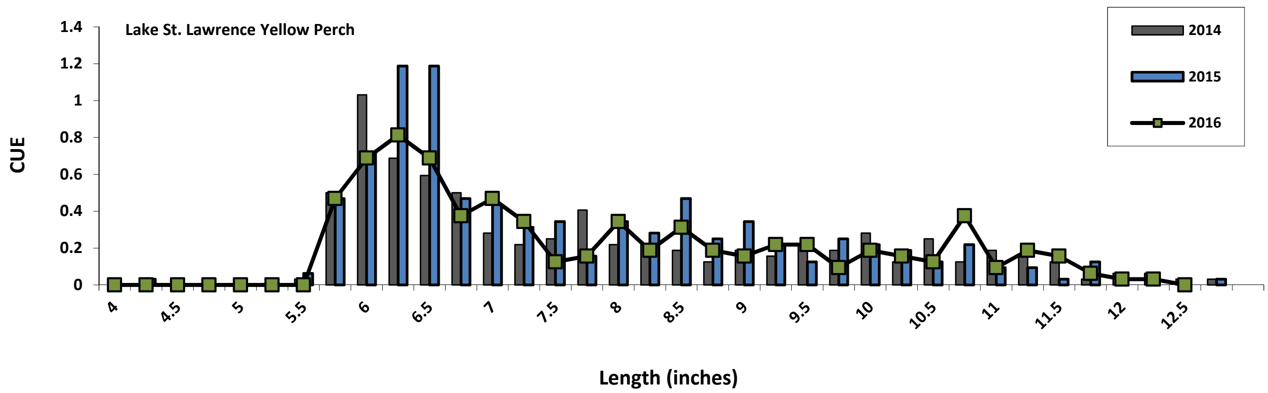


*Figure 4. Yellow perch length-frequency distribution for Lake St. Lawrence.*

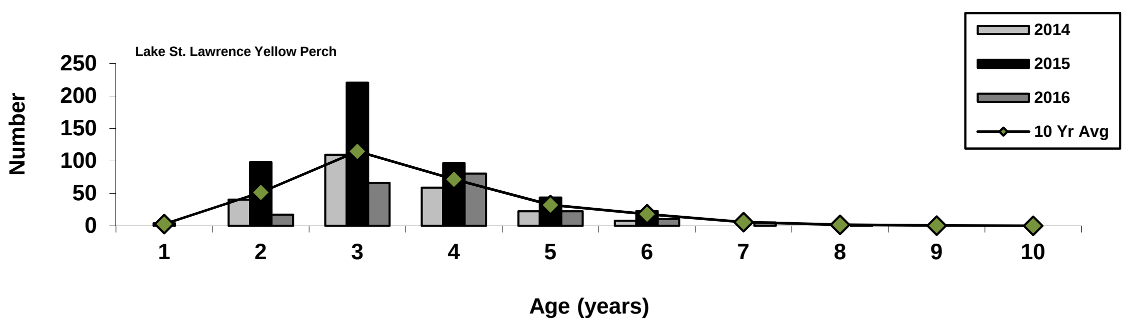


*Figure 5. Yellow perch age-frequency distribution for Lake St. Lawrence.*

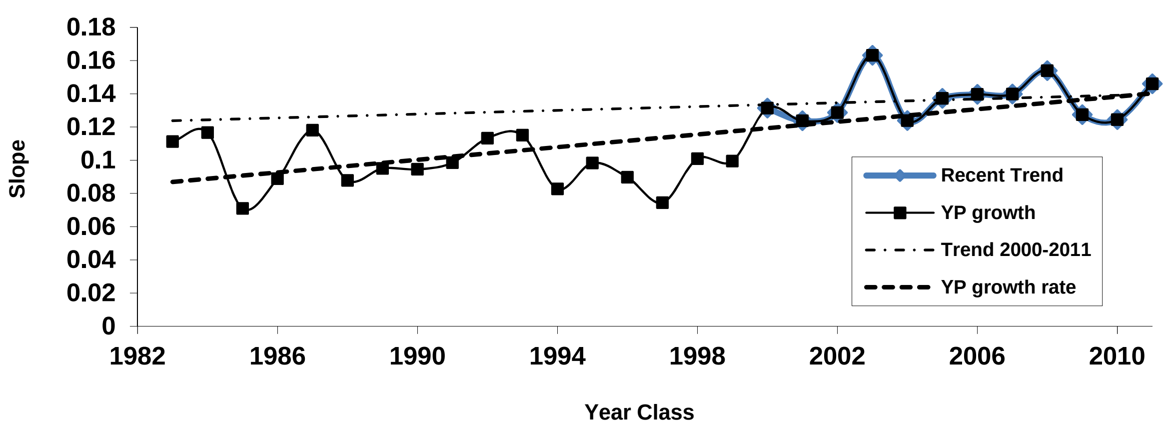


*Figure 6. Yellow perch growth rates by year class using fish ages 2-6.*

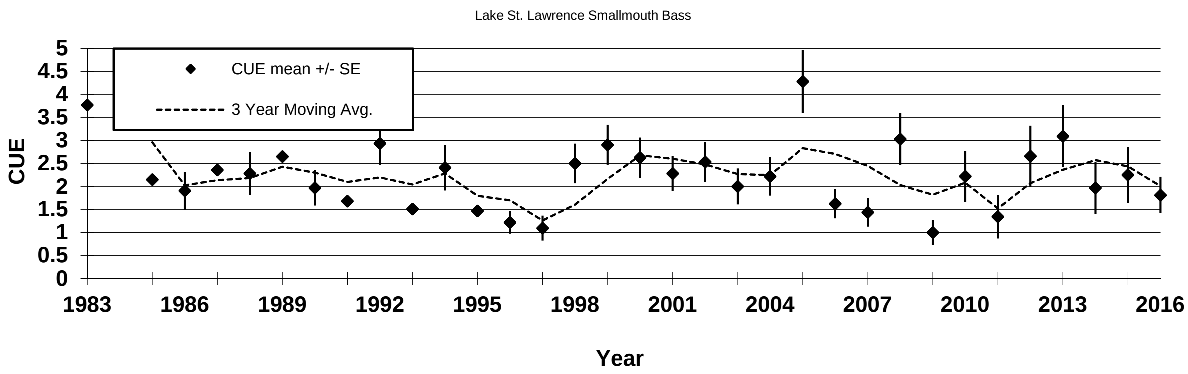


***Figure 7. Total catch per gill net night (CUE) for smallmouth bass in Lake St. Lawrence, 1983-2016.***

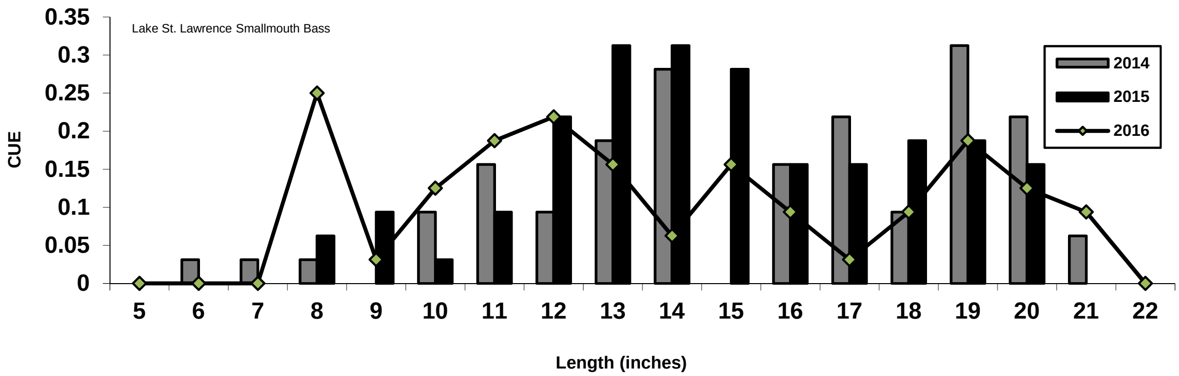


***Figure 8. Smallmouth bass length-frequency distribution for Lake St. Lawrence.***

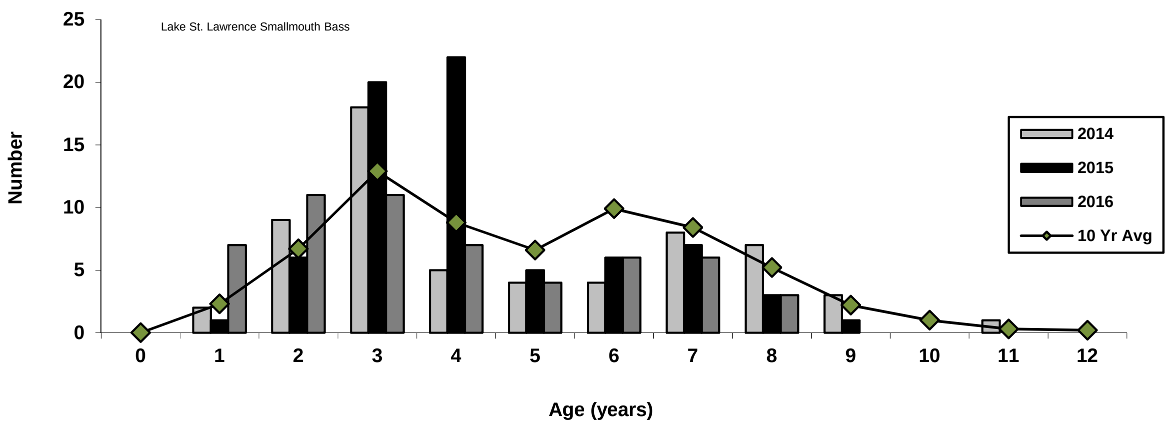


***Figure 9. Smallmouth bass age-frequency distribution for Lake St. Lawrence.***

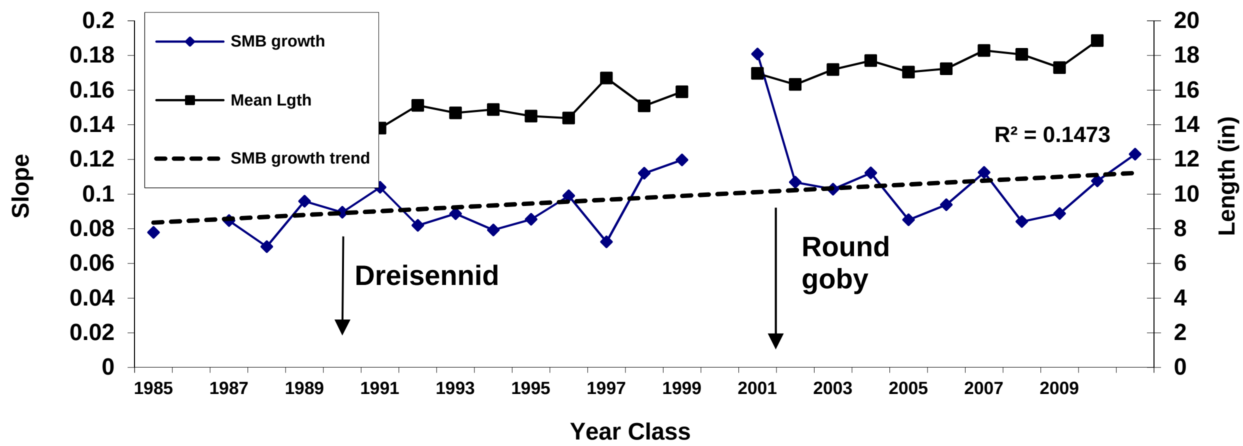


***Figure 10. Smallmouth bass growth by year class described using two methods: growth rate (slope) using fish ages 3-7 and mean length (in) at age-6.***

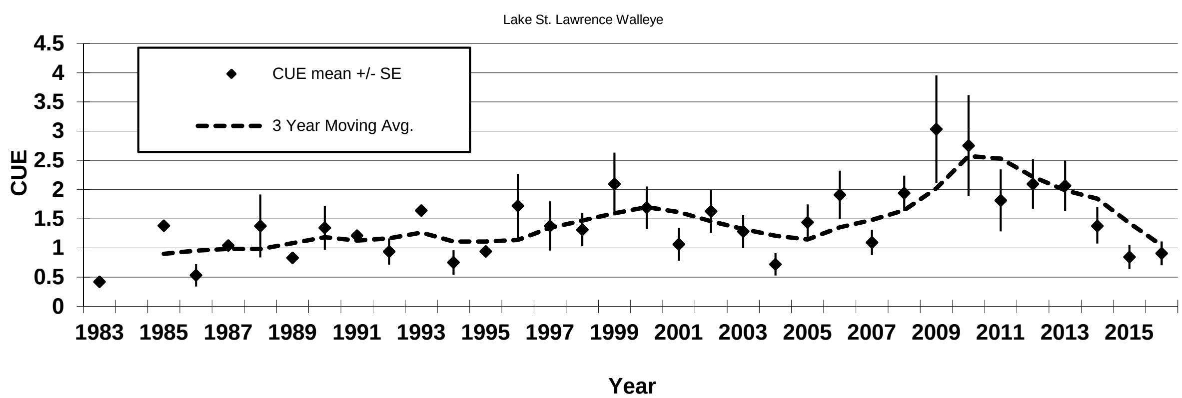


***Figure 11. Total catch per gill net night (CUE) for walleye in Lake St. Lawrence, 1983-2016.***

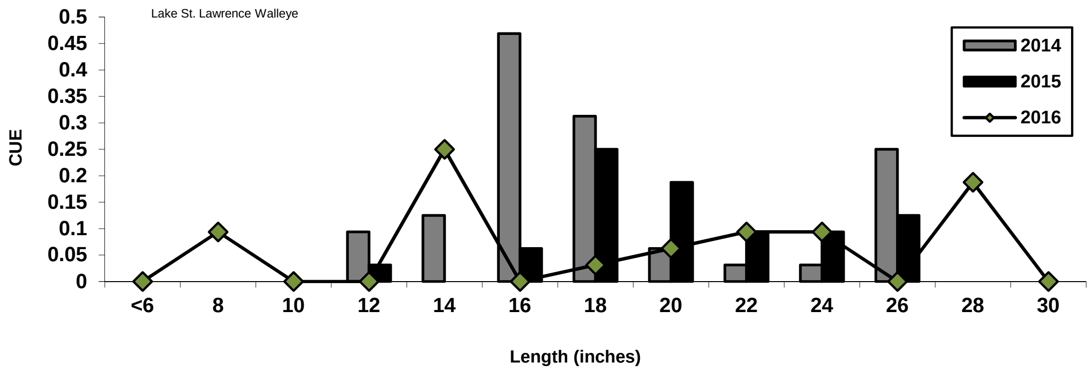


*Figure 12. Walleye length-frequency distribution for Lake St. Lawrence.*

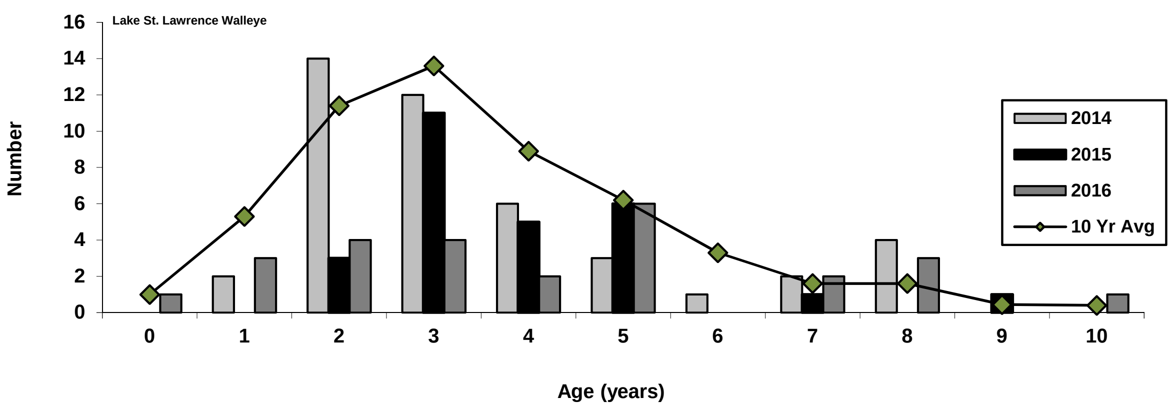


*Figure 13. Walleye age-frequency distribution for Lake St. Lawrence.*

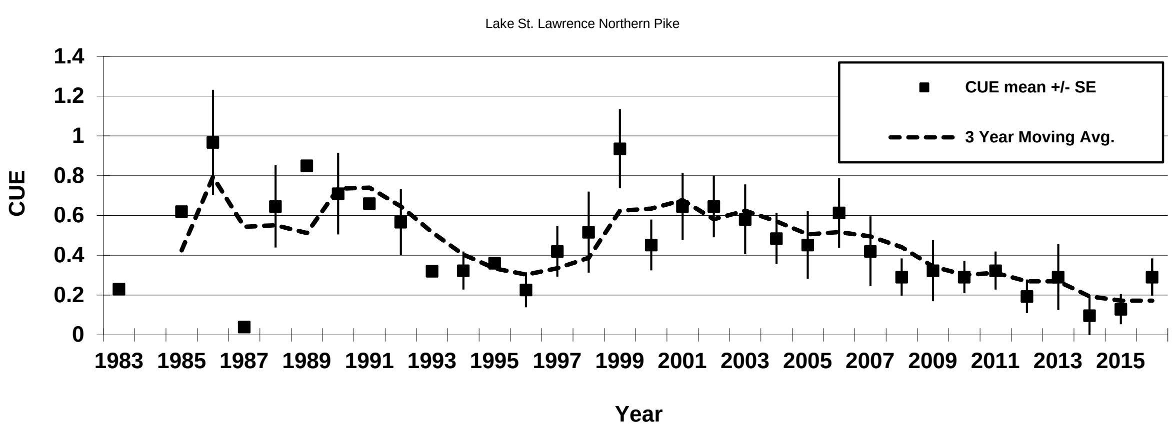


*Figure 14. Total catch per gill net night (CUE) for northern pike in Lake St. Lawrence, 1983-2016.*

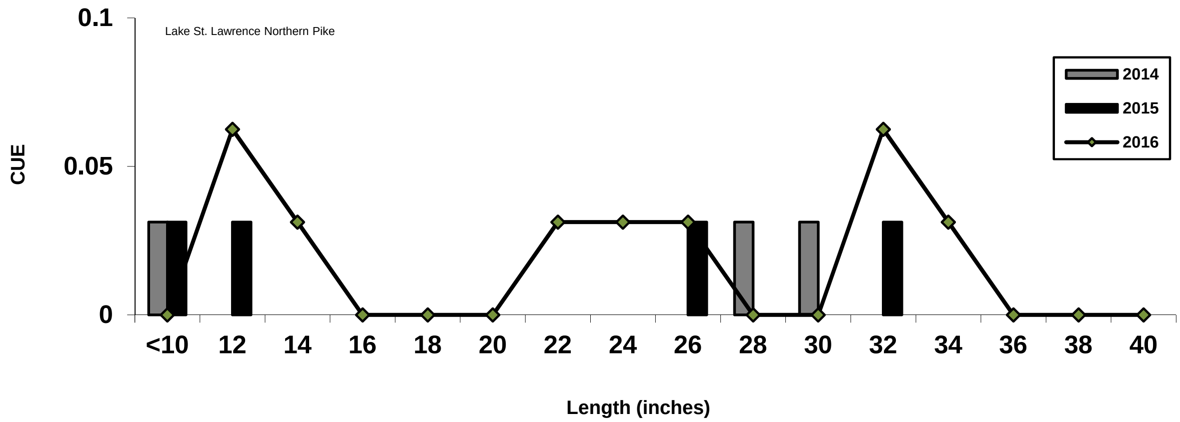


*Figure 15. Northern pike length-frequency distribution for Lake St. Lawrence.*

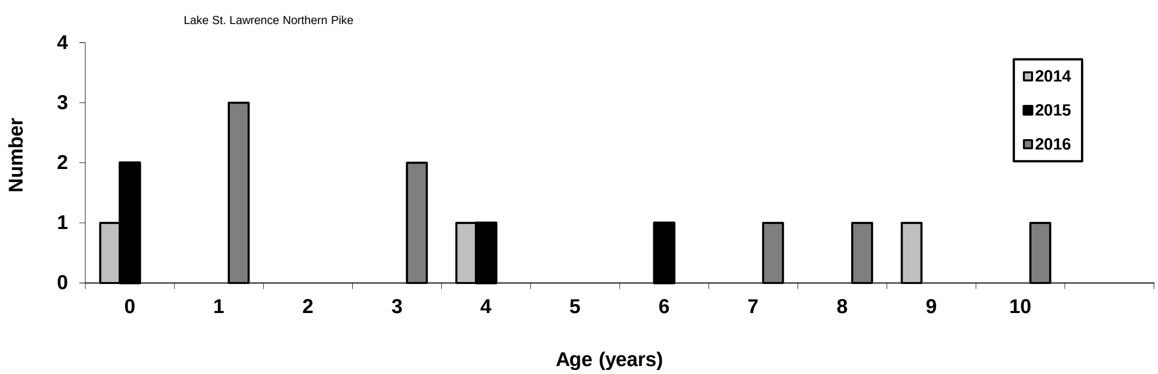


*Figure 16. Northern pike age-frequency distribution for Lake St. Lawrence.*

**2016 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 the relative abundance of wild young-of-year (YOY) Chinook salmon through space and time in the Salmon River, NY. The survey design was refined to its current form in 2001.

**Methods**

The survey design calls for weekly seine hauls during May and June at 4 sites: Altmar, Pineville, County Rt. 2A, and Douglaston (Figure 1). A bag seine measuring 20 feet wide by 6 feet deep with 1/8 inch bar mesh was used in all survey sampling. 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 an estimate of relative 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 from 2001 to the present to provide an index of relative abundance. We used 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 week of peak catch, so we used the average of the second and fourth weeks in May to generate a relatively high, but likely conservative, mean peak catch estimate. Catches likely peaked in the fourth week of May 2013, and we were unable to sample the first week of June. We therefore used the mean from the second through fourth weeks of May to estimate mean peak catch. Various weeks were also missed in other years which did not influence mean peak catch estimates. Flow events referenced in this report are mean daily discharges to the Salmon River from the Lighthouse Hill Reservoir available at: http://www.h2oline.com/365123.asp . We used correlation and regression analyses to study the relationship between flow characteristics and resulting production (SAS rel. 9.3, Cary, NC).

**Results and Discussion**

Sampling in 2016 produced the highest mean peak catch, daily total catch, and single site catch for one day in the history of the program (Figure 2). The record single day catch of 8,244 (2,061/haul) occurred on 2 May (Figure 3). The earlier than usual peak daily catch in 2016 was likely attributable to the mild winter of 2015-16. We used the catches from the first 3 weeks of May for our estimate of mean peak catch which was 1,067 fish /haul. Had we sampled the last week of April, that catch would have likely exceeded that of the third week of May and driven our mean peak catch estimate higher. This single largest haul for a single site was of 3,289, which occurred at Altmar on 2 May (Figure 4).

We have previously reported on the importance of adequate flows during the spawning period (October 1 – 21) to allow fish access to the upper river in the face of intense fishing pressure and the negative effects of high flow events during the incubation/nursery period (October 22 through May 31) which potentially move bed load and disturb redds. The relationships between flows and subsequent production are not linear and we found the best correlations to be on natural log transformed flows and catches. Mean peak catches were positively correlated with mean spawning flows ($r = 0.44$, $p = 0.09$) and negatively correlated with maximum incubation flows ($r = -0.70$, $p < 0.01$) for the 16 year study period. Correlation between the mean spawning and maximum incubation flows was weak and insignificant ($r = -0.18$ $p = 0.51$). Additionally, fitting a second order polynomial (i.e., adding an $x^2$ term) to the spawning flow regression model (Figure 5) increased the explained variability in catch (from $r^2 = 0.19$ to $r^2 = 0.38$ with $p = 0.09$ and $0.04$, respectively). Combining the polynomial mean spawning flows and maximum incubation flows in a single model yielded the following regression ($r^2 = 0.66$, $p < 0.01$):

$$y = - 0.49481\, x^2 + 6.52798\, x - 1.07156\, z - 6.79874$$

Where y = log mean peak catch, x = log mean spawning flow and z = log maximum incubation flow.

We also explored the use of heating degree days (HDD) from October through May for Pulaski NY as an additional predictor to account for temperatures during the spawning through incubation/nursery time period. These data are available at: http://www.weatherdatadepot.com/?gclid=CLumudWty80CFYMehgod_JwLGQ. There was a slight and insignificant correlation between HDD and the log transformed peak mean catches ($r= - 0.26$, $p = 0.32$) suggesting slightly higher production in warmer years. Addition of HDD to the above regression model raised the r-square from 0.66 to 0.70, but using Akaike's Information Criteria as a basis for "best" model selection resulted in leaving it out of the model.

Note in Figure 5 that the 2002, 2005, 2012, 2014, 2015 and 2016 year classes all had near baseflow conditions (335 cubic feet/second or cfs or log = 5.8) during the spawning period. The largest year class was produced in 2016, and the 2002 year class was below average. This suggests that the prescribed baseflow of 335 cfs generally allows sufficient numbers of fish to reach the spawning grounds, which are predominately located in the upper stretches of the river.

The two years of lowest production were 2003 and 2008. These year classes were both subjected to the lowest mean spawning flows on record, well below the prescribed 335 cfs. Additionally, they were subjected to relatively high maximum incubation/nursery flow events. There were, however, some relatively strong year classes produced which withstood similar maximum incubation/nursery flows to those that the 2008 year class was subject to, suggesting that the spawning flow in fall 2007 likely limited production. Not coincidentally, numbers of Chinook salmon reaching the Salmon River Hatchery in the fall 2007 were insufficient to meet NYSDEC's egg take quota.

The three years of highest YOY production were 2012, 2015 and 2016. Spawning flows were at or near the prescribed base flow of 335 cfs in each of those years. The two years (2012 and 2016) with the lowest maximum flow event during the incubation period were also the years of highest production.

In summary, extreme low flows during the spawning period (1-21 October) result in low production of YOY Chinook. Spawning flows at the prescribed baseflow or above offer the potential to produce large year classes. Large maximum flow events during the incubation/nursery period (22 October through May) tend to reduce production and small maximum flows tend to increase production.

We are rapidly gaining an understanding of the role of naturally reproduced fish in the Lake Ontario and Salmon River systems. Results of a Chinook salmon "mass marking" study have shown that wild fish comprise a substantial portion of the angler harvest in the open lake and in the Salmon River (Connerton et al. 2016). From 2010-14, an average of 51% of age-2 and age-3 in the Salmon River harvest were wild. The proportions of wild age-2 and age-3 Chinook salmon in other New York tributaries were lower (3.3% - 24.2%) 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 in the Province of Ontario; however, mass marking results to date demonstrate that wild Chinook salmon produced in the Salmon River are surviving and are an important component of the Lake Ontario sportfishery.

## References

Connerton, M.J., C.J. Balk, S.E. Prindle, J.R. Lantry, J.N. Bowlby, M. Yuille, C. Bronte and M.E. Holey. 2016. 2015 Mass Marking of Chinook Salmon in Lake Ontario. Section 3. *In* NYSDEC Lake Ontario Annual Report, Bureau of Fisheries Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission's Lake Ontario Unit.

Federal Energy Regulatory Commission (FERC). 1996. Order issuing original license (Major Project). Washington, D.C.: Federal Energy Regulatory Commission. FERC Project No. 11408, New York.

SAS Institute Inc., Copyright 2002-2010. 9.3 TS Level 1M2 W32_7PRO platform. Cary, NC, USA.

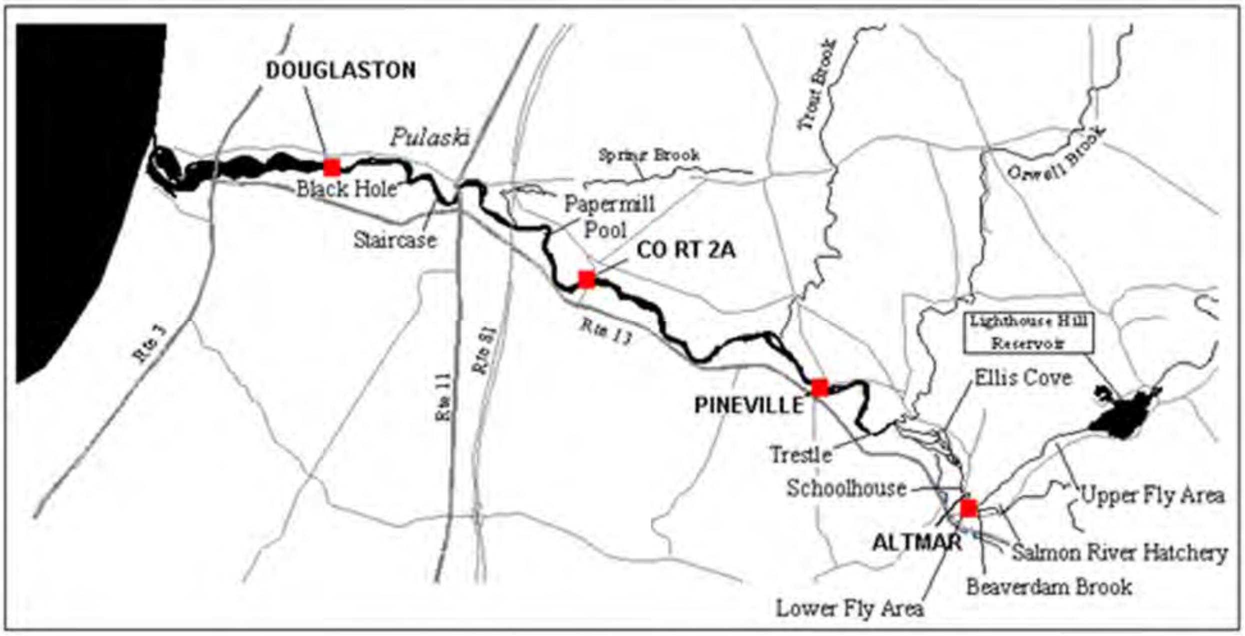


*Figure 1. Sampling sites for the USGS/DEC Salmon River seining program.*

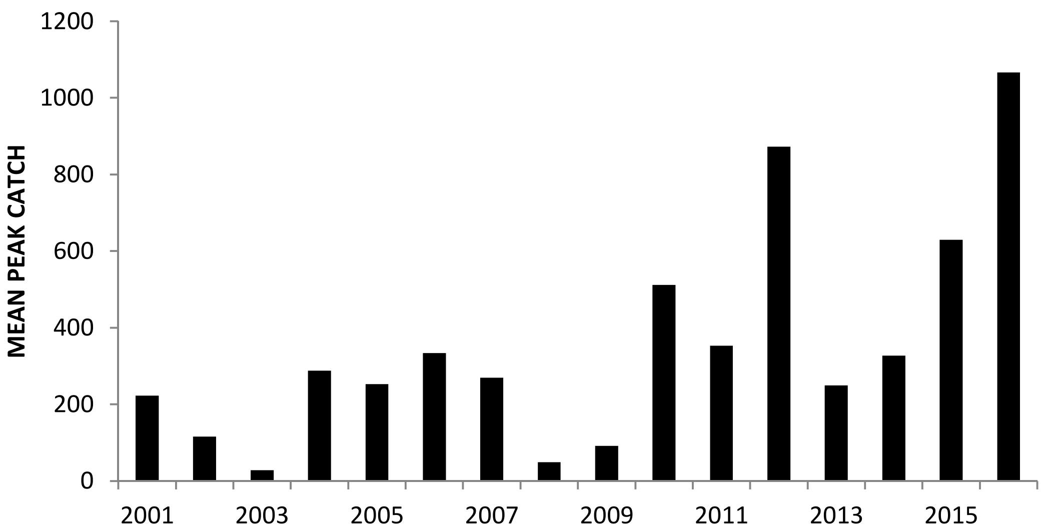


*Figure 2. Mean peak catches of YOY Chinook salmon (mean number per seine haul) captured in the three consecutive weeks with the highest catches from the USGS/DEC Salmon River seining program 2001-2016.*

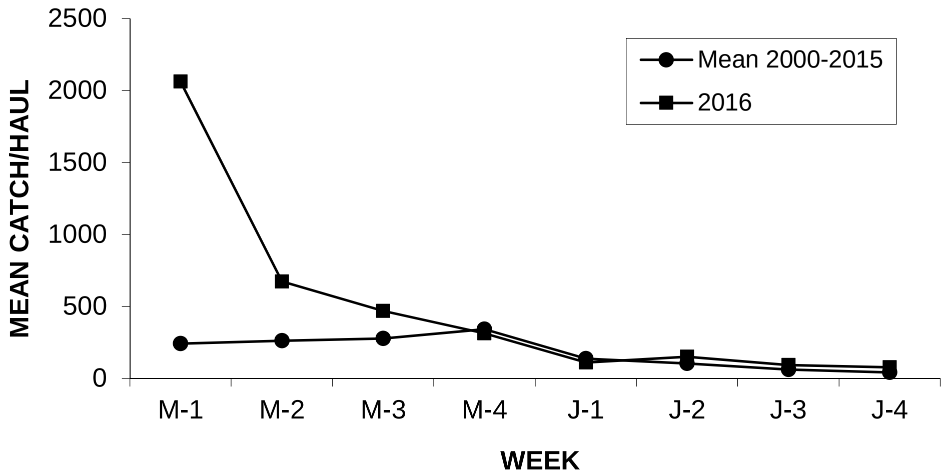


***Figure 3. Mean numbers of YOY Chinook salmon captured per seine haul by week in the USGS/DEC Salmon River seining program for 2000-2015 and 2016 (M=May, J=June).***

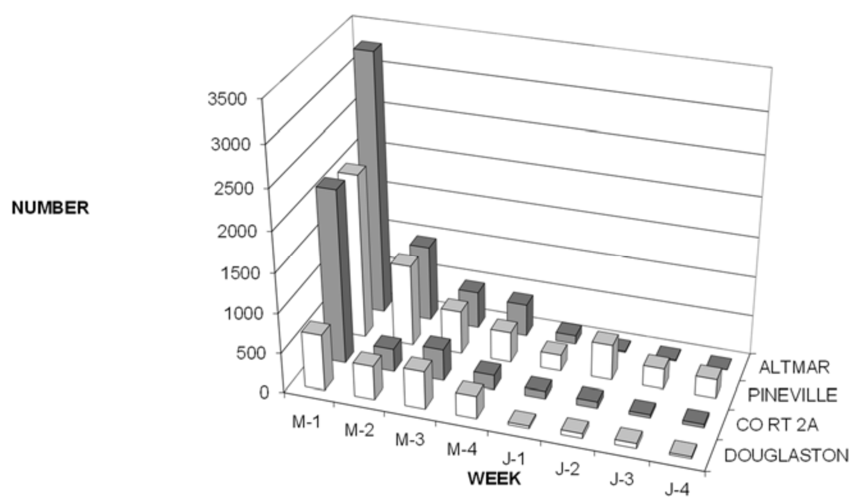


***Figure 4. Numbers of YOY Chinook caught by week and site from the USGS/NYSDEC seining program 2016.***

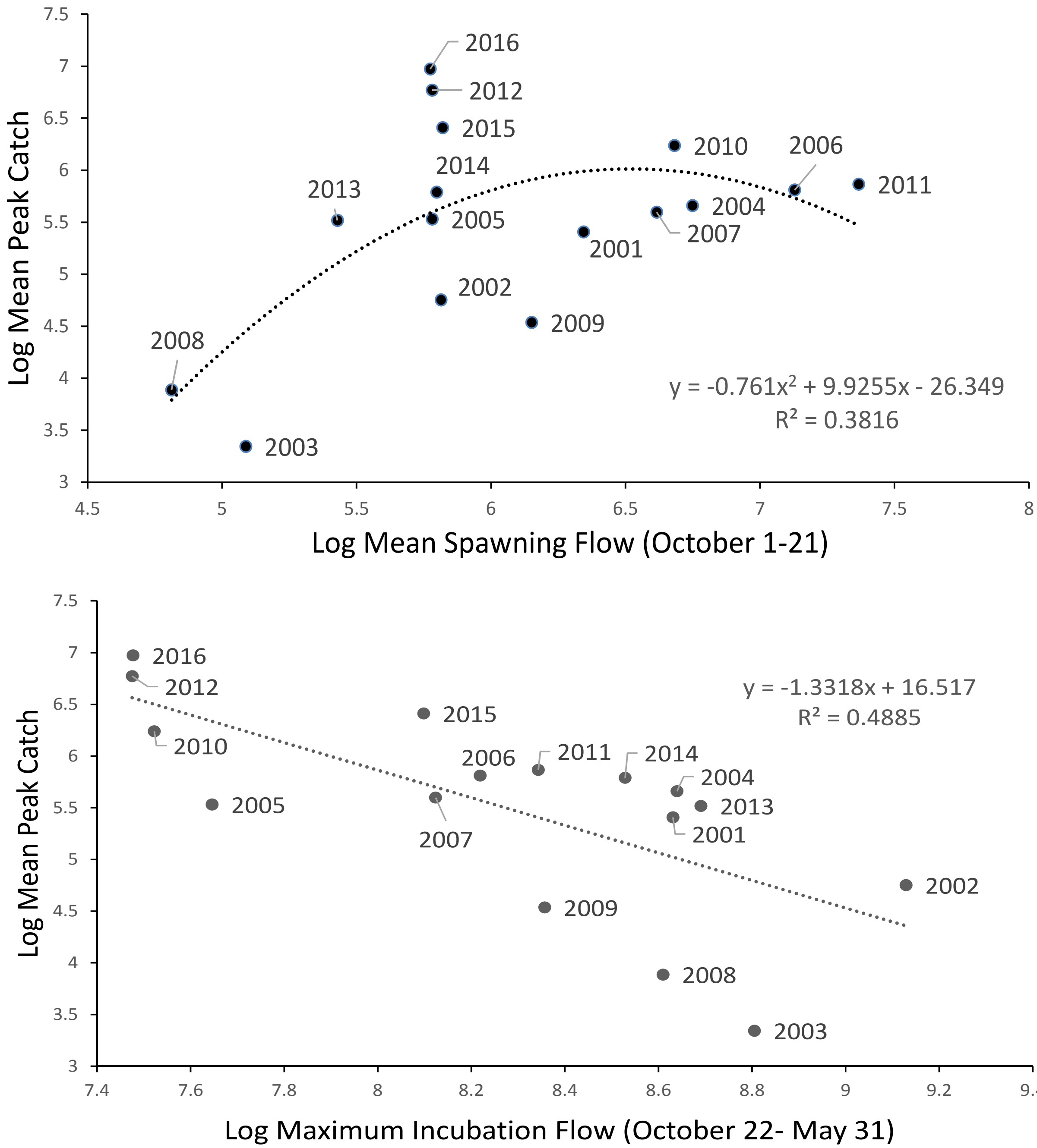


***Figure 5. Mean spawning flows from fall of the previous year (top graph) and maximum incubation/nursery flows (bottom graph) predicting mean peak catches of YOY Chinook salmon from the USGS/NYSCEC seining program 2001-2015. Combining both flow factors in a single regression model yields ($r^2 = 0.66$ $p = 0.01$).***

# Population Characteristics of Pacific Salmonines Collected at the Salmon River Hatchery 2016

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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 2,335 steelhead during the spring 2016 spawning operations (Nelson 2016a). Adult Washington strain (Chamber's Creek) winter run fish comprised 93% (2,170) of the returns. Marked Skamania strain summer run fish (left pelvic) accounted for the remaining 7% (165).

A total of 2.4 million Washington strain steelhead eggs were taken from 704 females. The Skamania egg total was 209,000 from 55 females. Biological data were collected from 246 Washington strain steelhead.

Returns of Pacific salmon in the fall included 7,155 Chinook salmon (775 females) and 5,049 coho salmon. Biological data were collected at the hatchery from 555 Chinook salmon and 345 coho salmon. The egg totals were 3.2 million Chinook salmon from 729 females and 1.7 million coho salmon from 602 females (Nelson 2016b).

All statistical analyses were done with PC-SAS rel. 9.3 (SAS Institute 2012). 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

<u>Growth</u>

The mean weight of age-1 Chinook males (jacks) sampled in 2015 was 5.4 pounds which was the eighth highest value in the 1988-2016 time series (Figure 1). They weighed significantly more than in 11 of the 30 years compared. Age 2 males were 11.8 pounds, 1.6 pounds below the long term average with 19 years being significantly heavier. Age 2 females were 12.5 pounds, 2.2 pounds below the long term average, with no years being significantly lighter (Figure 2). Age 3 males were 17.0 pounds, nearly 2.0 pounds below average, significantly lighter than weights observed in 26 of 30 years compared. Age 3 females were 17.2 pounds, 1.9 lbs below than the long term average, but up from the previous two years. Mean lengths and weights at age for all species sampled in 2016 are provided in Table 1.

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 16.4 pounds in 2016, 0.2 pounds below the long term average and similar to the previous eight years results. This is the ninth consecutive year of at or near average condition, following six consecutive years of below average condition (Figure 3).

The relatively low weights of Chinook salmon sampled in 2014 and 2015 may have been influenced by the preceding winters' unusually cold weather and relatively cooler water temperatures during the summers of 2014 and 2015, which likely contributed to reduced growth rates.

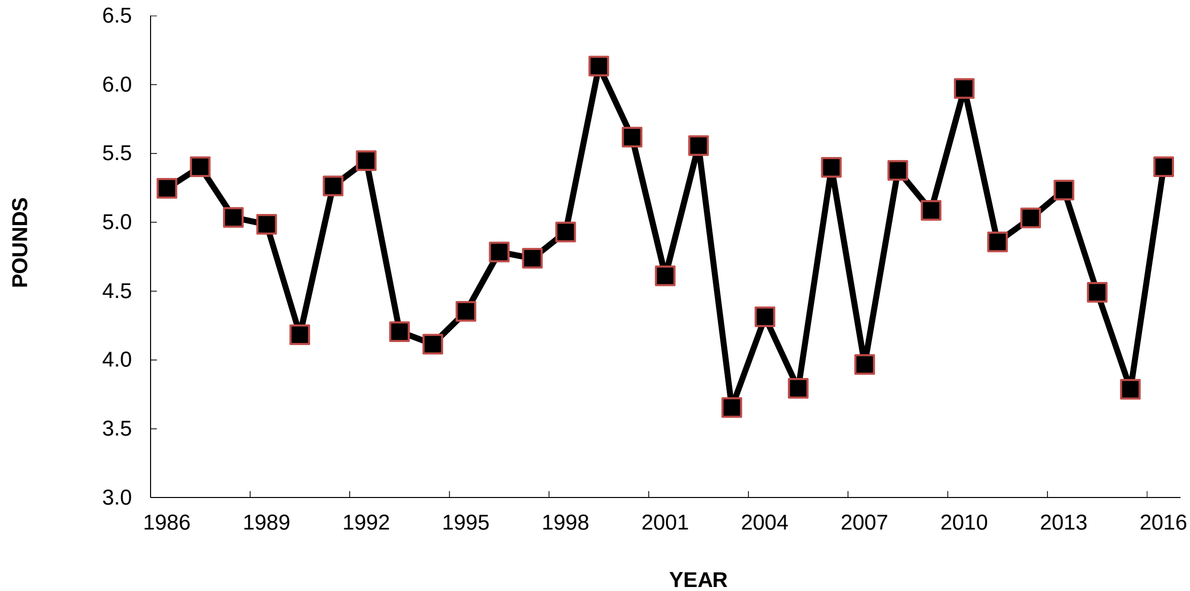


***Figure 1. Mean weights of Chinook jacks at Salmon River Hatchery, 1986-2016.***

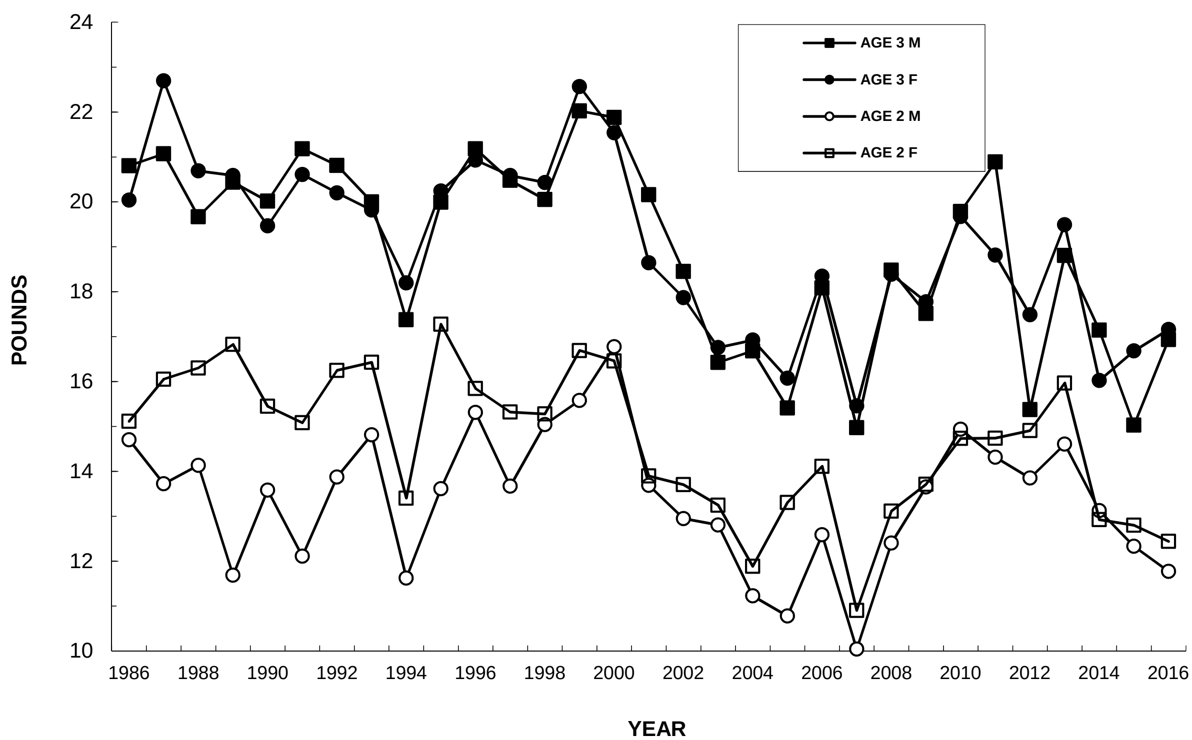


***Figure 2. Mean weights of age 2 and 3 Chinook salmon at Salmon River Hatchery, 1986-2016.***

***Table 1. Mean lengths and weights of Chinook salmon, coho salmon and Washington steelhead sampled at Salmon River Hatchery 2016 (STD= standard deviation).***

| AGE | SEX | N | MEAN LENGTH (in) | STD | MEAN WEIGHT (lbs) | STD |
|---|---|---|---|---|---|---|
| | | | **CHINOOK SALMON** | | | |
| 1 | M | 34 | 24.9 | 2.6 | 5.4 | 1.7 |
| 2 | M | 196 | 32.0 | 2.8 | 11.8 | 3.1 |
| 2 | F | 63 | 32.1 | 2.0 | 12.5 | 2.5 |
| 3 | M | 83 | 36.6 | 3.1 | 17.0 | 3.9 |
| 3 | F | 164 | 36.0 | 2.1 | 17.2 | 3.0 |
| | | | **COHO SALMON** | | | |
| 1 | M | 11 | 14.9 | 1.9 | 1.7 | 1.7 |
| 2 | M | 181 | 27.7 | 2.1 | 7.1 | 1.9 |
| 2 | F | 153 | 26.9 | 1.8 | 7.2 | 1.7 |
| | | | **WASHINGTON STEELHEAD** | | | |
| 3 | M | 112 | 26.8 | 3.9 | 6.4 | 2.7 |
| 3 | F | 63 | 28.3 | 2.2 | 8.2 | 1.9 |
| 4 | M | 34 | 29.8 | 2.6 | 8.7 | 2.4 |
| 4 | F | 27 | 28.6 | 1.1 | 8.1 | 1.1 |
| 5 | M | 0 | | | | |
| 5 | F | 3 | 31.1 | 1.1 | 10.2 | 1.3 |

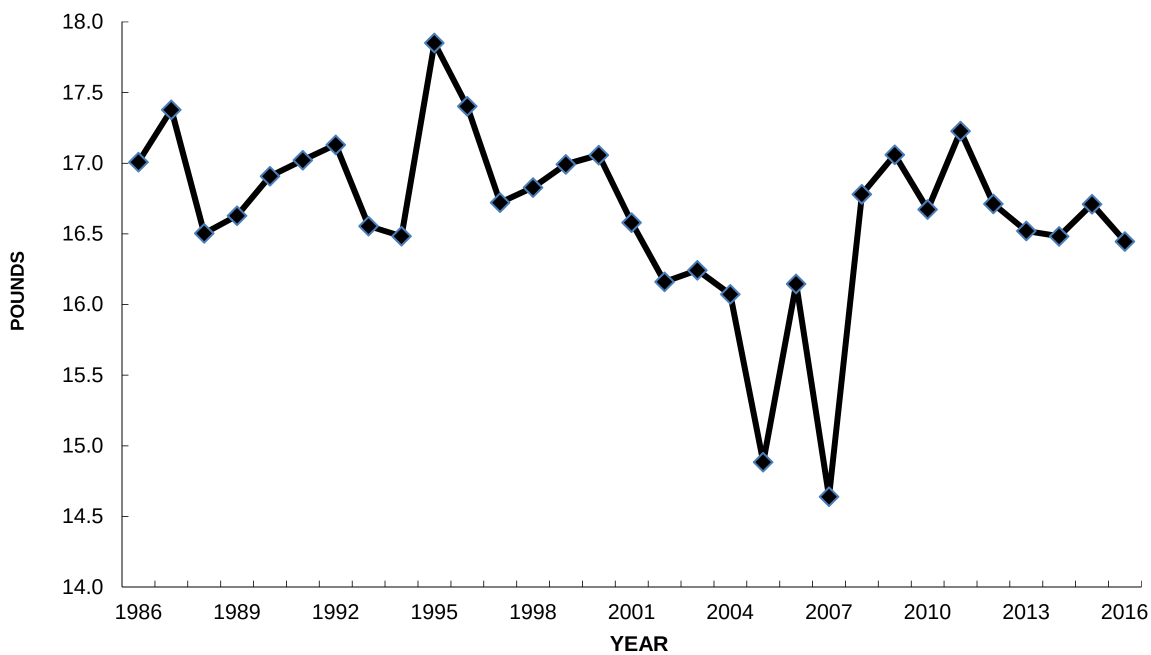


***Figure 3. Estimated weights of a 36-inch Chinook salmon from the Salmon River Hatchery fall (October) collections 1986-2016.***

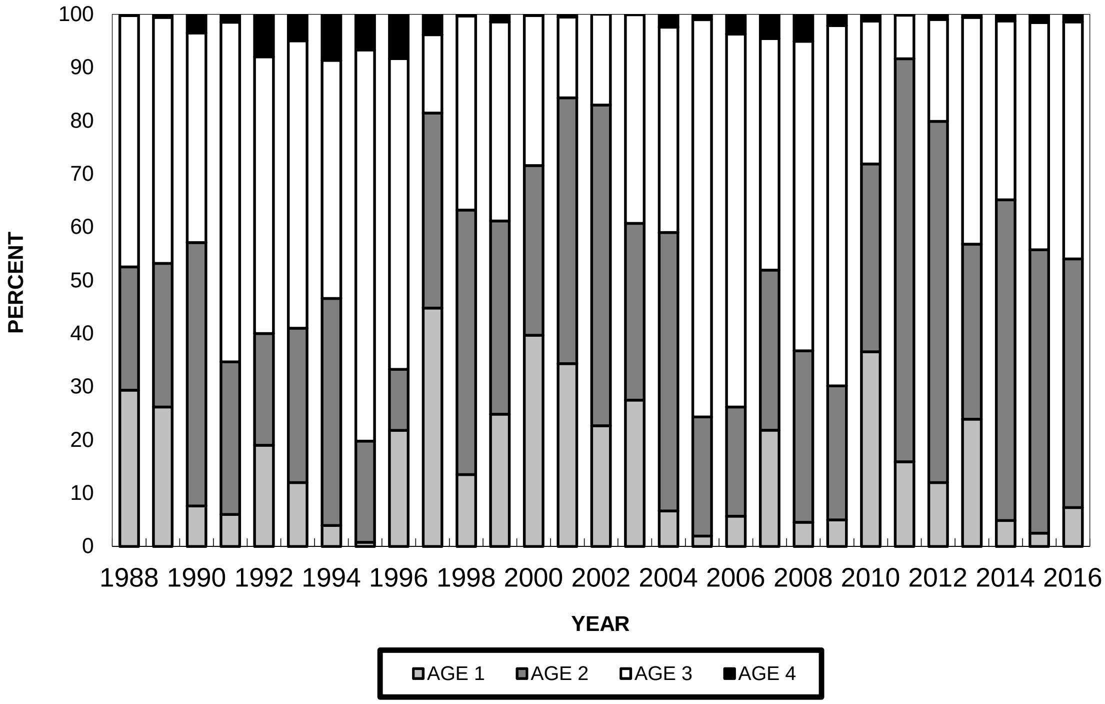


***Figure 4. Estimated age structures of Chinook salmon runs at Salmon River Hatchery 1989-2016.***

Prey abundance and/or distribution can also influence predator growth. Yearling alewife abundance was very low in 2014 and at record-low levels in 2015 (Weidel *et al.* 2017). Those two weak year-classes will decrease the density of adult alewife as they mature and the older year classes naturally decline.

Age Structure

The estimated age structure of the 2016 Chinook salmon run to the Salmon River Hatchery was 7.3% age-1, 47% age-2, 45% age-3, and 1.4% age-4 (Figure 4). Changes in the dominant age represented in the run are likely influenced strongly by relative Chinook year class strength.

### Coho Salmon

Growth

The average weight of age-2 female coho salmon in 2016 was 7.1 pounds), approximately 1.2 pounds less than the long term average (8.4 lbs, Figure 5). Age-2 males weighed 7.1 pounds, 1 pound less than the long term average (8.2 lbs., Figure 5). The males were significantly heavier than 2015, but significantly less than eleven other years in the time series. Female coho were only heavier (not significantly) than the record low observed in 2015, and significantly lighter than fish sampled in 13 of 30 years.

### Washington Steelhead

Growth

Steelhead are sampled in the spring and, unlike Chinook and coho salmon, do not reflect growth during the 2016 growing season. Weights reported here reflect conditions prior to and including 2015. The mean weights of age-3 males and females were 6.4 and 8.2 lbs, respectively, which were above their respective long-term averages (Figure 6). The mean weights of age-4 males and females were 8.7 lbs and 8.1 lbs, respectively, with males 0.1 lbs and females 0.2 lbs lighter than their long-term averages. Only age-3 females in 2001 (8.7 lbs.) were heavier (not significantly) than those in 2016. Age 3 males fell in the middle of observed weights, but weighed significantly less than only two of those observations.

Age 4 males were not significantly heavier than those in any other year, but only weighed significantly less than the 1997 fish (9.8 lbs). As with age 3 males, Age 4 female average weight was near the lower end of observed weights, but

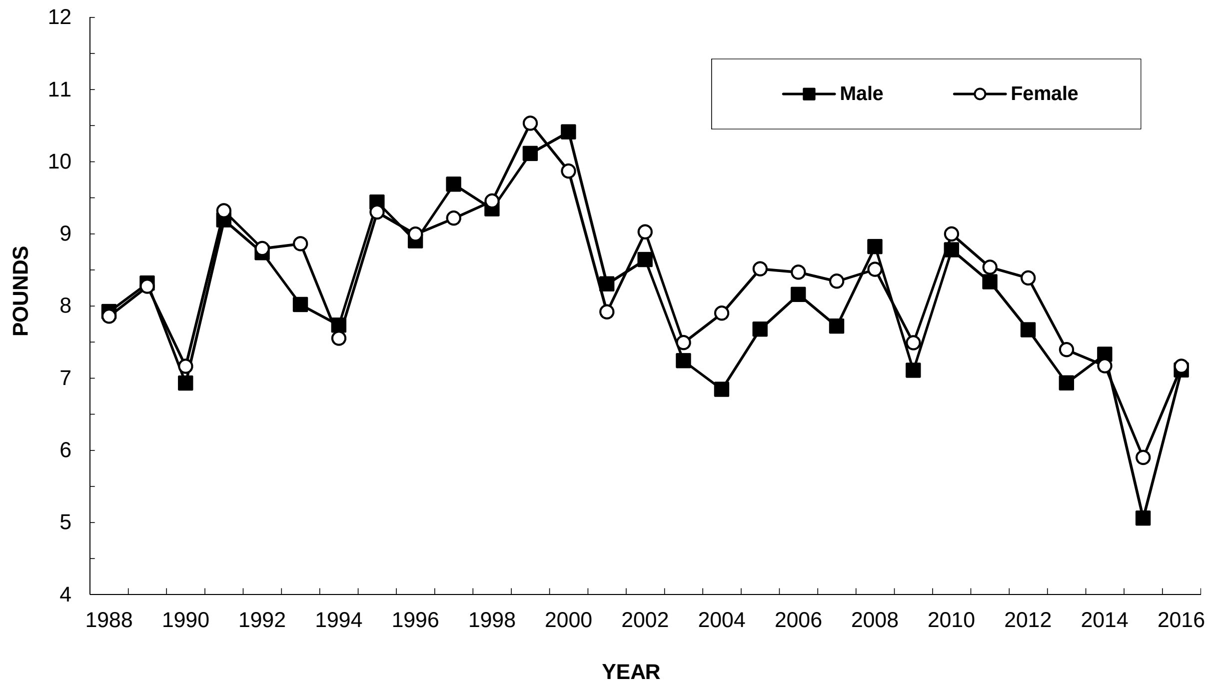


*Figure 5. Mean weights of age-2 coho salmon at Salmon River Hatchery, 1988-2016.*

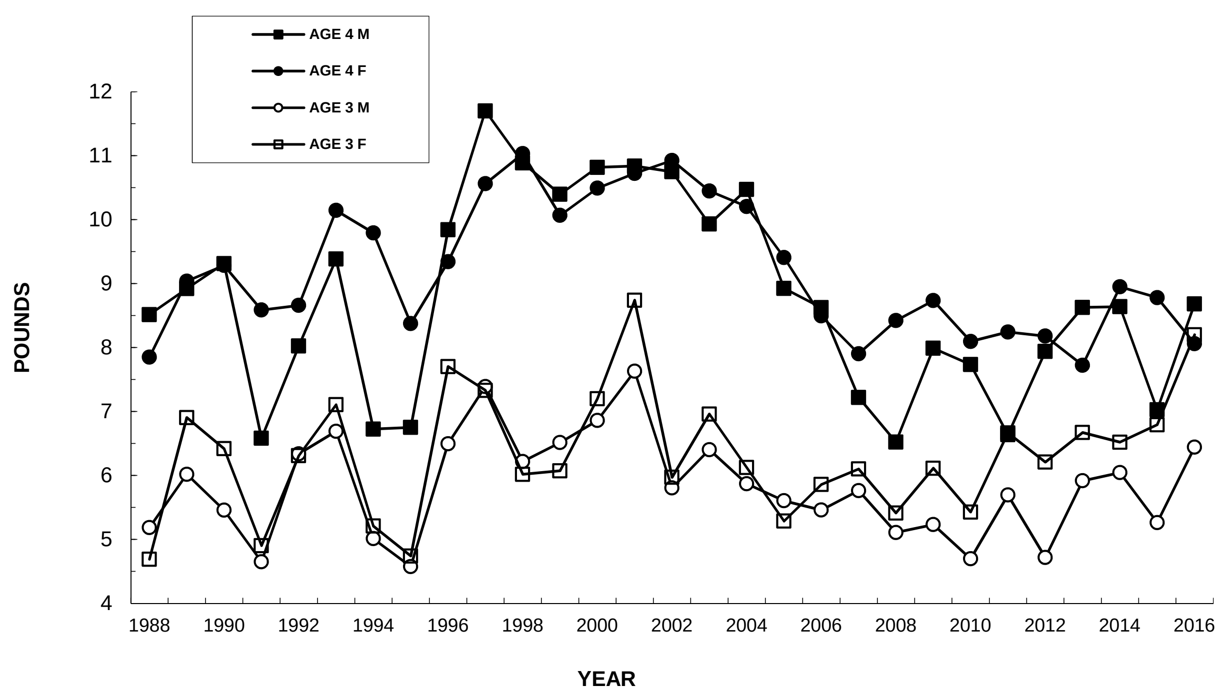


*Figure 6. Mean weights of ages 3-4 Washington steelhead at Salmon River Hatchery, 1988-2016.*

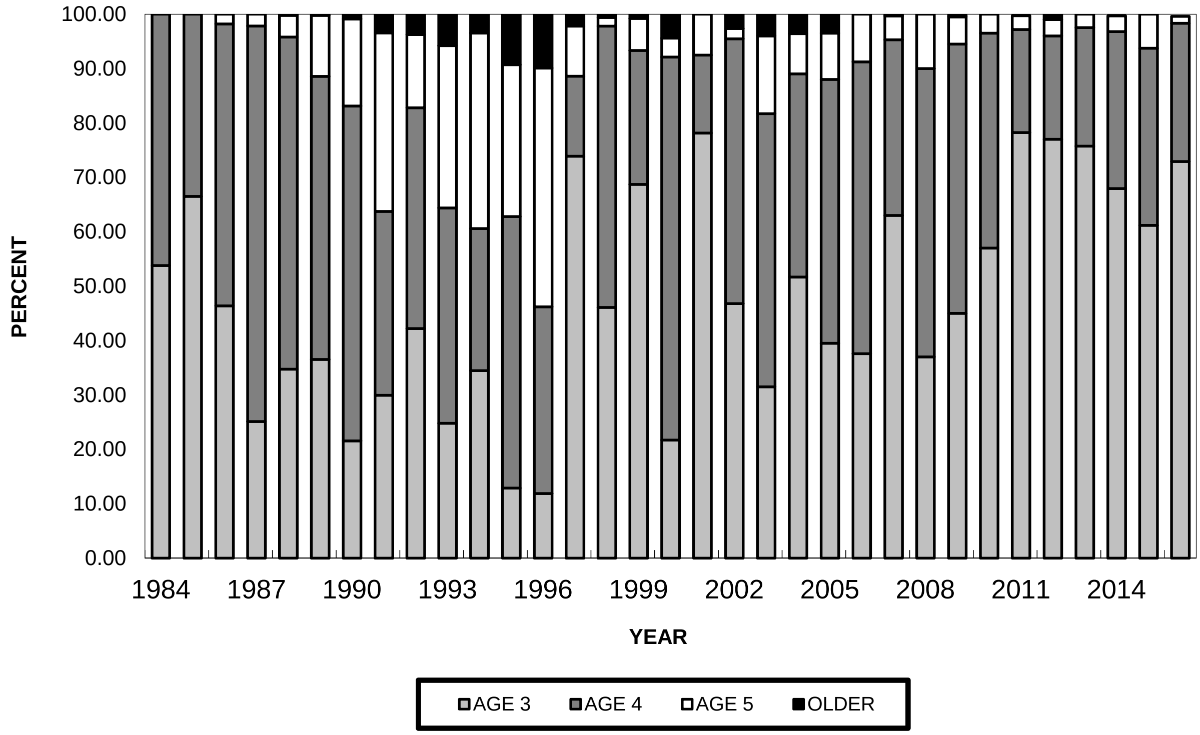


***Figure 7. Age structures of Washington steelhead samples at Salmon River Hatchery, 1984-2016.***

was not significantly different than in 15 of the 28 years.

<u>Age Structure</u>
Similar to age structures observed in recent years, age-3 and age-4 steelhead dominated the run again in 2015 (Figure 7). As in the previous five years, age-3 fish comprised a noticeably higher proportion of the run. The age structure of the fish sampled was 73% age-3, 25% age-4, 1.2% age-5.

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# 2016 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 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 from 2011-2013. Skamania strain steelhead were reared at the Little Salmon River pen site in 2014, and Washington strain in 2015.

This report summarizes pen-rearing activities and results for 2016, the nineteenth year of pen projects along the New York shoreline of Lake Ontario.

## Methods

Pen rearing was conducted at nine sites along New York's coastline of Lake Ontario in 2016. 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 the NYS Department of Environmental Conservation (DEC; 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 2015 is provided in Table 2.

Water temperature was monitored primarily using hand-held and digital thermometers, with manual recording of observations. Frequency of temperature measurements is provided in Table 2.

During 2010 and 2011, all eight Chinook salmon rearing sites were part of a three-year study to assess the relative performance of pen-reared and direct-stocked salmon in open lake and tributary sportfisheries (Connerton et al. 2016). The third and final year of marking for this project was scheduled for 2012; however, salmon-rearing densities at the hatchery were not consistent with the previous two years. Hatchery procedures in 2013 duplicated those in 2010 and 2011, and Chinooks pen-reared and direct stocked at seven sites in spring 2013 received an adipose fin-clip and a coded wire tag. Due to high water temperatures, Chinooks at Sandy Creek in 2013 were not tagged and were direct stocked only.

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. Twenty Chinook salmon were removed from certain pens at release time for a scale growth study. These were also not included in mortality calculations.

## Results and Discussion

A total of 56,000 Washington strain steelhead were raised at seven pen sites, comprising 11% of NYSDEC's Lake Ontario steelhead stocking allotment in 2016 (Table 3). Observed mortalities were relatively low at most steelhead pen sites, ranging from 0 to 0.5%. Results for all steelhead pen projects are summarized in Table 3.

Seven pen-rearing sites raised a total of 450,800 Chinook salmon fingerlings, representing 24% of NYSDEC's 2016 Chinook salmon stocking allotment. Observed mortalities were also low ranging from 0.04 to 0.10%. Results for all Chinook salmon pen projects are provided in Table 3.

The Little Salmon River, Oswego, Little Sodus Bay, and Sodus Bay pen projects are now all using automated feeders on all their pens and they have worked well. The growth rates are comparable to hand feeding. The projects further benefit by not having to line up five people a day to feed, and has been a huge relief for the coordinators. Only one person is needed to load the feed hopper and wind the spring in the morning, and they are set for the day.

<u>Little Salmon River</u>
Washington strain steelhead for the Little Salmon River project were placed in a pen on 19 April at 28 fish per lb. The steelhead were released 27 days later on 16 May at a weight of 16 fish per lb. One mortality was observed.

<u>Oswego Harbor</u>
Chinook salmon were delivered to the pen site on 21 April, weighing 100 fish per lb. Salmon were released on 12 May after 21 days at a weight of 72 per lb. Thirty five mortalities were observed.

<u>Little Sodus Bay</u>
At Little Sodus Bay**,** steelhead weighing 30 fish per lb. were delivered to a pen on 19 April. Steelhead were released on 12 May weighing 14 fish per lb. Pens were towed to the bay outlet for fish release. Only 1 mortality was reported by the coordinator.

Chinook salmon were also delivered to the pen site on 19 April. Salmon weighed 120 fish per lb. when delivered and weighed 66 fish per lb. when released on 12 May. Salmon pens were towed to the bay outlet for fish release. Eleven mortalities were reported by the coordinator.

<u>Sodus Bay</u>
Chinook salmon were placed into pens on 18 April and grew from 120 to 62.4 fish per lb. after 23 days. Average length of released salmon was 3.5 in. Forty seven mortalities were recorded. The salmon were released on 11 May at a water temperature of 57°F.

<u>Genesee River</u>
Steelhead were placed into pens on 15 April and held for 25 days. They were released on 10 May weighing 14.7 fish per lb., compared to a delivery weight of 27 fish per lb. The average length of the steelhead was 5.7 inches at release. Mortalities were not reported.

Chinook salmon were delivered to Shumway Marina at a weight of 120 fish per lb. on 15 April. They were held in pens for 25 days and released on 10 May weighing 70.9 fish per lb. The average length of the Chinook salmon was 3.5 inches at release. Mortalities were not reported.

Sandy Creek

Approximately two weeks prior to the scheduled 2016 fish delivery date, the marina that hosted the pen project informed the pen coordinator that they would no longer host the project. Hence, all steelhead and Chinook salmon were directly stocked into Sandy Creek near the mouth of Lake Ontario on 29 April. The steelhead were stocked at 30 fish per lb. and the Chinook salmon were stocked at 100 fish per lb.

Oak Orchard Creek

Steelhead were delivered at a weight of 25.3 fish per lb. on 12 April. They were held for 28 days and released on 10 May. The steelhead weighed 15.6 fish per lb. with an average total length of 5.8 in at release. Seventy mortalities were reported.

Chinook salmon were delivered at a weight of 121 fish per lb. on 12 April. They were also held for 28 days and released on 10 May. At release, the Chinooks weighed 74.6 fish per lb. with an average total length of 3.3 in. One hundred ten mortalities were reported.

Water temperatures at the pen site ranged from 48 to 58$^{o}$ F. Salmon and steelhead were released at the pen site, rather than towed to the lake because a large flock of cormorants were observed on the pier at the mouth of Oak Orchard Creek. Water temperature was 56$^{o}$F on the release date.

Olcott Harbor

Steelhead were delivered at a weight of 24.3 fish per lb. on 13 April. They were held for 19 days and released on 2 May, weighing 15.9 fish per lb. The steelhead pen was towed to harbor outlet for release. No mortalities were observed.

Chinook salmon were delivered at a weight of 116 per lb. on 13 April. They were held for 20 days and released on 3 May, weighing 59.5 fish per lb. Chinook salmon were released at the pen site at dusk. Thirty Five mortalities were observed.

Wilson Harbor

Steelhead were delivered at a weight of 25 fish per lb. on 18 April. They were held for 22 days and released on 10 May, weighing 10 fish per lb. Five mortalities were observed.

Lower Niagara River

The lower Niagara River pen site is typically last to receive fish delivery due to slowly warming water temperatures. Steelhead were delivered at a weight of 25 fish per lb. on 27 April. They were held for 20 days and released on 17 May, weighing 15 fish per lb. Mortalities were not reported.

Chinook salmon were delivered at a weight of 120 fish per lb. on 27 April. They were held for 20 days and released on 17 May, weighing 70 fish per lb. Mortalities were not reported.

## Conclusions

Of the seven locations where steelhead were penned, target weights (12-15 fish per lb.) were reached at four sites in 2016. Results at other sites were just below target, about 16 per lb.

Chinook target weights (90 fish per lb.) were exceeded at all seven sites. It is likely that a large percentage of the penned salmon imprinted to their respective pen sites, increasing the likelihood that salmon will return as spawning adults.

The nineteenth year of pen-rearing steelhead and Chinook salmon along the New York shoreline of Lake Ontario was successful due to relatively low fish mortality, all of the Chinook salmon and nearly all of the steelhead 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 2016 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<br>Oswego Marina |
| Little Sodus Bay | Anchor Resort and Marina | Anchor Resort and Marina<br>Jim Jared |
| Sodus Bay | Sodus Bay near Sodus Point | Krenzer's Marina<br>Lake Ontario Charter Boat Association<br>Prime Time Storage<br>Wayne County Tourism<br>Wayne County Pro-Am |
| Genesee River | Shumway Marina | Genesee Charter Association<br>Greater Rochester Sportfishing Association<br>Irondequoit Bay Fish and Game Club<br>Shumway Marina |
| Sandy Creek | Sandy Creek Marina | Boy Scouts<br>Genesee Charter Association<br>Sandy Creek Shoot - Out Fishing Tournament<br>S.U.N.Y. at Brockport |
| Oak Orchard Creek | Lake Breeze Marina | Lake Breeze Marina<br>Oak Orchard Pen-Rearing Association<br>Orleans County Department of Tourism |
| Olcott Harbor | Town of Newfane Marina | Lake Ontario Trout and Salmon Association<br>Slippery Sinker Bait and Tackle<br>Town of Newfane (including Town Marina) |
| Wilson Harbor | Bootlegger's Cove Marina | Town of Wilson<br>Wilson Boat House Restaurant<br>Bootlegger's Cove Marina |
| Lower Niagara River | Constitution Park, Youngstown | Fox Fence Company<br>Niagara River Anglers Association<br>Village of Youngstown |

***Table 2. Methods used at 2016 Lake Ontario pen project sites.***

| **Pen Site** | **Pen Stocking Method** | **Feeding Frequency (times per day)** | **Water Temperature Measurement (times per day)** | **Pen Cleaning Frequency** | **Fish Release Method** |
|---|---|---|---|---|---|
| Little Salmon River | Hydraulic transfer | 5 | 5 | not noted | Pen towed to river mouth for fish release |
| Oswego Harbor | Hydraulic transfer | 5 | Rarely | 4 times | Fish released at pen site. |
| Little Sodus Bay | Hydraulic transfer | Automated | 1-5 | not noted | Pens towed to bay outlet for fish release. |
| Sodus Bay | Hydraulic transfer | 5 | 5 | weekly | Pens towed to lake for fish release, pens inverted. |
| Genesee River | Hydraulic transfer | 5 | daily | weekly | Fish released at pen site. |
| Sandy Creek | -- | -- | -- | -- | -- |
| Oak Orchard Creek | Hydraulic transfer | 5 | 2 | every five days | Fish released at pen site; cable ties cut to release fish |
| Olcott Harbor | Hydraulic transfer | 5 | 5 | weekly | Chinook salmon released at pen site. Steelhead towed to harbor mouth |
| Lower Niagara River | Hydraulic transfer | 5 | 1 | not noted | Fish released at pen site |
| Wilson | Hydraulic transfer | 5 | 5 | 2/week | Fish released at pen site |

***Table 3. Results of 2016 Lake Ontario trout and salmon pen-rearing projects.***

| Pen Site | Species | Number Stocked (into pens) | 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 | 15 Apr | 120 | 10 May (25) | 70.9 | N/A | -- |
| Little Sodus | Chinook | 25,000 | 2 | 19 Apr | 120 | 12 May (23) | 66 | 11 | 0.04 |
| Lower Niagara | Chinook | 75,000 | 1 | 27 April | 120 | 17 May (20) | 70 | N/A | -- |
| Oak Orchard | Chinook | 106,560 | 5 | 12 Apr | 121 | 10 May (28) | 70.9 | 110 | 0.10 |
| Olcott | Chinook | 67,100 | 3 | 13 Apr | 116 | 3 May (20) | 59.5 | 35 | 0.05 |
| Oswego | Chinook | 41,890 | 3 | 21 Apr | 100 | 12 May (21) | 72 | 35 | 0.08 |
| Sandy Creek | Chinook | 0 | 0 | -- | -- | -- | -- | -- | -- |
| Sodus | Chinook | 50,000 | 2 | 18 Apr | 120 | 11 May (23) | 62.4 | 47 | 0.09 |
| Genesee | steelhead | 10,000 | 2 | 15 Apr | 27 | 10 May (25) | 14.7 | N/A | -- |
| Little Salmon | steelhead | 5,000 | 1 | 19 Apr | 28 | 16 May (27) | 16 | 1 | 0.02 |
| Little Sodus | steelhead | 6,000 | 1 | 19 Apr | 30 | 12 May (23) | 14 | 1 | 0.017 |
| Lower Niagara | steelhead | 10,000 | 1 | 27 April | 25 | 17 May (20) | 15 | N/A | -- |
| Oak Orchard | steelhead | 14,000 | 3 | 12 Apr | 25.3 | 10 May (28) | 15.6 | 70 | 0.5 |
| Olcott | steelhead | 3,500 | 1 | 13 Apr | 24.3 | 2 May (19) | 15.9 | 0 | 0.0 |
| Sandy Creek | steelhead | 0 | 0 | N/A | -- | N/A | -- | -- | -- |
| Wilson | steelhead | 7,500 | 2 | 18 Apr | 25 | 10 May (22) | 10 | 5 | 0.07 |

N/A not available

# SEA LAMPREY CONTROL IN LAKE ONTARIO 2016

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This report summarizes Sea Lamprey (*Petromyzon marinus*) control activities conducted by the United States Fish and Wildlife Service (Service) and Fisheries and Oceans Canada (Department) as agents of the Great Lakes Fishery Commission (Commission) in Lake Ontario during 2016. 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-20$^{th}$ century and continues to affect efforts to restore and rehabilitate the fish-community. Sea Lampreys subsist on the blood and body fluids of large-bodied fish. It is estimated that about half of Sea Lamprey attacks result in the death of their prey and on average, 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.

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 annual performance of the SLCP is evaluated by contrasting lake-specific adult Sea Lamprey index estimates and Lake Trout marking rates with prescribed targets. Adult Sea Lamprey abundance indices are estimated by the Service and Department by summing mark-recapture estimates from a sub-set of streams that were selected based on a consistent trapping history and large Sea Lamprey spawning runs. The index approach was first used during 2015, replacing regression model estimates of lake-wide abundance that were derived from multiple variables. Lake Trout marking rates are assessed and collected by member agencies that comprise the lake committees and their technical committees.

The adult index target for Lake Ontario of 11,368 Sea Lampreys 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). During 2016, the index of adult abundance in Lake Ontario was estimated to be 7,191 (95% CI; 4,310 – 10,072), which is lower than the index target.

The target for Lake Ontario Sea Lamprey abundance was first calculated using the same marking statistics as the other lakes (A1-A3 marks). During 20016, 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 Lake Trout was explicitly identified as producing tolerable mortality in the Lake Trout rehabilitation plan. The number of A1 marks on Lake Trout from standardized fall assessments in 2016 has not yet been analyzed.

**LAMPRICIDE CONTROL**

Tributaries harboring Sea Lamprey larvae are treated periodically with lampricides to eliminate or reduce larval populations before they recruit to the lake as feeding juveniles. During stream treatments, Service and Department control units administer and analyze several lampricide formulations including TFM or TFM mixed with Bayluscide (70% wettable powder or 20% emulsifiable concentrate). Specialized equipment and techniques are employed to maintain lampricide concentrations at levels that eliminate approximately 95% of resident Sea Lamprey larvae while minimizing risk to non-target organisms. To control larval populations that inhabit lentic areas and interconnecting waterways, field crews apply a bottom-release formulation of lampricide, Bayluscide 3.2% granular (gB), which is 75% effective on average.

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, 36 tributaries (18 Canada, 18 U.S.) have been treated with lampricides at least once during 2007-2016. Twenty-eight tributaries (14 Canada, 14 U.S.) are treated on a regular 3-5 year cycle. Details on lampricide applications to Lake Ontario tributaries and lentic areas during 2016 are found in Table 1 and Figure 1.

- Lampricide applications were conducted in 10 streams (6 Canada, 4 U.S.).

- Levi and Heritage creeks (Credit River tributaries) were treated for the first time in 2016.

**ALTERNATIVE CONTROL**

The Service and Department continue to coordinate with the Commission and other partners to research and develop alternatives to lampricide treatments to provide a broader spectrum of strategies to control Sea Lampreys. During 2016, barriers were the only operational alternative control method used. Alternative control methods that are currently being investigated include the use of attractants (e.g. pheromones), repellents (e.g. alarm cues), and new trap designs.

**Barriers**

The Sea Lamprey Barrier Program priorities are to:

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 a cost-effective alternative to lampricide control;
    b. provide control where other options are impossible, excessively expensive, or ineffective;

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.

The Commission has invested in 16 barriers on Lake Ontario (Figure 2). Of these, 10 were purpose-built as Sea Lamprey barriers and 6 were constructed for other purposes, but have been modified to block Sea Lamprey migrations.

Data gathered during field visits to assess the status of other dams and structures were recorded in the SLCP's Barrier Inventory and Project Selection System (BIPSS) and may be used to select barrier projects, monitor inspection frequency, schedule upstream larval assessments, assess the effects of barrier removal or modifications on Sea Lamprey populations, or identify structures that are important in controlling Sea Lampreys.

*Barrier Inventory and Project Selection System (BIPSS)*

- Field crews visited 34 structures on tributaries to Lake Ontario to assess Sea Lamprey blocking potential and to improve the information in the BIPSS database.

*Operation and Maintenance*

- Routine maintenance, spring start-up, and safety inspections were performed on 21 barriers (9 Canada, 12 U.S.).

*Ensure Blockage to Sea Lamprey Migration*

- Bowmanville Creek – A new fishway at the Goodyear Dam was constructed in 2014. Since then, there has been escapement of spawning phase Sea Lampreys in successive years, leading to the establishment of a larval population in upstream areas of the watershed. Department staff is communicating with the dam owner to identify potential routes of escapement and evaluate and implement remedial measures.
- Credit River – Escapement at the Streetsville Dam has continued since it was rehabilitated as a Sea Lamprey barrier in the mid-2000s. Improvements, including installation of an overhanging lip, were completed during 2013-2015. Data loggers were installed in fall of 2015 to monitor the hydraulic conditions at the barrier. A fall 2016 site meeting of Department and OMNRF representatives was convened to determine possible remediation. One potential avenue of escapement that was identified in a previous pit-tagging study is through the fishway that OMNRF and its partners operate. Remedial measures, including modification of the fishway and changes to operating procedures are planned in cooperation with OMNRF prior to the spring 2017 migration.

Consultations to ensure blockage were conducted with partner agencies for four sites in four streams during 2016 (Table 2).

*New Construction*

- Rouge River – The Toronto Regional Conservation Authority (TRCA) has completed a draft Fisheries Management Plan (FMP), which included the recommendation of a Sea Lamprey barrier feasibility study. The FMP is consistent with the 2007 Rouge River Watershed Management Plan, which identifies the evaluation of the installation or maintenance of barriers to partition species or to exclude invasive species as a priority for the watershed. Portions of the watershed that were formerly under TRCA jurisdiction will be incorporated into an Urban National Park under Parks Canada (PC). PC has been apprised of the Department's barrier feasibility studies, and further discussion between the Department and PC is planned in spring 2017.

**Table 1**. Details on the application of lampricides to tributaries of Lake Ontario during 2016 (letter in parentheses corresponds to location of stream in Figure 1).

| Tributary | Date | Discharge ($m^3/s$) | Distance Treated (km) | Liquid TFM (kg)[1] | Solid TFM (kg)[1] | Wettable Powder Bayluscide (kg)[1] | Emulsifiable Concentrate Bayluscide (kg)[1] | Granular Bayluscide (kg)[1] |
|---|---|---|---|---|---|---|---|---|
| **Canada** | | | | | | | | |
| Bronte Cr. (A) | Apr 22 | 3.5 | 41.4 | 1624.8 | --- | --- | --- | 0.1 |
| Credit R. (B) | Jun 04 | 9.0 | 52.3 | 1564.9 | --- | --- | 18.4 | 0.5 |
| Port Britain Cr. (C) | Apr 18 | 0.4 | 1.4 | 111.3 | --- | --- | --- | 0.1 |
| Covert Cr. (D) | Apr 19 | 0.2 | 5.0 | 58.9 | --- | --- | --- | 0.1 |
| Shelter Valley Br. (E) | Apr 20 | 1.0 | 0.6 | 247.9 | --- | --- | --- | --- |
| Salmon R. (F) | Jun 01 | 2.5 | 3.6 | 252.6 | --- | --- | 3.1 | --- |
| **Total (Canada)** | | **16.6** | **104.3** | **3860.4** | **0** | **0** | **21.5** | **0.8** |
| **United States** | | | | | | | | |
| South Sandy Cr. (G) | Apr 20 | 3.8 | 12.0 | 512.1 | 0.2 | 2.1 | --- | 0.1 |
| Little Sandy Cr. (H) | May 27 | 0.5 | 13.1 | 74.5 | --- | --- | --- | 0.1 |
| Grindstone Cr. (I) | Apr 14 | 1.6 | 60.2 | 328.0 | 4.4 | --- | --- | 0.3 |
| Oswego River. (J) | | | | | | | | |
| Fish Cr. | May 29 | 9.0 | 30.4 | 887.8 | 0.3 | --- | --- | 0.1 |
| **Total (United States)** | | **14.9** | **115.7** | **1802.4** | **4.9** | **2.1** | **0** | **0.6** |
| **Total for Lake** | | **31.5** | **220.0** | **5662.8** | **4.9** | **2.1** | **21.5** | **1.4** |

[1]Lampricide quantities are reported in kg of active ingredient.

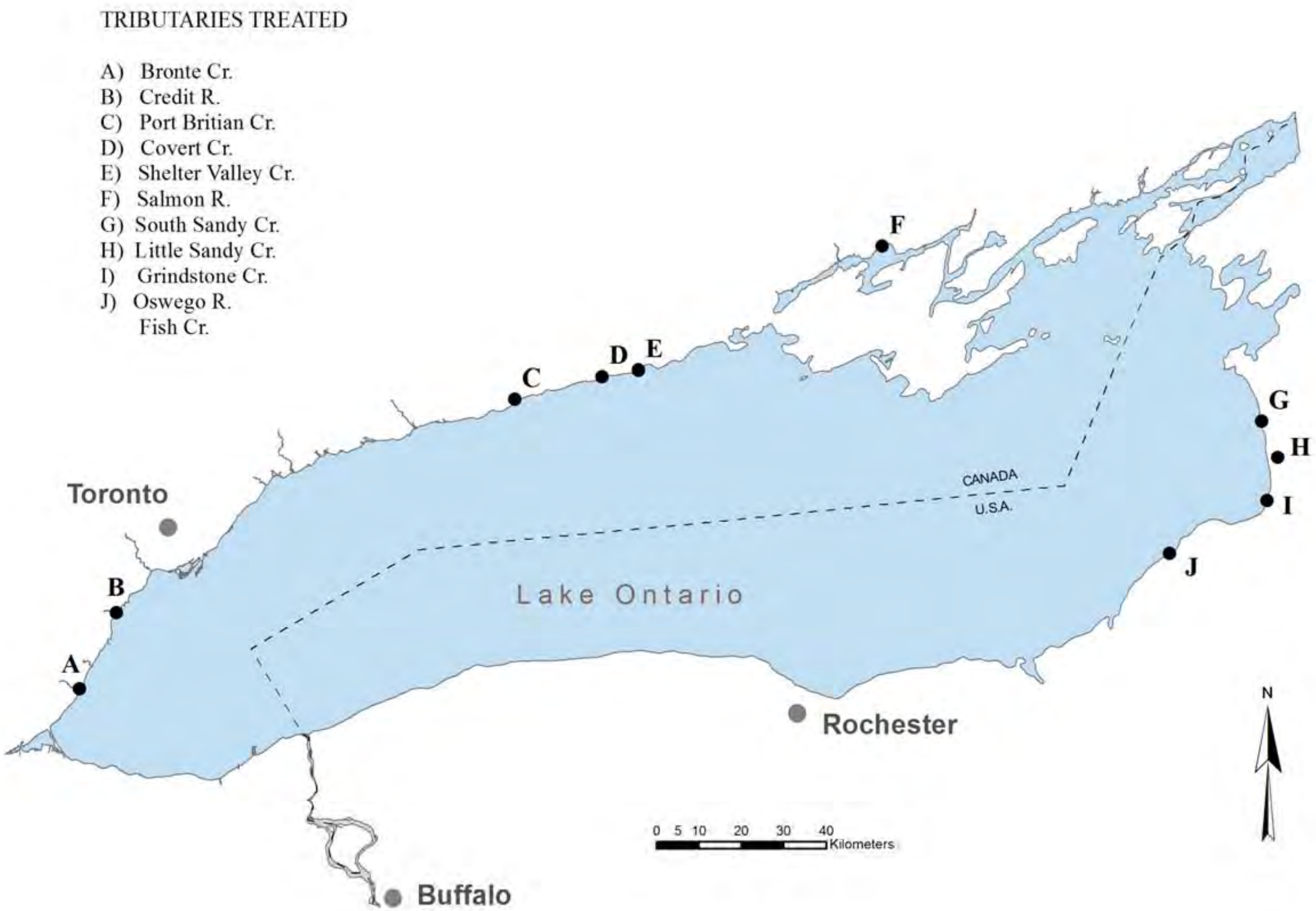


**Figure 1**. Location of Lake Ontario tributaries treated with lampricides (corresponding letters in Table 1) during 2016.

**Table 2**. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Ontario tributaries.

| Mainstream | Tributary | Lead Agency | Project | SLCP Position | Comments |
|---|---|---|---|---|---|
| Genesee R. | Ludington Run | PCCD[1] | Ludington Run culvert | Concur | Ineffective barrier |
| Oswego R. | West Br. Onodaga Cr. | OEI[2] | Red Mill Rd. culvert | Concur | Ineffective barrier |
| Tonawanda Cr. | Crow Cr. | BNR[3] | Krotz Rd. culvert | Concur | Ineffective barrier |
| Humber R. | Albion Pond | DFO-FPP[4] | Dam removal | Concur | Upstream of blocking barrier |

[1]Potter County Conservation District.
[2]Onodaga Environmental Institute.
[3]Buffalo Niagara Riverkeeper.
[4]Fisheries and Oceans Canada, Fisheries Protection Program.

## ASSESSMENT

The assessment program has three components:

1. Larval assessment determines the relative abundance and distribution of Sea Lamprey larvae in streams and lentic areas. These data are used to predict where larvae greater than 100 mm total length will most likely be found by the end of the growing season during the year of sampling. These predictions are used to prioritize lampricide treatments for the following year.

2. Juvenile assessment evaluates the lake-specific rate of Lake Trout marking inflicted by Sea Lampreys. These time series data are used in conjunction with adult assessment data to assess the effectiveness of the SLCP for each lake. In addition, several indices of relative abundance of feeding juveniles are used in some lakes to monitor Sea Lamprey populations over time.

3. Adult assessment annually estimates an index of adult Sea Lamprey abundance in each lake. Because this life stage is comprised of individuals that have either survived or avoided exposure to lampricides, the time series of adult abundance indices is the primary metric used to evaluate the effectiveness of the SLCP.

### Larval Assessment

Tributaries considered for lampricide treatment during 2017 were assessed during 2016 to define the distribution and estimate the abundance and size structure of larval Sea Lamprey populations. Assessments were conducted with backpack electrofishers in waters <0.8 m deep, while waters ≥0.8 m in depth were surveyed with gB or by deep-water electrofishing (DWEF). 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.

- Larval assessments were conducted on 58 tributaries (20 Canada, 38 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 6 tributaries (2 Canada, 4 U.S.).

- Surveys to detect the presence of new larval Sea Lamprey populations were conducted in 23 tributaries (5 Canada, 18 U.S.). No new populations were detected.

- Post-treatment assessments were conducted in 10 tributaries (5 Canada, 5 U.S.) to determine the effectiveness of lampricide treatments conducted during 2015 and 2016. Surveys indicated that all treatments were highly effective, precluding the need to consider re-treatment.

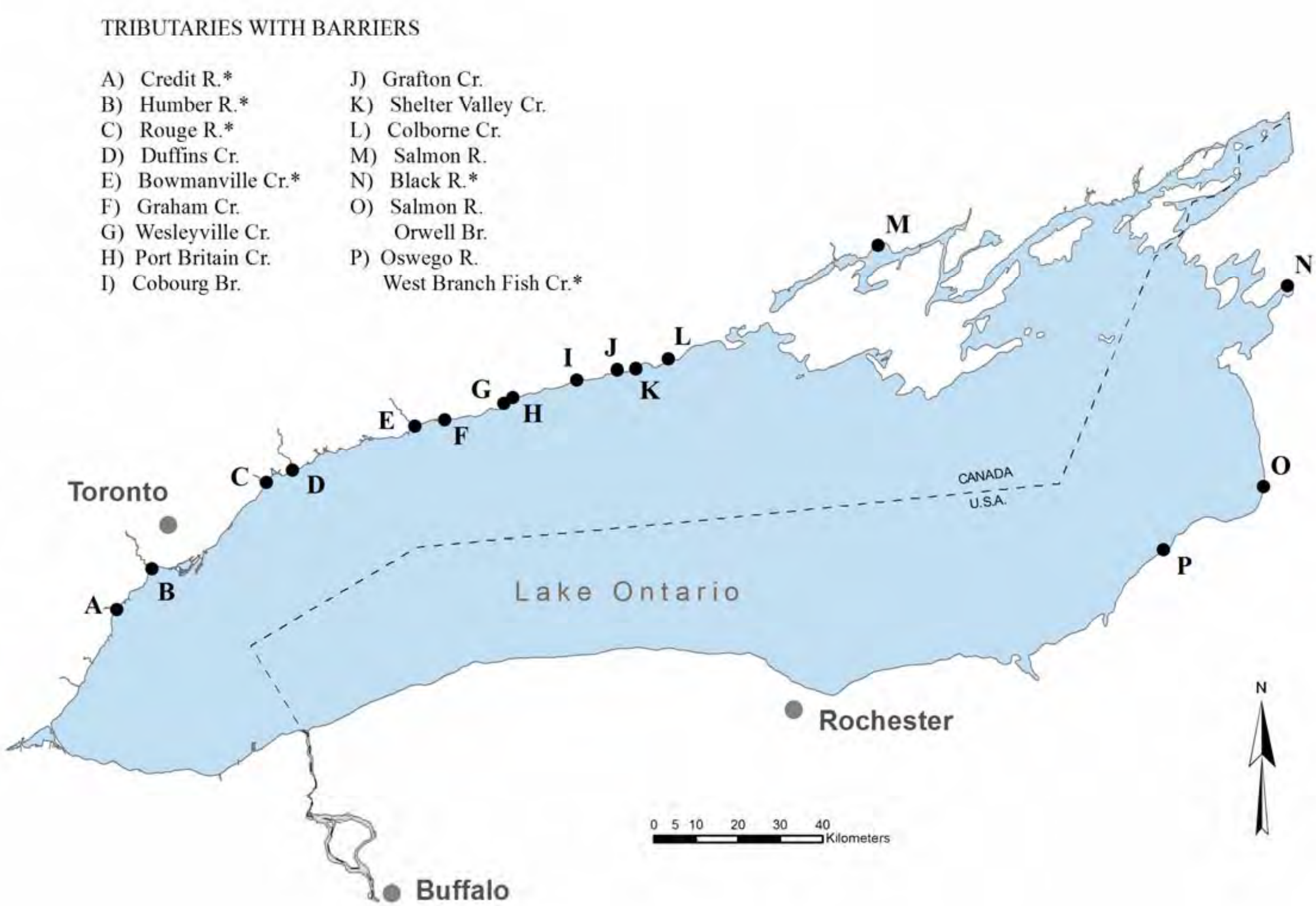


**Figure 2.** Location of Lake Ontario tributaries with Sea Lamprey barriers. Structures that were not constructed by the Commission, but have been modified to prevent the upstream migration of Sea Lampreys are indicated by an asterisk (*).

- Surveys to evaluate barrier effectiveness were conducted in 7 tributaries (4 Canada, 3 U.S.). Two year classes of Sea Lampreys were detected upstream of the Veyance Dam on Bowmanville Creek.

- In 2015, larval Sea Lampreys were detected in Levi and Heritage creeks (Credit River tributaries) with no prior history of infestation. Multiple age classes of larvae, including those newly-metamorphosed, were found and subsequently treated during 2016. Post treatment assessments in 2016 yielded no residual lampreys.

- Due to the discovery of production from the Owasco Lake Outlet (Seneca River tributary), additional surveys were performed on several Seneca River and Erie Canal tributaries. No native lampreys or Sea Lampreys were found despite the presence of suitable habitat.

- Following a long history of lentic infestation off the mouth of the Black River (New York), the first gB treatment of this area took place in 2015 in conjunction with the TFM application. Post-treatment surveys in 2016 yielded no residual Sea Lampreys.

- Larval assessment surveys were conducted in non-wadable lentic and lotic areas using 5.88 kg active ingredient of gB (1.68 Canada; 4.20 U.S; Table 5).

**Juvenile Assessment**

The juvenile life stage is assessed through the interpretation of marking rates by juvenile Sea Lampreys on Lake Trout >431 mm. 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. Marking rates on Lake Trout are estimated from fisheries assessments conducted by state, provincial, tribal and federal fishery management agencies associated with each lake, and are updated when the data become available. These data provide a metric of the mortality inflicted on Lake Trout on a lake-wide basis. The Commission contracts the Service's Green Bay Fish and Wildlife Conservation Office (GBFWCO) to calculate marking statistics and Lake Trout abundance estimates to better understand the damage caused by Sea Lampreys.

- Lake Trout marking data for Lake Ontario are provided by the U.S. Geological Survey, OMNRF, and the New York State Department of Environmental Conservation.

- The number of A1 marks per 100 Lake Trout >431 mm from standardized fall assessments during 2016 were submitted in February 2017 and have yet to be analyzed.

- Based on standardized fall assessment data, the marking rate during 2015 was 1.8 A1 marks per 100 Lake Trout >431 mm. The current marking rate is below target (Figure 3).

**Adult Assessment**

An annual index of adult Sea Lamprey abundance is derived by summing individual population estimates from traps operated in a specific suite of streams (index streams) during spring and early summer. A mark-recapture estimate is attempted in each index stream, however, in the absence of an estimate due to an insufficient number of marked or recaptured Sea Lampreys, abundance is estimated using the annual pattern of adult abundance observed in all streams and years, and adjusted to the stream-specific average abundance estimate in the time series. The index targets are estimated as the mean of indices during a period within each lake when marking rate was considered acceptable, or the percentage of the mean that would be deemed acceptable.

- A total of 4,004 Sea Lampreys were trapped in 8 tributaries, 5 of which are index locations. Adult population estimates based on mark-recapture were obtained from 4 of the 5 index locations; the other (Sterling Cr.) was estimated using the relative annual pattern of abundance (Table 6, Figure 4).

- The index of adult Sea Lamprey abundance was 7,191 (95% CI; 4,310-10,072), which was less than the target of 11,368 (Figure 5-6).

**Table 3.** Status of larval Sea Lampreys in Lake Ontario tributaries with a history of Sea Lamprey production and estimates of abundance from tributaries surveyed during 2016 using a quantitative method.

| 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 | Jun-14 | --- | Yes | --- | --- | Unknown |
| Ancaster Cr. | May-03 | Jun-15 | --- | Yes | --- | --- | Unknown |
| Grindstone Cr. | Never | Jun-16 | --- | No | --- | --- | Unknown |
| Bronte Cr. | Apr-16 | Jun-16 | No | No | --- | --- | 2019[1] |
| Sixteen Mile Cr. | Jun-82 | Aug-16 | --- | No | --- | --- | Unknown |
| Credit R. | Jun-16 | Jun-16 | No | No | --- | --- | 2019[1] |
| Humber R. | Never | Jun-14 | --- | No | --- | --- | Unknown |
| Rouge R. | Jun-11 | Jun-15 | --- | Yes | --- | --- | Unknown |
| Little Rouge. R. | Jun-15 | Jun-15 | No | No | --- | --- | Unknown |
| Petticoat Cr. | Sep-04 | Jun-16 | --- | Yes | --- | --- | Unknown |
| Duffins Cr. | Jun-15 | Jul-15 | No | No | --- | --- | 2018[1] |
| Carruthers Cr. | Sep-76 | Jul-16 | No | No | --- | --- | Unknown |
| Lynde Cr. | Jun-15 | Jul-15 | No | No | --- | --- | 2018[1] |
| Oshawa Cr. | Jun-15 | Jul-15 | Yes | No | --- | --- | 2018[1] |
| Farewell Cr. | Jun-15 | Jul-15 | Yes | No | --- | --- | 2018[1] |
| Bowmanville Cr. | May-14 | Jun-16 | No | Yes | --- | --- | ***2017***[1] |
| Wilmot Cr. | Jun-15 | Jul-15 | No | No | --- | --- | 2018[1] |
| Graham Cr. | May-96 | Jul-15 | --- | No | --- | --- | Unknown |
| Wesleyville Cr. | Oct-02 | Jul-14 | No | No | --- | --- | Unknown |
| Port Britain Cr. | Apr-16 | Jun-16 | No | No | --- | --- | 2019 |
| Gage Cr. | May-71 | Jun-16 | --- | No | --- | --- | Unknown |
| Cobourg Br. | Oct-96 | Jun-15 | --- | Yes | --- | --- | Unknown |
| Covert Cr. | Apr-16 | Jun-16 | Yes | No | --- | --- | Unknown |
| Grafton Cr. | May-14 | Jun-16 | No | Yes | 1,448 | 1,024 | Unknown |
| Shelter Valley Cr. | Apr-16 | Jun-16 | No | No | --- | --- | Unknown |
| Colborne Cr. | May-14 | Jun-16 | No | Yes | 1,338 | 1,142 | ***2017*** |
| Salem Cr. | Jun-15 | Jul-15 | Yes | No | --- | --- | 2018[1] |
| Proctor Cr. | Jun-15 | Jul-15 | Yes | No | --- | --- | Unknown |
| Smithfield Cr. | Sep-86 | Jul-15 | --- | No | --- | --- | Unknown |
| Trent R. (Canal System) | Sep-11 | Jun-16 | No | Yes | --- | --- | Unknown |
| Mayhew Cr. | Jun-15 | Jul-15 | No | No | --- | --- | 2018[1] |
| Moira R. | Jun-15 | Jul-15 | Yes | No | --- | --- | Unknown |
| Salmon R. | Jun-16 | Jun-15 | --- | --- | --- | --- | Unknown |
| Napanee R. | Never | Jul-15 | --- | Yes | --- | --- | Unknown |

**Table 3.** *Continued*

| 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 |
|---|---|---|---|---|---|---|---|
| **United States** | | | | | | | |
| Black R. | Aug-15 | Jul-16 | Yes | Yes | --- | --- | 2018[1] |
| Stony Cr. | Sep-82 | Aug-14 | --- | No | --- | --- | Unknown |
| Sandy Cr. | Never | Jul-16 | --- | No | --- | --- | Unknown |
| South Sandy Cr. | Apr-16 | Jul-16 | --- | Yes | 6,341 | 3,012 | ***2017***[1] |
| Skinner Cr. | Apr-05 | Aug-15 | --- | No | --- | --- | Unknown |
| Lindsey Cr. | Jun-14 | Jul-16 | Yes | Yes | --- | --- | ***2017***[1] |
| Blind Cr. | May-76 | Jul-16 | --- | No | --- | --- | Unknown |
| Little Sandy Cr. | May-16 | Jul-16 | Yes | Yes | 2,673 | 1,184 | Unknown |
| Deer Cr. | Apr-04 | Jul-16 | --- | No | --- | --- | Unknown |
| Salmon R. | May-14 | Aug-14 | Yes | Yes | --- | --- | ***2017***[1] |
| Orwell Brook | May-14 | Jul-16 | No | No | --- | --- | Unknown |
| Trout Brook | May-14 | Jul-16 | Yes | Yes | --- | --- | ***2017***[1] |
| Altmar Cr. | Oct-15 | Jul-16 | Yes | No | --- | --- | ***2017***[1] |
| Grindstone Cr. | Apr-16 | Jul-16 | Yes | No | --- | --- | 2019[1] |
| Snake Cr. | Apr-15 | Aug-15 | No | No | --- | --- | 2018[1] |
| Sage Cr. | May-78 | Jul-16 | --- | No | --- | --- | Unknown |
| Little Salmon R. | Jun-14 | Jul-16 | Yes | Yes | --- | --- | ***2017***[1] |
| Butterfly Cr. | May-72 | Jul-16 | --- | No | --- | --- | Unknown |
| Catfish Cr. | Apr-15 | Jul-16 | Yes | Yes | --- | --- | 2018[1] |
| Oswego R. | | | | | | | |
| Black Cr. | May-81 | Aug-14 | --- | No | --- | --- | Unknown |
| Big Bay Cr. | Sep-93 | Aug-15 | --- | No | --- | --- | Unknown |
| Scriba Cr. | Jun-10 | Apr-14 | --- | No | --- | --- | Unknown |
| Fish Cr. | May-16 | Jul-16 | No | No | --- | --- | 2019[1] |
| Carpenter Br. | May-94 | Jul-16 | --- | No | --- | --- | Unknown |
| Putnam Br./ Coldsprings Cr. | May-96 | Aug-16 | --- | No | --- | --- | Unknown |
| Hall Br. | Never | Aug-15 | --- | No | --- | --- | Unknown |
| Crane Br. | Never | Aug-16 | --- | No | --- | --- | Unknown |
| Skaneateles Cr. | Never | Aug-16 | --- | No | --- | --- | Unknown |
| Owasco Outlet | Oct-15 | Jul-16 | Yes | Yes | --- | --- | Unknown |
| Rice Cr. | May-72 | Aug-15 | --- | No | --- | --- | Unknown |
| Eight Mile Cr. | Apr-15 | Aug-15 | Yes | Yes | --- | --- | Unknown |
| Nine Mile Cr. | May-14 | Aug-16 | Yes | Yes | 75,032 | 45,806 | ***2017*** |
| Sterling Cr. | May-15 | Aug-15 | Yes | Yes | --- | --- | 2018[1] |
| Blind Sodus Cr. | May-78 | Aug-16 | --- | No | --- | --- | Unknown |
| Red Cr. | Apr-15 | Aug-15 | No | Yes | --- | --- | Unknown |
| Wolcott Cr. | May-79 | Aug-14 | --- | No | --- | --- | Unknown |
| Sodus Cr. | Apr-15 | Aug-15 | No | No | --- | --- | Unknown |
| Forest Lawn Cr. | Never | Aug-15 | --- | Yes | --- | --- | Unknown |
| Irondequoit Cr. | Never | Aug-16 | --- | No | --- | --- | Unknown |
| Larkin Cr. | Never | Aug-15 | --- | No | --- | --- | Unknown |

**Table 3.** *Continued*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Northrup Cr. | Never | Aug-15 | --- | No | --- | --- | Unknown |
| Salmon Cr. | Apr-05 | Aug-15 | --- | Yes | --- | --- | Unknown |
| Sandy Cr. | Apr-14 | Aug-16 | No | No | --- | --- | Unknown |
| Oak Orchard Cr. | | | | | | | |
| Marsh Cr. | Apr-14 | Aug-16 | No | No | --- | --- | Unknown |
| Johnson Cr. | Apr-10 | Aug-16 | --- | No | --- | --- | Unknown |
| Third Cr. | May-72 | Aug-14 | --- | No | --- | --- | Unknown |
| First Cr. | May-95 | Aug-16 | --- | No | --- | --- | Unknown |

[1]Stream is being treated based on expert knowledge.
[2]Stream being treated based on geographic efficiency.

**Table 4.** Status of larval Sea Lampreys in historically infested lentic areas of Lake Ontario during 2016.

| Tributary | Lentic Area | Last Surveyed | Last Survey Showing Infestation | Last Treated |
|---|---|---|---|---|
| **Canada** | | | | |
| Duffins Cr. | Duffins Cr. - lentic | Aug-15 | Aug-12 | Never[1] |
| Oshawa Cr. | Oshawa Cr. - lentic | Jul-13 | Oct–81 | Never[1] |
| Wilmot Cr. | Wilmot Cr. - lentic | Aug-11 | Aug-11 | Never[1] |
| | | | | |
| **United States** | | | | |
| Black R. | Black River Bay | Jul-16 | Aug-14 | Aug-15 |

[1] Low-density larval population monitored with 3.2% granular Bayluscide surveys.

**Table 5.** Details on application of granular Bayluscide to tributaries and lentic areas of Lake Ontario for larval assessment purposes during 2016.

| Tributary | Bayluscide (kg)[1] | Area Surveyed (ha) |
|---|---|---|
| **Canada** | | |
| Trent R. (lotic) | 1.68 | 0.30 |
| **Total (Canada)** | **1.68** | **0.30** |
| | | |
| **United States** | | |
| Black R. (lentic) | 1.68 | 0.30 |
| Black R. (lotic) | 1.68 | 0.30 |
| Catfish Cr. (lotic) | 0.84 | 0.15 |
| **Total (United States)** | **4.20** | **0.75** |
| | | |
| **Total for Lake** | **5.88** | **1.05** |

[1] Lampricide quantities are reported in kg of active ingredient.

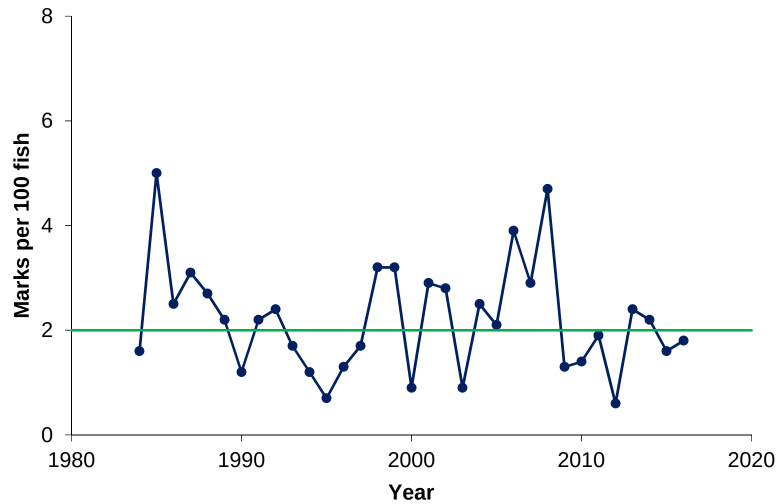


**Figure 3.** Number of A1 marks per 100 Lake Trout >431 mm from standardized fall assessments in Lake Ontario. The horizontal line represents the target of 2 A1 marks per 100 Lake Trout.

**Table 6.** Information collected regarding adult Sea Lampreys captured in assessment traps or nets in tributaries of Lake Ontario during 2016 (letter in parentheses corresponds to stream in Figure 4). Tributaries that are not index locations are denoted with a [3].

| 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) | 2,648 | 3,656 | 72 | 174 | 61 | 493 | 474 | 279 | 260 |
| Duffins Cr. (B) | 326 | 1,260 | 26 | 8 | 75 | 512 | 479 | 296 | 247 |
| Bowmanville Cr. (C) | 403 | 803 | --- | 195 | 67 | 498 | 500 | 267 | 278 |
| Cobourg Cr.[3] (D) | 179 | 411 | 44 | 100 | 54 | 468 | 460 | 238 | 211 |
| Salmon R.[3] (E) | 4 | --- | --- | --- | --- | --- | --- | --- | --- |
| **Total or Mean (Canada)** | **3,560** | --- | --- | **477** | **64** | **491** | **480** | **267** | **253** |
| **United States** | | | | | | | | | |
| Black R. (F) | 280 | 800 | 35 | 20 | 50 | 467 | 472 | 228 | 248 |
| Salmon R.(G) | | | | | | | | | |
| Orwell Br.[3] | 158 | 416 | 38 | 22 | 59 | 499 | 519 | 288 | 291 |
| Sterling Cr. (H) | 6 | --- | --- | --- | --- | --- | --- | --- | --- |
| **Total or Mean (U.S.)** | **444** | --- | --- | **42** | **55** | **485** | **494** | **262** | **269** |
| **Total or Mean (for lake)** | **4,004** | --- | --- | **519** | **61** | **491** | **481** | **266** | **255** |

[1] The number of Sea Lampreys used to determine percent males, mean length, and mean weight.
[2] Gender was determined using external characteristics.
[3] Not an index location.

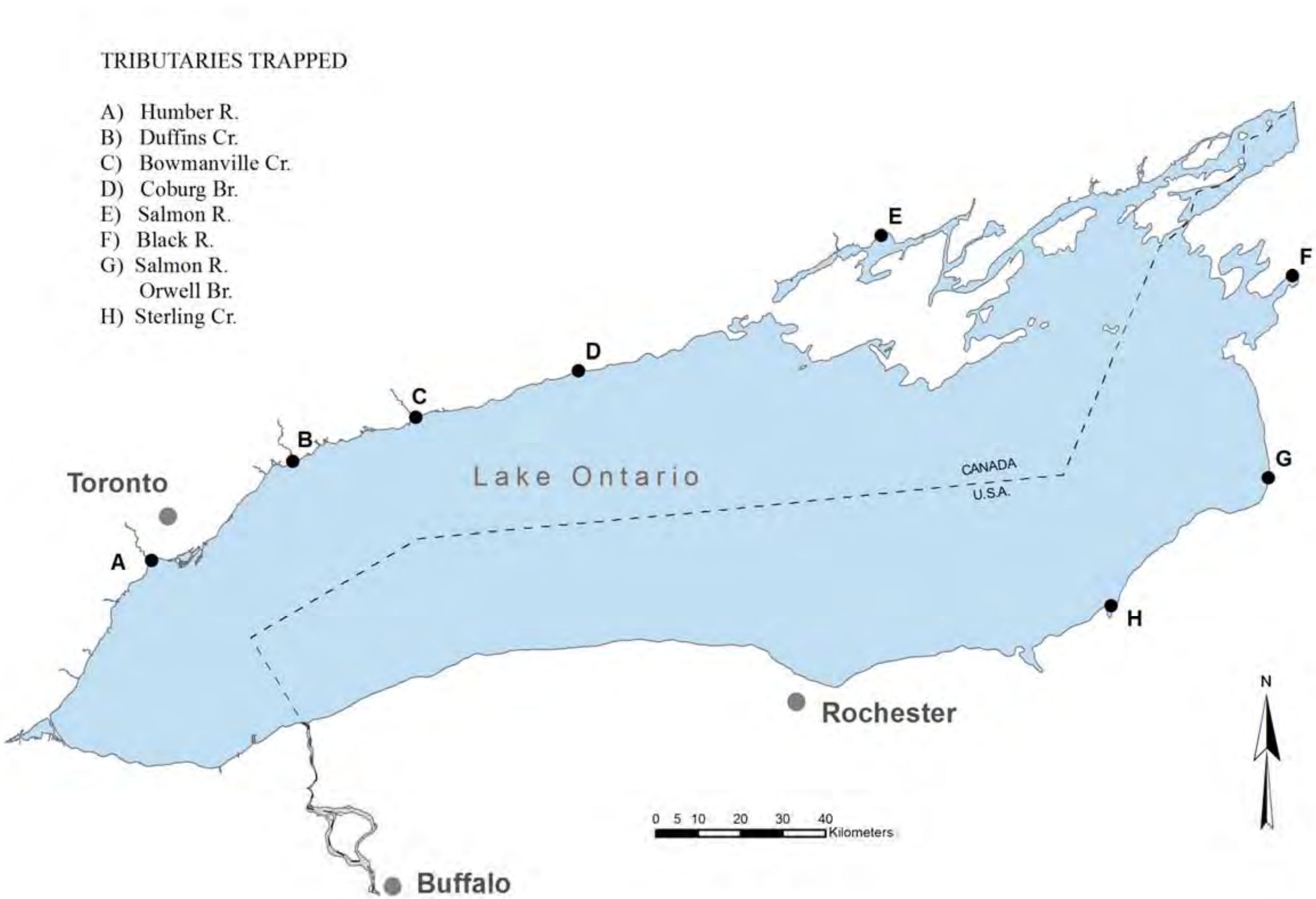


**Figure 4.** Location of Lake Ontario tributaries where assessment traps were operated (corresponding letters in Table 5) during 2016.

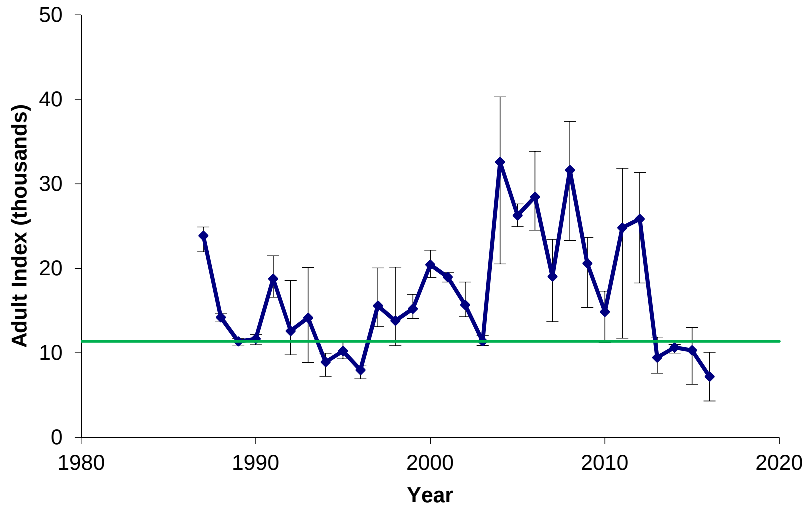


**Figure 5**. Index estimates with 95% confidence intervals (vertical bars) of adult Sea Lampreys. The adult index in 2016 was 7,191 with 95% confidence interval (4,310-10,072). The point estimate met the target of 11,368 (green horizontal line). The index target was estimated as the mean of indices during a period with acceptable marking rates (1993-1997).


**Figure 6.** LEFT: Estimated index of adult Sea Lampreys during the spring spawning migration, 2016. Circle size corresponds to estimated number of adults from mark-recapture studies (blue) and model predictions (orange). All index streams are identified. RIGHT: Maximum estimated number of larval Sea Lampreys in each stream surveyed during 1995-2012. Tributaries composing over half of the lake-wide larval population estimate are identified (Salmon 1,400,000; Little Salmon 970,000; Credit 590,000; Black 470,000).

# Trawl-based assessment of Lake Ontario pelagic prey fishes including Alewife and Rainbow Smelt

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## Abstract

*Managing Lake Ontario fisheries in an ecosystem-context, requires reliable data on the status and trends of prey fishes that support predator populations. We report on the community and population dynamics of Lake Ontario pelagic prey fishes, based on bottom trawl surveys. We emphasize information that supports the international Lake Ontario Committee's Fish Community Objectives. In 2016, 142 bottom trawls were collected in U.S. waters, and for the first time 46 trawls were conducted in Canadian waters. A total of 420,386 fish from 24 species were captured. Alewife were 89% of the total fish catch and 93% of the pelagic prey fish catch. The Rainbow Smelt abundance index in U.S. waters increased slightly in 2016 relative to 2015. Interestingly, the Rainbow Smelt abundance index from tows in Canadian waters was 35% higher than the U.S. index. Abundances of Threespine Stickleback and Emerald Shiners in both U.S. and Canadian waters were low in 2016 relative to their peak abundances in the late 1990s, but Cisco abundance indices suggest a recent increase in their abundance. This year, the reported Alewife abundance time series was truncated to only include values since 1997, which were collected with the same trawl and eliminated the need to adjust values for different trawls. The 2016 adult Alewife abundance index was the second lowest abundance ever observed in the time series. This value was expected to decline from the 2015 value since the indices of juvenile Alewife were low in 2014 and the lowest ever observed in 2015. The fall condition index of adult Alewife increased in 2016 and is consistent with lower abundance and reduced competition for zooplankton resources. The 2016 Age-1 Alewife index increased relative to 2014 and 2015, and suggested lake conditions were favorable for Age-1 survival and growth during the summer of 2015 and the 2015-2016 winter. Interestingly, the catch of adult and Age-1 Alewife was higher in trawls conducted in Canadian waters relative to U. S. waters. The larger trawl catches in Canadian waters suggest there may be important spatial differences in lake-wide distribution of prey fishes in April when trawling is conducted. Future surveys should to continue to sample at the whole-lake scale to understand the year to year variability in spatial distribution and the physical or biotic factors driving those distribution differences.*

## Introduction

Managing Lake Ontario fisheries in an ecosystem-context, requires reliable data on the status and trends of prey fishes that support predator populations (Stewart et al., 2013). Currently, nonnative Alewife are the primary pelagic prey fish in Lake Ontario and support most of the lake's predators (Brandt, 1986; Stewart and Sprules, 2011). Nonnative Rainbow Smelt play a lesser role, but can be important at certain times and locations (Rand and Stewart, 1998). Pelagic prey fish populations, like Alewife, are prone to dramatic population changes, due to environmental conditions (prolonged winters), excessive predation, inadequate food, or combinations of these factors (Stewart et al., 2013).

The Lake Ontario pelagic prey fish community has undergone dramatic change. Historically the dominant native pelagic prey fishes, Cisco and Bloater, sustained native predators and supported commercial fisheries (Christie, 1972). In the early and mid-1900's, Cisco and Bloater populations began to decline due to overfishing, habitat alterations and competition with introduced species (Christie, 1972). Introduced Alewife became established in Lake Ontario in the late 1800's after the opening of the Erie Canal system (Smith, C.L., 1985). Rainbow Smelt were first reported in Lake Ontario in 1929, and supposedly moved from the upstream Finger Lakes, where they were introduced (Greely 1939, Nellbring 1989, Rooney and Patterson 2009). Alewife and Rainbow Smelt populations proliferated in the mid-1900s and have dominated the Lake Ontario fish community during the modern period of observation (1978-present). In contrast, native Cisco catches declined to low levels and Bloater were exceptionally rare (Owens et al., 2003).

Survey designs and sampling gear for pelagic prey fish assessment have changed over time in response to management information needs and ecosystem changes. From 1978-2014, assessments were based on two collaborative NYSDEC and USGS bottom trawl surveys, conducted in US waters. One survey, conducted in late April, targeted Alewife, while a different survey in May and June targeted Rainbow Smelt. Both used the same sampling gear and covered many of the same habitats. Comparing data from the two surveys suggested Rainbow Smelt trends were similar and concluded that one survey, in late April, could index both species while freeing resources to expand the survey's spatial extent (Weidel et al., 2015). Concerns over spatial differences in Alewife distribution resulted in the April survey being expanded to a whole-lake perspective, including Canadian waters. In 2016, the OMNRF *RV Ontario Explorer* joined the survey and sampled new lake areas in northern and eastern Lake Ontario, while the USGS *RV Kaho* sampled new habitats around Hamilton Harbor and Toronto. Finally, the proliferation of dreissenid mussels in the mid 1990's forced the survey to employ a different bottom trawl design that minimized mussel catches but strained a higher volume of water. Comparison tows between the old and new style trawls were used to create a correction factor which has been applied to trawl catches from certain depths (> 92m) since 1997 to match the historic catches.

This annual publication reports on the community and population dynamics of the Lake Ontario pelagic prey fishes, based on bottom trawl surveys. We emphasis information that supports the Lake Ontario Committee's Fish Community Objectives, specifically number 2.3 that seeks to: "*Increase prey fish diversity – maintain and restore a diverse prey fish community that includes Alewife, Lake Cisco, Rainbow Smelt, Emerald Shiner, and Threespine Stickleback*". In addition, we illustrate how different analyses and assumptions

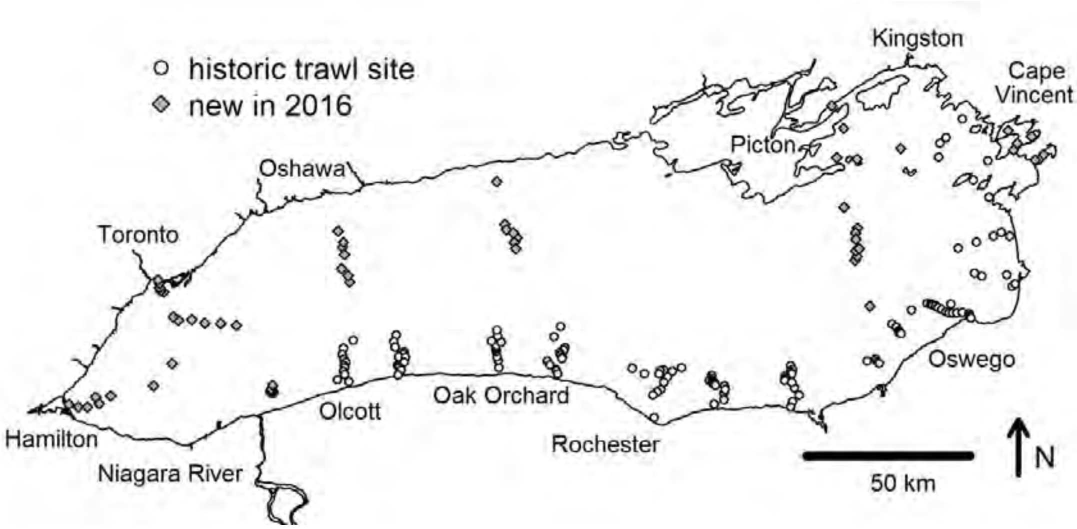


***Figure 1. Lake Ontario sampling sites (N=188) from the early-spring bottom trawl survey collaboratively conducted by USGS, NYSDEC, and OMNRF. Historic sites are noted as circles while new sites added in 2016 are noted as gray diamonds.***

about bottom trawl data influence our interpretation of prey fish population dynamics. For instance, Lake Ontario's water clarity has drastically increased since the early 1990's (Binding et al., 2007; Holeck et al., 2016) and early-spring prey fish distributions have moved deeper (O'Gorman et al., 2000). The combination of shifting depth distributions, and a trawl-change adjustment factor, that was applied only to deep catches, has influenced interpretations of Lake Ontario Alewife dynamics.

## Methods

The bottom trawl survey is conducted in late-April and early-May and uses fixed sites extending from shallow (6m; 20ft) to deep water (225m; 738ft), on transects distributed around the lake (Figure 1). Although random sampling is preferable for estimating population abundance, random trawl sampling is not practical in Lake Ontario because of varied bottom substrates that tear bottom trawls (MacNeill et al., 2005). As noted in MacNeill et al. (2005), a team of international experts in fish sampling reviewed the Lake Ontario trawl program and found the fixed-station sampling design generated a suitable estimate of relative abundance (ICES, 2004; MacNeill et al., 2005). In the Great Lakes, Alewife seek out the warmest waters during winter and are most abundant near the lake bottom (Bergstedt and O'Gorman, 1989; Wells, 1968). The early-spring timing of the survey is important because a substantial proportion of the Alewife are still associated with the lake bottom where bottom trawls are most effective.

The original survey bottom trawl was a nylon Yankee bottom trawl with an 11.8-m (39 ft) headrope and flat, rectangular, wooden trawl doors (2.12m x 0.95m). Overly abundant catches of dreissenid mussels in the 1990's ultimately led to changing to a polypropylene 3N1 bottom trawl in 1997. The 3N1 trawl had an 18-m (59 ft) headrope and was spread with slotted, metal, cambered V-doors. Paired tows, collected in 1995-1998, were used to calibrate catches between the two gears. An adjustment factor was derived to annually adjust the 3N1 or current trawl catches of Alewife to Yankee-trawl

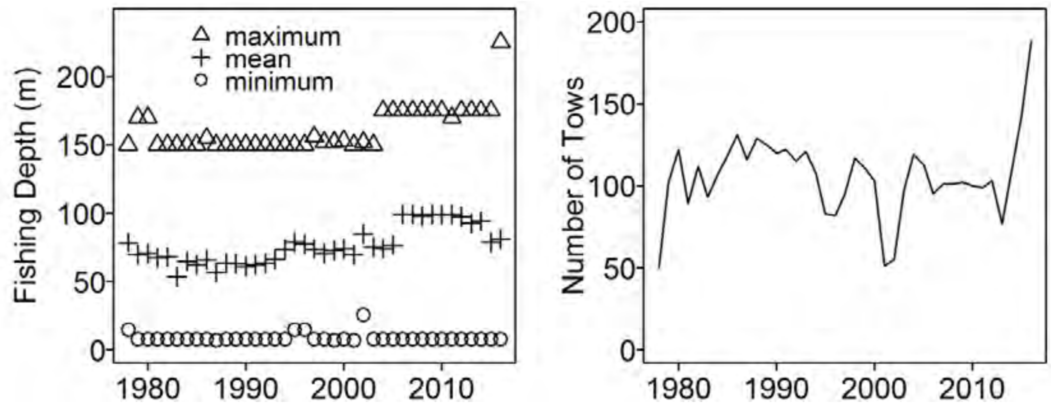


***Figure 2 Survey statistics for the April bottom trawl survey including the depth ranges sampled (left panel) and the number of tows (right panel) in Lake Ontario, 1978-2016.***

equivalents. That adjustment was applied to Alewife catches in waters greater than 92 meters (302 ft) and reduced the number caught in those tows by 72%. At the time an adjustment for shallower Alewife catches or other species was not deemed necessary (O'Gorman et al., 2005).

For most of the survey's history the depths sampled ranged from 8 to 150 meters (26 to 492 ft) with 100-150 trawls per year (Figure 2). More recently, both the maximum depth sampled and the number of trawls have increased (Figure 2). In addition to providing a more accurate pelagic prey fishes assessment, the increased spatial coverage and additional shallow and deep samples allow this survey to contribute observations to the Lake Ontario Fish Community Objectives focused on native and nearshore prey fishes (Stewart et al., 2013). Additional details regarding the survey changes through time are available in Walsh et al. (2016).

Bottom trawl catches are separated to species, counted, weighed in aggregate, and total length (mm) is measured on a random sample of 20-80 individuals. At each transect, a subsample of Alewife and Rainbow Smelt were measured for individual length and weight, and stomachs, muscle tissue, and aging structures (whole otoliths for Alewife, fin rays for Rainbow Smelt) were removed for age determination and archival storage. To index Alewife adult condition, length-weight regressions collected in both the spring and fall are used to estimate the average wet weight of a 165-mm Alewife.

Bottom trawls abundance or weight indices for all species reported were based on the mean catch per 10 minute bottom trawl. Mean stratified catch was area-weighted (Table 1) with 20 meter (66 ft) stratification depth intervals for waters in the U.S. Mean and standard error calculations were from Cochrane (1977). From 1978-2003 the stratification depths involved were from 0 – 160m (0 to 525 ft) , but from 2004-2015 depths were from 0-180m (0 to 591 ft) due to an increase in Alewife and other prey fish depth distributions (O'Gorman et al., 2000) (Table 1). Statistics reported for trawl catches in Canadian waters followed a similar analysis, however the area within 20m (66 ft) strata in Canada differed from U.S. waters (Table 1).

Statistics for the pelagic fish community composition and diversity were based on the five species mentioned in the Fish Community Objectives (Stewart et al., 2013). The Shannon index was used to describe pelagic community diversity based on the combined trawl catch (Shannon and Weaver, 1949).

***Table 1. The percent of 20m depth strata within the 0 -180m region, in both U.S. and Canadian portions of Lake Ontario.***

| Depth Strata | Strata Percentage U.S. | Strata Percentage Canada |
|---|---|---|
| 0-19 | 15% | 18% |
| 20-39 | 12% | 16% |
| 40-59 | 9% | 13% |
| 60-79 | 7% | 14% |
| 80-99 | 6% | 12% |
| 100-119 | 7% | 13% |
| 120-139 | 10% | 10% |
| 140-159 | 14% | 4% |
| 160-179 | 21% | 0% |

## Results and Discussion

*Lake-wide Sampling* - In 2016, 142 bottom trawls were collected in U.S. waters and 46 trawls in Canadian waters as part of the Lake Ontario pelagic prey fish survey. The 188 trawls represents a substantial increase in effort from historic methods and the depth range sampled (6 – 225m) increased relative to historic surveys (Figure 2). The 2016 depth distribution of tows across depths more closely matches the distribution of depths available in the lake, however the shallowest and deepest lake depths are not being sampled in proportion to their area (Figure 3). Expanding the survey into Canadian waters and sampling in proportion to lake depths were recommendations made by MacNeill et al. (2005) in their review of the Lake Ontario pelagic prey fish bottom trawl survey.

*Community and Diversity*- Twenty-four different species were captured in the 2016 spring bottom trawl and 420,386 individual fish were caught. Alewife continue to dominate the catches of all fishes caught during the pelagic prey fish surveys (Figure 4). The dominance of Alewife in the community resulted in a low diversity index value (Figure 5). That index value quantifies the evenness of species abundance within the community. It has generally declined since the survey began as the proportion of Rainbow Smelt in the catch has declined and Alewife have increasingly dominated the pelagic fish community. ] (Figure 4). The increasing

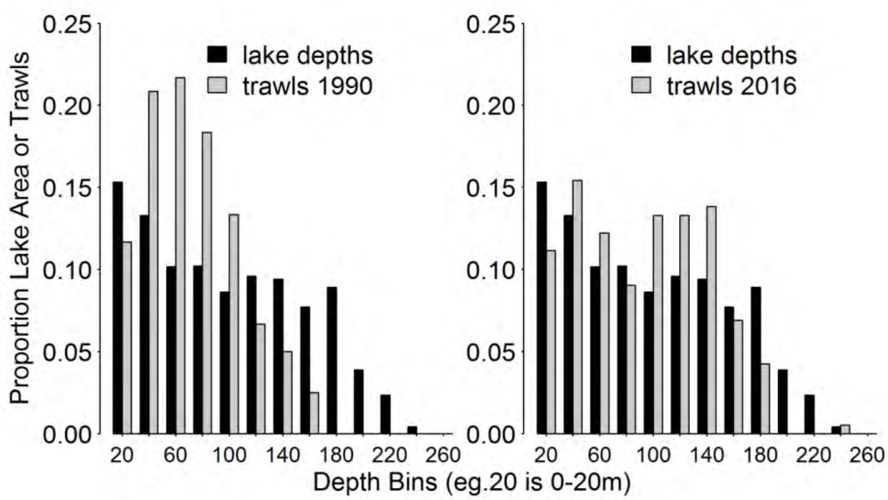


***Figure 3. Distribution of trawls by 20m depth bin for Lake Ontario pelagic prey fish bottom trawl survey for two years. Left panel shows the distribution of tows in 1990 (N=120) relative to the distribution of depths in the lake whereas the right panel show the distribution of tows in 2016 (N=182)***

proportional importance of Alewife over Rainbow Smelt may be related to predation on Age-0 Rainbow Smelt as their spatial distribution overlaps with adult Rainbow Smelt in the spring and adult Alewife during the summer (Simonin et al., 2016).

*Rainbow Smelt* -The abundance index for Rainbow Smelt in US waters increased slightly in 2016 relative to 2015 and was 11% higher than the previous five year average (Figure 6). Interestingly, the abundance index in Canadian waters was 35% higher than the index from trawls in U.S. waters. This suggests there may be important spatial differences in Lake Ontario Rainbow Smelt abundance in April when trawling is conducted (Figure 6). Rainbow Smelt length distributions illustrated a large catch, relative to previous years, of Age-1 Rainbow Smelt (less than 95 mm) in 2016. (Figure 7). This indicates a moderate to high year class was produced in 2015 and the Rainbow Smelt index may increase in the near future.

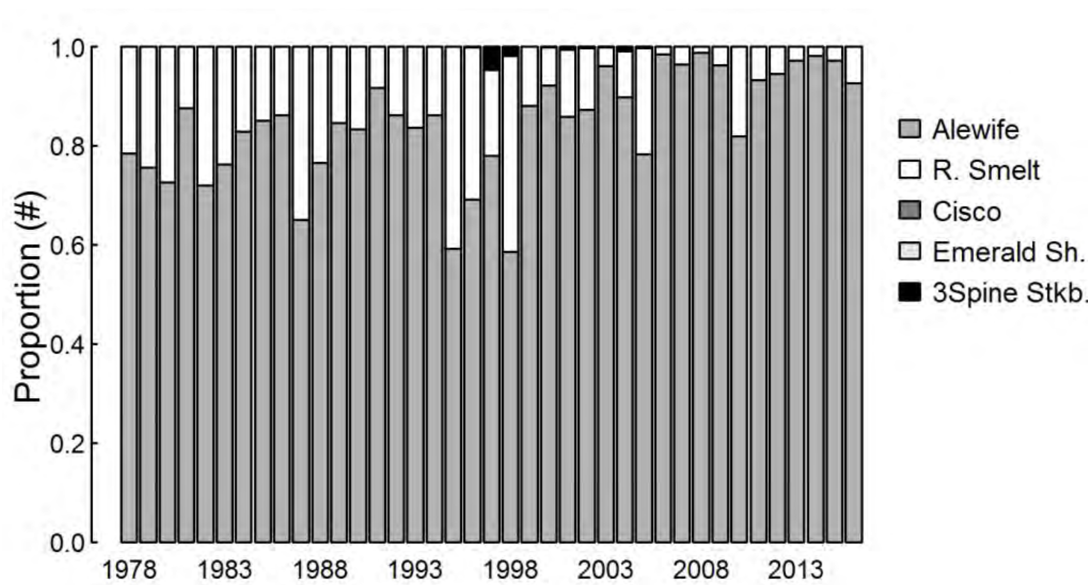


***Figure 4. Lake Ontario bottom trawl catch composition (by number) of the five pelagic prey fish mentioned in the Lake Ontario fish community objectives (Stewart et al., 2013), 1978-2016. Values from 1978-1996 were based surveys using the 11.8m Yankee trawl while values from 1997-2016 are based on the 3N1 trawl. Values for 2016 represent whole-lake sampling while the values from 1997-2015 represent US waters only.***

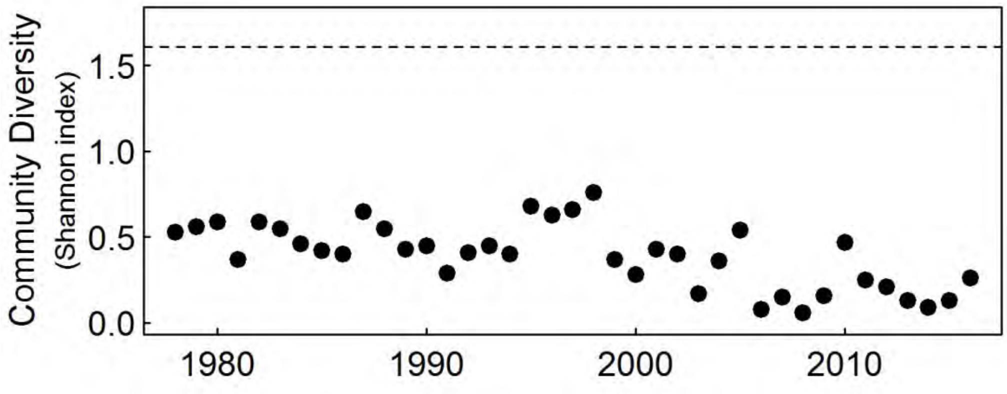


***Figure 5. Pelagic prey fish diversity based on April bottom trawl catches in Lake Ontario 1978-2016. Diversity is measured using the Shannon index (Shannon and Weaver, 1949) based on catches of the five pelagic prey fishes mentioned in the Lake Ontario Fish Community Objectives (Stewart et al., 2013). The dashed line at 1.7 represents the maximum diversity index value if five species made up equal proportions of the catch. Values from 1978-1996 and 1997-2016 are based on different trawls. Values for 2016 represent whole-lake sampling while the values from 1997-2015 represent US waters only.***

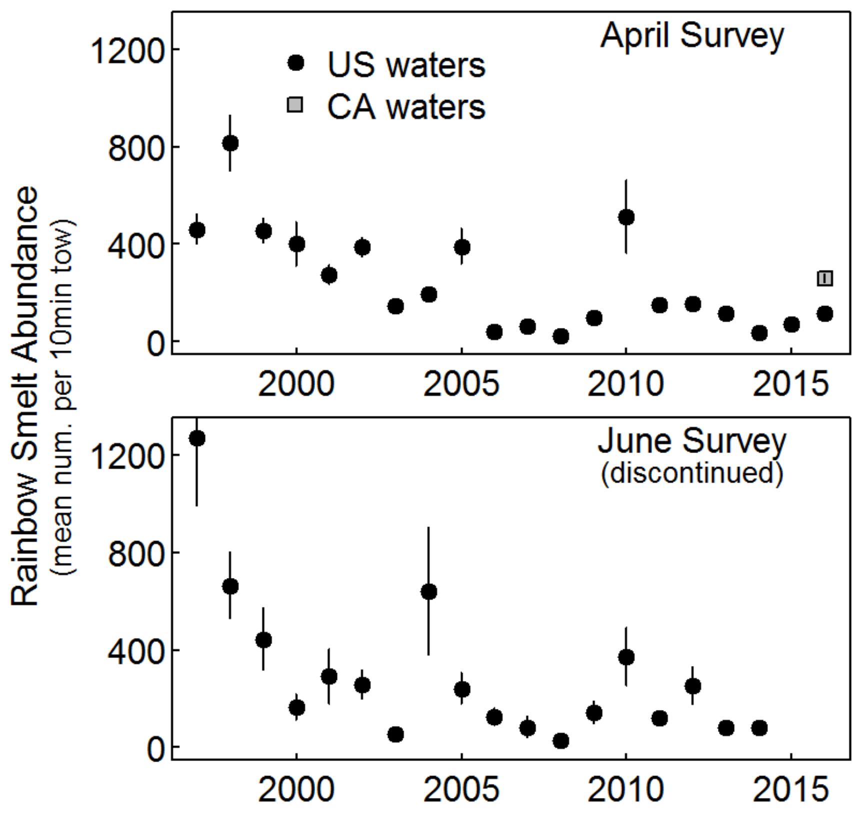


***Figure 6. Rainbow Smelt abundance index based on April and June bottom trawl surveys in U.S. (1978-2016) and Canadian waters (2016) of Lake Ontario. Error bars represent one standard error.***

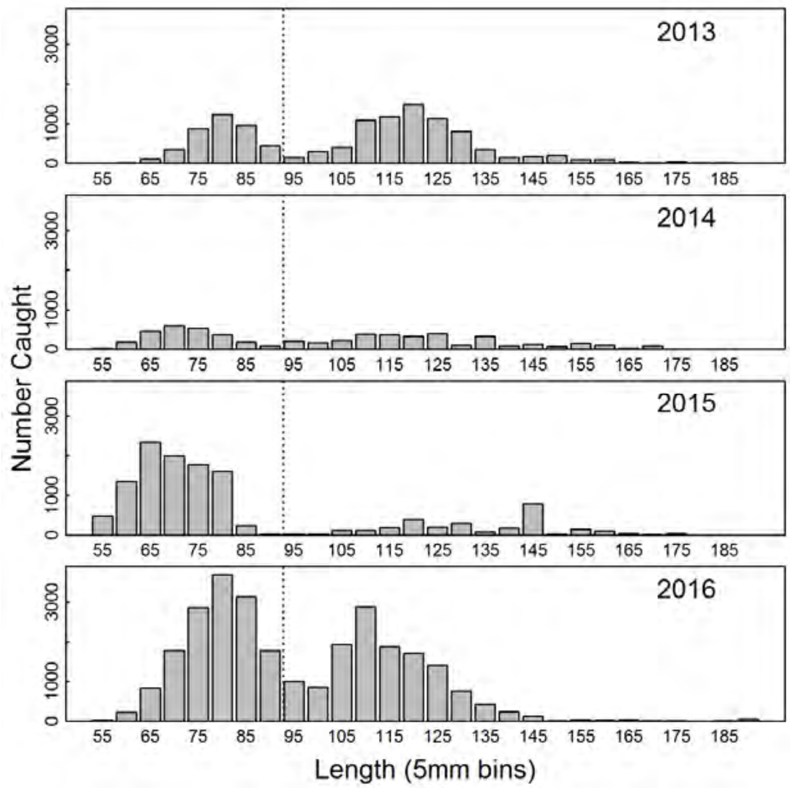


***Figure 7. Rainbow Smelt length distributions from April bottom trawls in U.S. waters of Lake Ontario, 2013-2016. The dashed vertical line represents the upper size range for Age1 Rainbow Smelt***

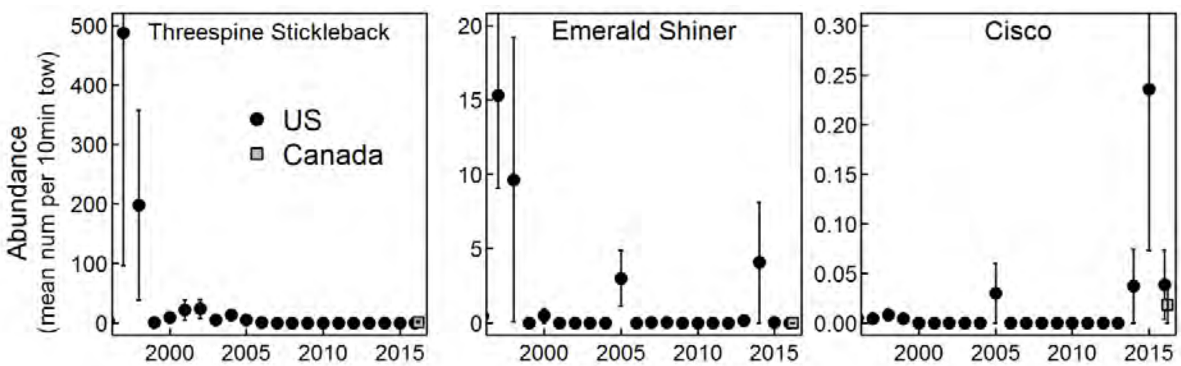


***Figure 8. Abundance indices for other Lake Ontario pelagic prey fishes based on bottom trawls in U.S. and Canadian waters, 1997-2016. Error bars represent one standard error.***

*Other Pelagic Fishes* – Abundances of Threespine Stickleback and Emerald Shiners in both U.S. and Canadian waters were low in 2016 relative to the late1990s (Figure 8). In contrast, Cisco abundance indices suggest a recent increase in the their abundance, however day time bottom trawls have been shown to underestimate Cicsco abundance relative to night trawling and other methods (Stockwell et al., 2006).

*Alewife* - Since the early 1990s, Lake Ontario water clarity has increased and early-spring bottom trawl catches of Alewife are deeper (Binding et al., 2007; O'Gorman et al., 2000). When the trawl change was made in 1997 and the adjustment factor between the two trawls was developed, a small proportion of the adult Alewife catch occurred deeper than 92m (302 ft), the depth where the adjustment factor began. However, the percentage of the catch deeper than the 92m (302 ft) threshold has increased over time causing the adjustment factor to have a greater effect of reducing catches (Figure 9). In 2017, it was decided to stop reporting the entire Alewife abundance time series because there were 20 years of data with the new trawl. Because the reported index does not include the older portion of the time series (1978-1996) there is no need to adjust values for different trawls. On average, the unadjusted value from the 1997-2016 for the adult Alewife abundance index was approximately double the value that was adjusted to the historic trawl (Figure 10). Similarly, removing the adjustment factor has changed the Age-1 Alewife abundance index relative to the previously adjusted version (Figure 11). It is important to recognize these changes in the time series should not be interpreted as an increase in Alewife abundance, but rather a change in how the abundance index is reported.

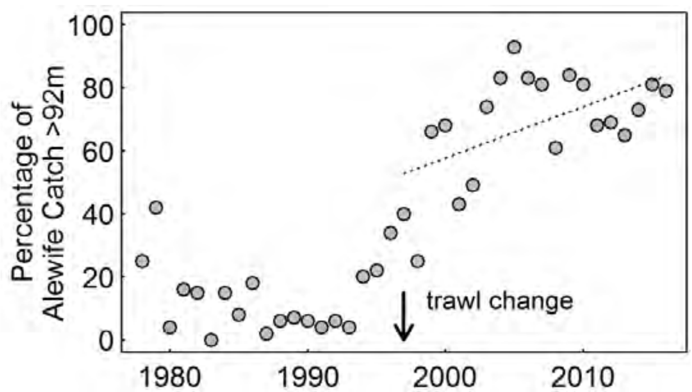


***Figure 9. Proportion of the Lake Ontario bottom trawl Alewife catch that is deeper than 92m, 1978-2016.***

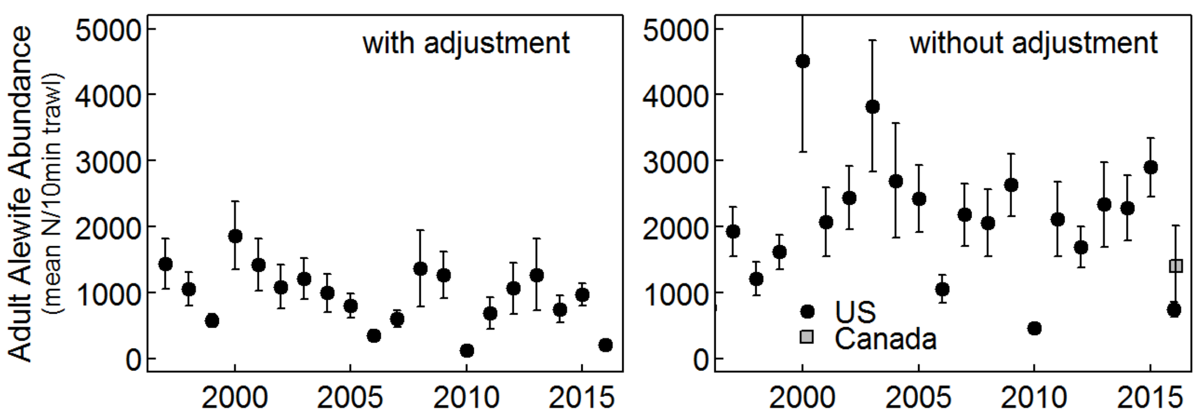


***Figure 10. Adult (Age -2 and older) Alewife abundance index based on the April bottom trawl survey from U.S. (1978-2016) and Canadian (2016) waters of Lake Ontario. The left panel represents the time series including the adjustment factor that adjusts current trawl catches to the historic trawl, while the right panel represents those same catches without the adjustment factor. Points represent area-weighted mean numbers caught per 10 minute tow and error bars represent 1 standard error.***

The adult Alewife abundance index in 2016 was the second lowest ever recorded in 20 years (Figure 10). This value was expected to decline from 2015, because the 2014 Age-1 Alewife index was low and the 2015 Age-1 index was the lowest ever observed (Figure 11). The high condition index of adult Alewife in 2016 is also consistent with a decrease in adult abundance. Adult Alewife condition, measured in the fall of 2016, increased from 2015 and was substantially above the 38-year survey mean (1978-2015 mean=32.8g, 2016=36.6 g) (Figure 12). When Alewife densities decline, the reduced competition among Alewife for zooplankton resources results in higher condition (O'Gorman and Schneider, 1986; Rand et al., 1994). The increase in the Age-1 index in 2016 relative to 2014-2015 suggests the lake conditions were favorable for Age-1 survival and growth during the summer of 2015 and the 2015-2016 winter.

Interestingly, the catch of adult and Age-1 Alewife was higher in trawls conducted in Canadian waters relative to U. S. waters (Figures 10 and 11). It is important to recognize that the total number of trawls conducted in Canadian waters was substantially lower (N=46) than was conducted in U.S. waters (N=142) and the Canadian mean catch was strongly influenced by one large catch. That catch, from 90m of water off of Toronto, included over 42,000 adult Alewife and was one of the heaviest catches of adult Alewife ever recorded in Lake Ontario. Similar to higher catches of Rainbow Smelt in Canadian waters, these higher Alewife values in northern Lake Ontario habitats suggests there are substantial spatial differences in lake wide Alewife distribution in April when trawling is conducted. Future survey effort should to continue to sample at this whole-lake scale to understand the year-year variability in spatial distribution as well as factors that influence those distributions.

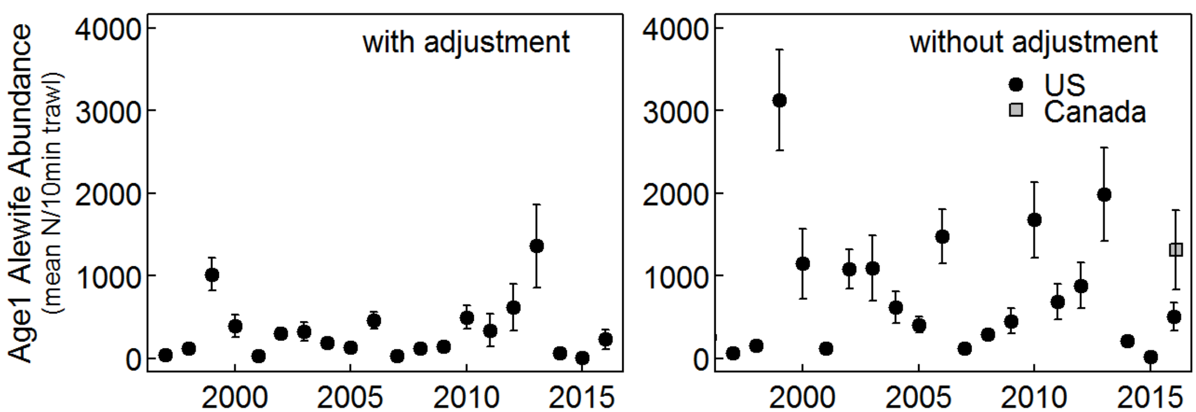


***Figure 11. Age -1 Alewife abundance index based on the April bottom trawl survey from U.S. (1978-2016) and Canadian (2016) waters of Lake Ontario. The left panel represents the time series including the adjustment factor that adjusts current trawl catches to the historic trawl, while the right panel represents those same catches without the adjustment factor. Points represent area-weighted mean numbers caught per 10 minute tow and error bars represent 1 standard error.***

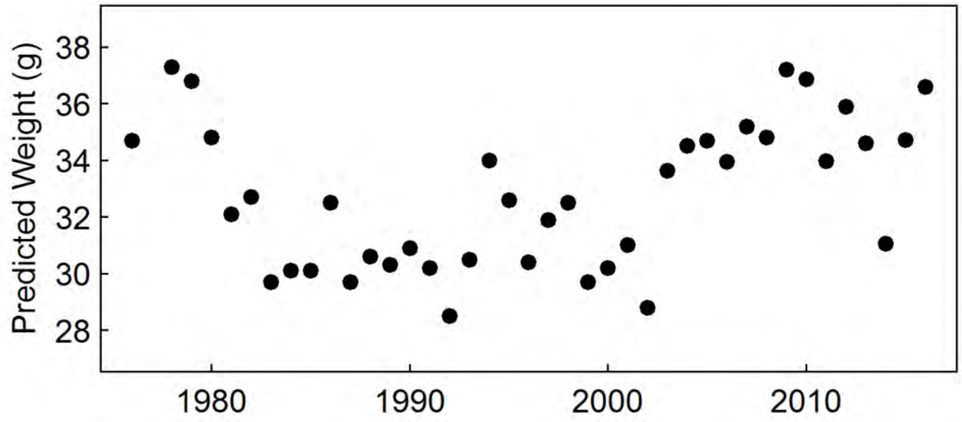


***Figure 12. Alewife condition based on the predicted weight of a 165mm Lake Ontario Alewife captured in October, 1978-2016. Length and weight data, used to predict weight, are collected annually in the fall-conducted benthic prey fish survey.***


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during research are carried out in accordance with guidelines for the care and use of fishes by the American Fisheries Society (http://fisheries.org/docs/ wp/Guidelines-for-Use-of-Fishes.pdf). Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.


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# Lake Ontario Benthic Prey Fish Assessment, 2016

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## Abstract

*Benthic prey fishes are a critical component of the Lake Ontario food web, serving as energy vectors from benthic invertebrates to native and introduced piscivores. Beginning in 1978, Lake Ontario benthic prey fishes were assessed using bottom trawls collected from the lake's south shore (depth range: 8 – 150 m;26 – 492 ft). Historically, the survey targeted the then dominant species, Slimy Sculpin, however in 2015, the Benthic Prey Fish Survey was cooperatively expanded to a whole-lake survey, to address resource management information needs related to Round Goby, Deepwater Sculpin, and nearshore native fishes. In 2016, 142 trawls were collected at 18 transects, and spanned depths from 6 – 225 m (20 – 738 ft). Trawl catches indicated the benthic and demersal prey fish community was dominated by Round Goby, however the proportional importance of native Deepwater Sculpin is increasing. Species-specific assessments found lake-wide Round Goby density (~600 fish per hectare) was slightly lower in 2016 relative to 2015. Deepwater Sculpin density has generally increased since 2004. In 2016 their estimated density was greater than 100 fish per hectare. Slimy Sculpin density (15 fish/ha) was similar to the past 3 years. Catches of juvenile Slimy Sculpin continue to be low relative to historic catches and the timing of their decline coincides with the proliferation of Round Goby. Additionally, we found a strong negative relationship between trawl catches of Round Goby and nearshore native benthic and demersal fishes such as Trout-perch, Johnny Darter and Spottail Shiner. The introduction of Round Goby and the reappearance of native Deepwater Sculpin have shaped the Lake Ontario benthic prey fish community.*

## Introduction

Benthic prey fish community dynamics and the role of benthic fishes in the Lake Ontario food web has changed dramatically over the past five decades. The modern period of observation for the lake's benthic prey fishes began in 1978, when native Slimy Sculpin dominated the community. At that time, Deepwater Sculpin and deepwater coregonines such as Bloater were considered extremely rare or extirpated. Since then Slimy Sculpin underwent two periods of decline, first, when their preferred food, the amphipod *Diporeia* sp. disappeared in the 1990s (Owens and Dittman, 2003) and again as the nonnative Round Goby increased in the early 2000s (Weidel and Walsh, 2015).

Round Goby, a suspected ballast water introduction, were first detected in the Great Lakes in 1990 (Jude et al., 1992) and were first reported in southwestern Lake Ontario in 1998 near the entrance to the Welland Canal (Owens et al., 2003). Since their introduction, Round Goby have become the most common species in the Lake Ontario benthic prey fish community while catches of nearshore native benthic prey fishes have declined (Weidel et al., 2016). Historically, Slimy Sculpin were an important diet item for native juvenile Lake Trout (Elrod and O'Gorman, 1991), but since their abundance has declined, Round Goby have become the most important benthic prey fish for Lake Ontario Lake Trout (Elrod and O'Gorman, 1991; Rush et al., 2012). Finally, Deepwater Sculpin, a native species of elevated conservation concern in both the U.S. and Canada, have undergone a dramatic population recovery since the mid-2000s (Weidel et al., 2017).

The United States Geological Survey (USGS) Benthic Prey Fish Bottom Trawl Survey, funded through USGS Ecosystems mission area, Fisheries program, has been a critical long-term data series illustrating changes in the Lake Ontario benthic prey fish community. The original survey was designed to assess the Slimy Sculpin population where sampling focused on the southern shoreline of the lake, however, as the ecosystem changed so did the information needs of resource management agencies. In 2015, the single-species-focused and spatially-restricted survey was collaboratively expanded to include the NYSDEC and OMNRF research teams to better address lake-wide information needs, especially those related to Deepwater Sculpin, Round Goby, and nearshore native prey fishes (Weidel et al., 2016). The survey changes expanded spatial coverage while also distributing trawling effort into both shallower and deeper waters to more completely sample the available lake depths (Weidel et al., 2016). This survey is the primary data source to assess the bi-national Lake Ontario Committee's Fish Community Objectives as well as cross-basin assessments like the State of Lakes Ecosystem Conference (SOLEC).

This annual publication reports on the community and population dynamics of the Lake Ontario benthic prey fishes with emphasis on information that supports the bi-national Lake Ontario Committee's Fish Community Objectives, specifically number 3.3 that seeks to:

"*Increase prey fish diversity – maintain and restore a diverse prey fish community that includes deepwater ciscoes, Slimy Sculpin, and Deepwater Sculpin.*"

The specific survey objectives vary slightly by agency but generally follow those of the USGS Great Lakes Science Center study plan (BASIS+ ND00GAP7) for benthic prey fishes which are to:

(1) improve our understanding of native and invasive Lake Ontario benthic prey fish population dynamics and ecology using enhanced partnerships and interdisciplinary approaches and;

(2) maintain, develop, and utilize time series, predictive models and assessment tools, using both local and regional data, to quantify anthropogenic impacts on benthic prey fishes and support resource management decision making.

**Methods**

*Sampling* – From 1978-2011, the Lake Ontario Benthic Prey Fish Survey design sampled six transects along the southern shore of Lake Ontario from Olcott, NY to Oswego, NY. Daytime trawls were typically 10 minutes and sample depths from 8 – 150 m. The original survey gear was a Yankee bottom trawl, constructed of nylon, with an 11.8 m (38.7 ft) headrope, and spread with rectangular wooden trawl doors (2.12m x 0.95m) (7 x 3.1 ft). Abundant dreissenid mussel catches led to a variety of alternate polypropylene bottom trawls and metal trawl doors being used from 2004 - 2010. Comparison towing indicated alternate trawls had low and variable catchability for benthic fishes and the alternative trawl doors influenced net morphometry (Weidel and Walsh, 2013). Since 2011, the survey has used the historical standard Yankee trawl and reduced tow times to reduce mussel catches. Experimental sampling at new transects and/or deeper habitats (maximum tow depth = 220 m, 2014) began in 2012. The catch composition from these new habitats differed from historic collection sites, reinforcing the need for a more spatially-distributed survey (Weidel and Walsh, 2015). In addition to the fall survey indices for some species, this report also used observations from the Spring Bottom Trawl Survey (eg. Round Goby, Bloater). That survey focuses on sampling Alewife and Rainbow Smelt and switched sampling gear in 1997 to a “3N1” bottom trawl that is less effective for capturing benthic fishes as it was designed to avoid capturing dreissenids mussels. Additional details on that survey can be found in the Alewife section of this report.

*Analysis* - Species assessment methods have also changed to accommodate varied sample designs and take advantage of new trawl morphometry information. Originally, benthic prey fish species-specific abundance indices were based on area-weighted means from two strata: a shallow stratum from 8 - 55 m (461 $km^2$) (26 - 180 ft; 286 $mi^2$) and a deep stratum from 60 - 160 m (670 $km^2$) (197 - 525 ft; 416 $mi^2$). Population dynamics were reported using abundance or weight indices since estimates of the area swept by trawls were unavailable or unreliable. Advances in our understanding of trawl morphometry, especially with respect to fishing depth, have allowed us to report current and historical catch data in density (eg. number per hectare) or biomass density (eg. grams per hectare; Weidel and Walsh 2013). Reporting in these units provides data in a more readily useable form to address ecosystem scale questions and make species and community comparisons across lakes. Time series are still regarded as density indices since we lack estimates of trawl catchability. Catchability is the proportion of fish caught by the trawl that are actually present. Evidence from a similar Lake Erie trawling program suggest that this proportion can be significantly less than one (Kocovsky and Stapanian, 2011), therefore our density indices represent a lower bound on the true density.

Lake wide estimates for density or biomass density are currently based on nonlinear generalized additive models that predict density and biomass density based on fishing depth. These models are fit using the ‘mgcv’ package in R (Wood, 2011) and scaled to whole-lake estimates by weighting the model-derived average density at a depth by the proportion of that depth relative to the whole lake area. It is important to recognize that results are based on lake areas that can be sampled with a bottom trawl. Lake habitats where the bottom type is primarily rock, such as the northern shore depths from 0 – 70m (0 – 230 ft) are not included in any results (Thomas et al., 1972).

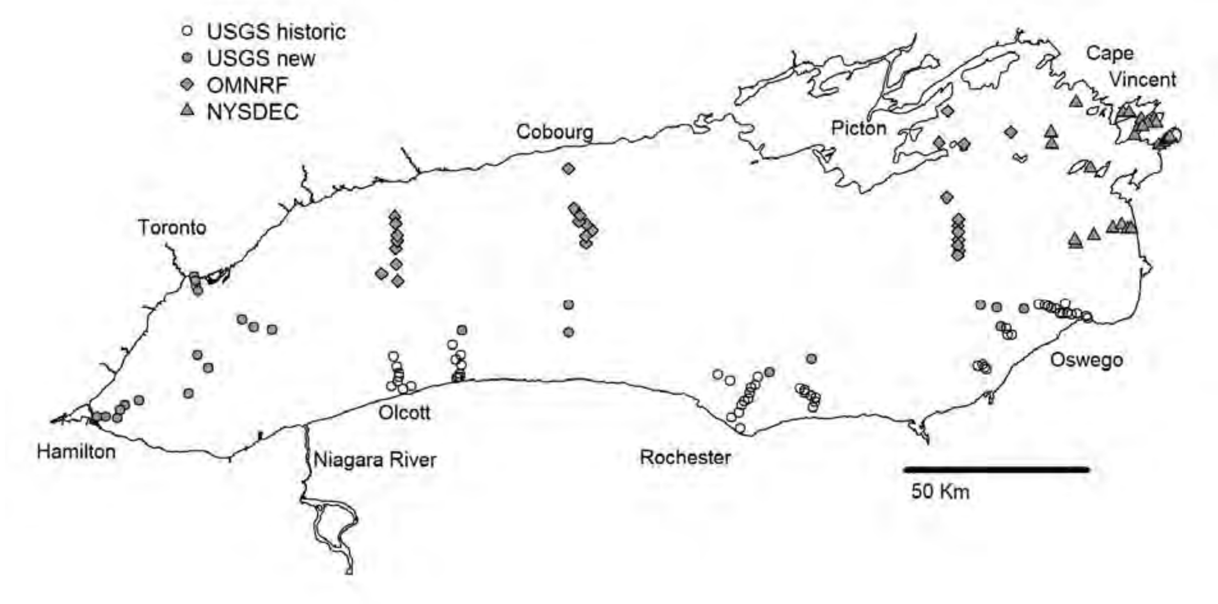


***Figure 1. Bottom trawl sites sampled in the 2016 Lake Ontario Benthic Prey Fish Survey. The original sites are noted by open symbols and new sites are shaded gray, with the symbol shape referring to the sampling research vessel.***

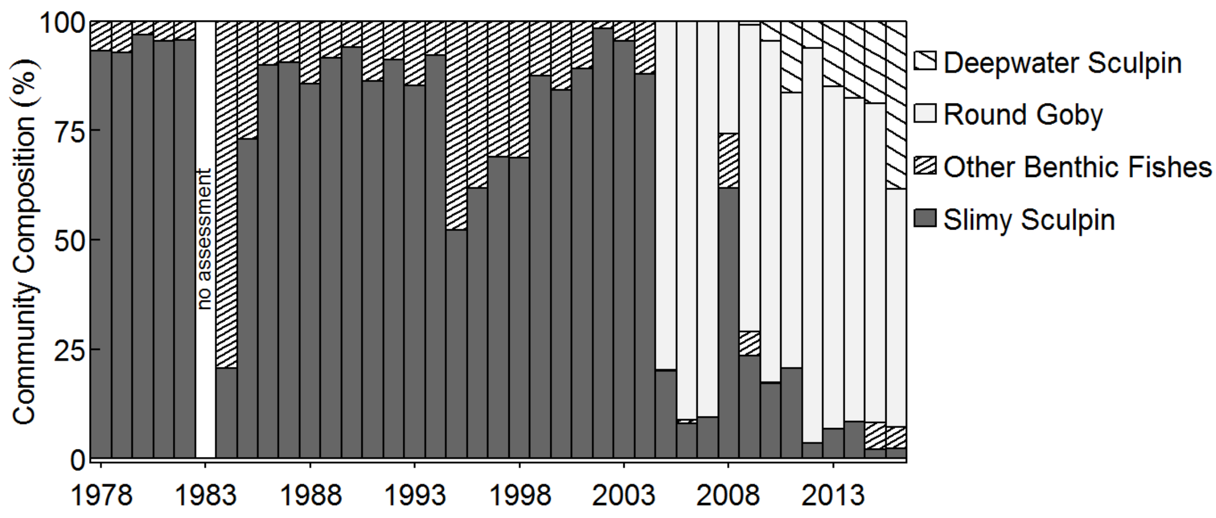


***Figure 2. Lake Ontario benthic prey fish community composition, by biomass density from fall bottom trawl surveys 1978-2016. The 'Other Benthic Fishes' is primarily composed of Trout-perch, Johnny Darter, and Spottail Shiner. Note: data prior to 2015 are based on Lake Ontario south shore sites only, while data from 2015 are based on a whole-lake survey.***

## Results and Discussion

*Current Year Statistics* - In 2016, over 111,000 fish were captured in the 142 trawls at 18 different sites (Figure 1). Special catches included a total of 9,510 Deepwater Sculpin that were captured in 57 of the 142 trawls. A single trawl off of Cobourg, in 160 m (525 ft) of water, captured over 1,000 individual Deepwater Sculpin. In contrast, over the previous 10 years the total combined catch of all Deepwater Sculpin on all boats and all trawls was 4,556 fish. Additionally, four Quillback were caught at 8m (26 ft) in Chaumont Bay. This was only the second instance of that species caught on this survey, with the previous catch occurring in 1997, from 16m (52 ft), in the Black River Bay. Despite continued stocking efforts, no Bloater were captured in Lake Ontario in any prey fish trawls in 2016.

*Benthic Prey Fish Community*- At a whole-lake scale, the Lake Ontario benthic and demersal prey community continues to be dominated by Round Goby, however the proportion of Deepwater Sculpin in the community has steadily climbed since 2009 (Figure 2). From 1978-2014, when the survey focused on the lake's south shore, the survey captured on average 14.5 species per year (minimum =9, maximum =19). Since expanding the survey to the whole lake the survey has captured 28 species in 2015 and 34 different species in 2016.

| Species | # Caught | Species | # Caught | Species | # Caught |
|---|---|---|---|---|---|
| Alewife | 59596 | White sucker | 109 | Logperch | 3 |
| Round goby | 31635 | Emerald shiner | 66 | Smallmouth bass | 3 |
| Deepwater sculpin | 9510 | Pumpkinseed | 32 | Lake whitefish | 2 |
| Yellow perch | 3561 | White bass | 31 | Northern pike | 2 |
| Rainbow smelt | 2870 | Lake trout | 30 | Bluntnose minnow | 1 |
| Slimy sculpin | 1321 | Johnny darter | 24 | Brown trout | 1 |
| Trout-perch | 830 | Largemouth bass | 13 | Channel catfish | 1 |
| Spottail shiner | 665 | Brook stickleback | 12 | Chinook salmon | 1 |
| White perch | 378 | Carp | 12 | Sea lamprey | 1 |
| Brown bullhead | 153 | Walleye | 9 | Dreissena spp. | 8.3 (tons) |
| Gizzard shad | 150 | Threespine stickleback | 7 | | |
| Freshwater drum | 111 | Quillback | 4 | | |

**Table 1. Fish species and total number caught during the Lake Ontario 2016 Benthic Prey Fish Survey. Note, dreissenid mussel data is total weight in tons.**

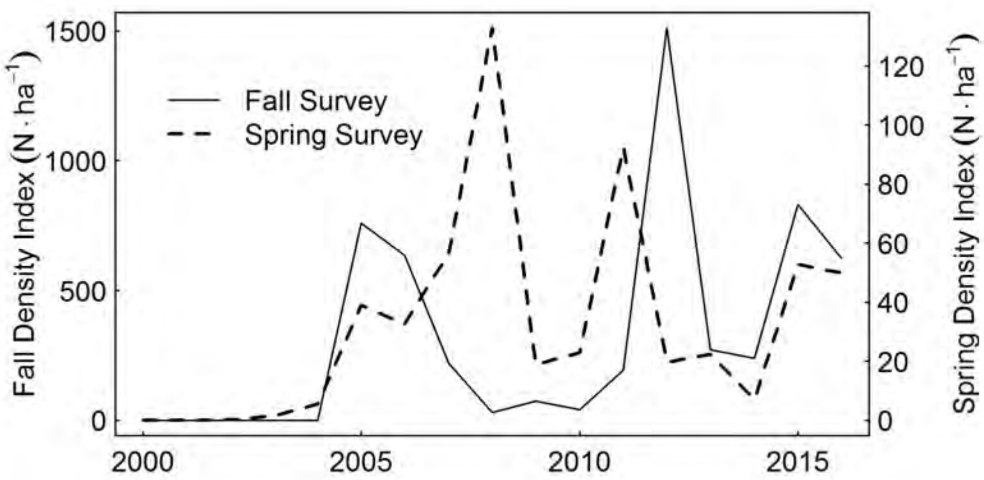


***Figure 3. Lake Ontario Round Goby density indices as number per hectare (N·ha$^{-1}$) from the fall (left y-axis and solid line) and the spring bottom trawl survey (right y-axis and dashed line), 2000-2016. The order of magnitude difference between the fall and spring survey estimates is partly a result of different trawls employed on each survey. The trawl used during the spring survey is specifically designed to avoid catching driessenid mussels and likely has a lower catchability for benthic fishes relative to the Yankee trawl used in the fall. Density values are presented as an index because they have not been corrected for trawl catchability. Data prior to 2015 are based on Lake Ontario south shore transects only, while data from 2015 are based on a whole-lake survey.***

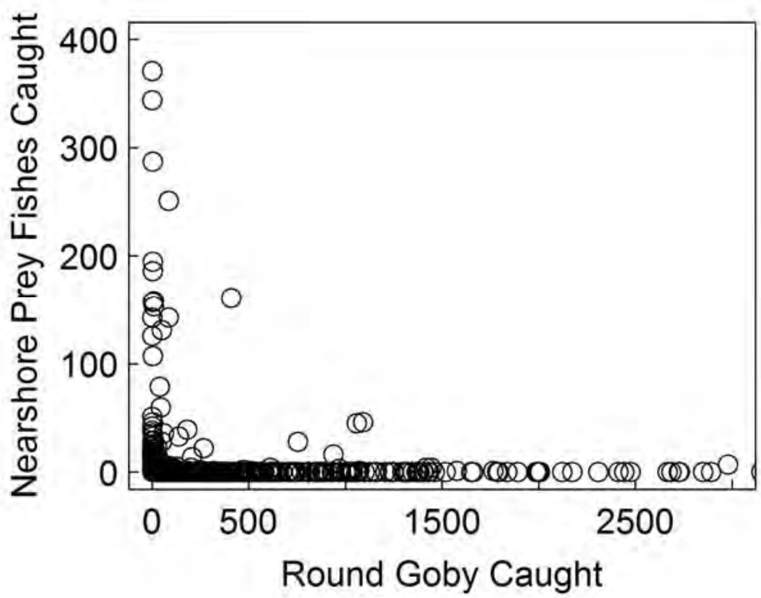


***Figure 4. Lake Ontario bottom trawl catches suggest a strong negative relationship between non-native Round Goby (x-axis) and nearshore native benthic and demersal fishes (y-axis) including Trout-perch, Johnny Darter, and Spottail Shiner. Data prior to 2015 are based on Lake Ontario south shore transects only, while data from 2015 are based on a whole-lake survey.***

*Round Goby*- Round goby abundance was similar or slightly lower in both the spring and fall bottom trawl surveys relative to 2015, however both 2016 estimates are within the range previously observed in the time series (Figure 3). Lake Ontario Round Goby biomass density has ranged from 1.0 – 7.0 kg·ha$^{-1}$ over the past five years, and was greater than values reported for Lake Michigan (0.5 - 3.0 kg·ha$^{-1}$; Bunnell et al., 2015) and Lake Huron (0.2 – 0.6 kg·ha$^{-1}$(Bunnell et al., 2015; Roseman et al., 2015). Lake-wide biomass densities in Lake Ontario may also be similar or higher than those reported for Lake Erie where biomass density in the early 2000s ranged from 0.07 - 1.8 kg·ha$^{-1}$(Johnson et al., 2005). Lake Ontario bottom trawl catches suggest a strong negative relationship between catches of non-native Round Goby and the catches of nearshore native benthic fishes, such as Trout-perch, Johnny Darter, and Spottail Shiner, in that same trawl (Figure 4).

*Deepwater Sculpin* - Deepwater Sculpin, have undergone a dramatic population recovery in Lake Ontario since the mid-2000s (Lantry et al., 2007; Weidel et al., 2017). In 2016, the population density continued to increase (Figure 5). Comparing Lake Ontario Deepwater Sculpin density (or biomass density) estimates to other Great Lakes provides context for how the Lake Ontario population has recovered. The 2016 lake-wide biomass density estimate for Deepwater Sculpin in Lake Ontario was 2.7 kg·ha$^{-1}$ which is similar to Lake Michigan over the past five years (2010 - 2014) where Deepwater Sculpin biomass density reportedly ranged from approximately 0.5 – 3.0 kg·ha$^{-1}$ (Bunnell et al., 2015).

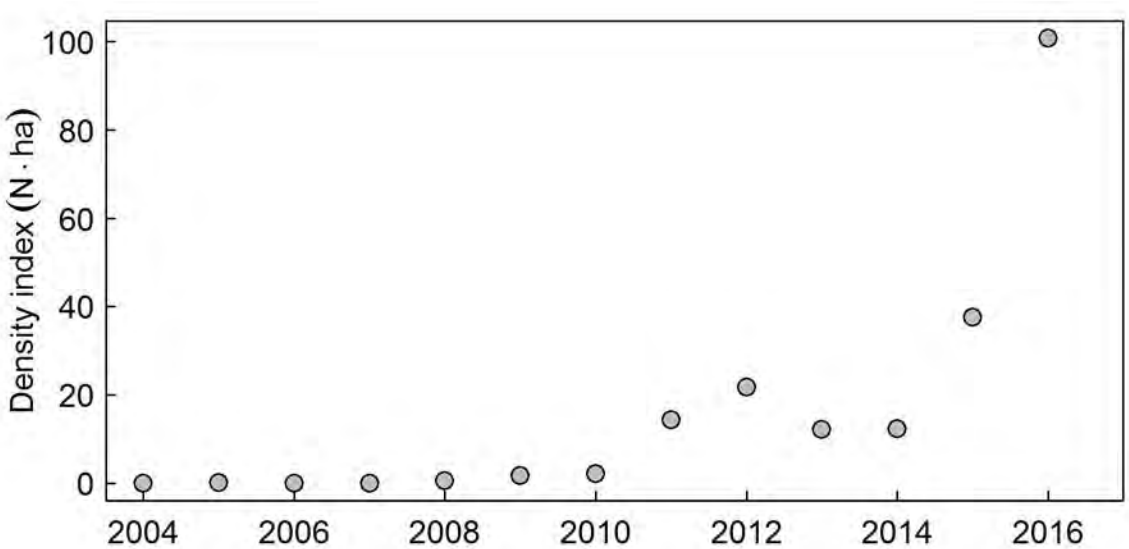


***Figure 5. Lake Ontario Deepwater Sculpin whole-lake, area weighted, density (N·ha$^{-1}$) from the fall bottom trawl survey, 2004-2016. Density values are presented as an index because they have not been corrected for trawl catchability. Data prior to 2015 are based on Lake Ontario south shore transects only, while data from 2015 are based on a whole-lake survey***

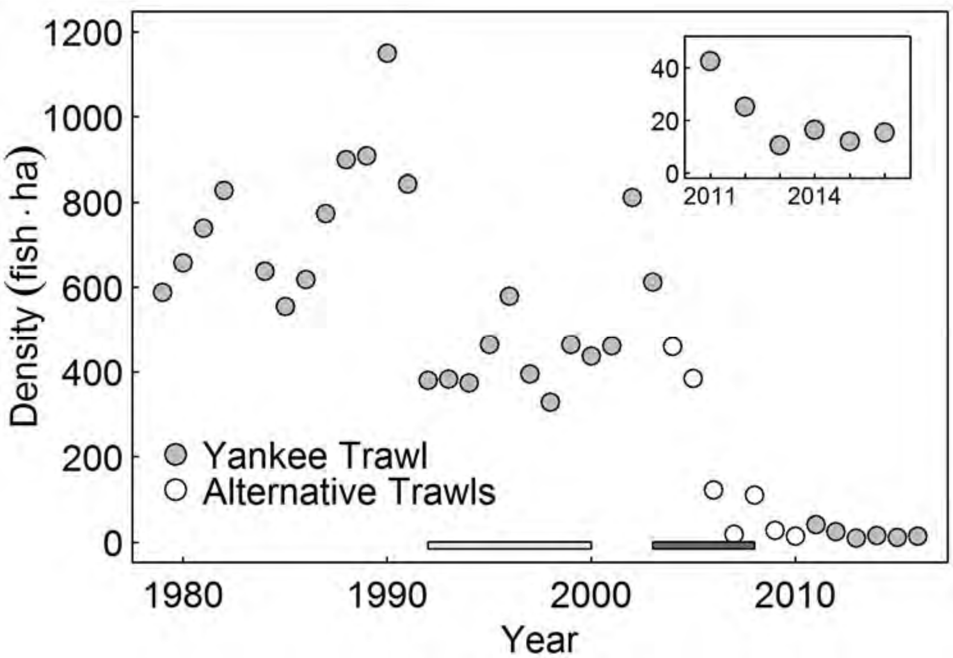


***Figure 6. Lake Ontario Slimy Sculpin whole-lake, area-weighted, density based on fall bottom trawl surveys from 1978-2016 (no assessment in 1983). The light gray bar above the x-axis represents the range when Dreissena sp. mussels were introduced and proliferated, while the darker gray bar represents when introduced Round Goby abundance increased. Density values are presented as an index because they have not been corrected for trawl catchability. Data prior to 2015 are based on Lake Ontario south shore transects only, while data from 2015 are based on a whole-lake survey.***

Over the same time period, Lake Huron Deepwater Sculpin biomass densities ranged from approximately 0.0 - 1.0 $kg \cdot ha^{-1}$ (Roseman et al., 2015). While Lake Ontario abundance may be similar to currently reported estimates in Lakes Michigan and Huron, it is important to recognize trawl surveys in those lakes sample to a maximum depth of ~110m (361 ft), while maximum lake depths are 281 and 229m (922 and 751 ft), respectively (Weidel et al., 2017, p. 20). If Deepwater Sculpin densities are higher in deeper habitats of those lakes, like we observe in Lake Ontario, the current Lake Huron and Lake Michigan estimates may be biased low. Data from this USGS-lead survey are currently being used by conservation groups and agencies in both the United States and Canada to reevaluate the conservation status of Deepwater Sculpin in Lake Ontario.

*Slimy Sculpin* - In 2016, Slimy Sculpin abundance was similar to 2015, however both values were among the lowest observed across the Lake's 39-year time series (Figure 6). Biomass density of Slimy Sculpin in Lake Ontario over the past five years (0.15 – 0.40 $kg \cdot ha^{-1}$) was similar to Lake Michigan (0.01-0.70 $kg \cdot ha^{-1}$) (Bunnell et al., 2015), but notably higher than Lake Huron (0.00 – 0.03 $kg \cdot ha^{-1}$ (Roseman et al., 2015) or Lake Superior where three common sculpin species in nearshore habitats are combined for reporting and are 0.02 - 0.05 $kg \cdot ha^{-1}$ (Vinson et al., 2015). As in previous years, few juvenile Slimy Sculpin less than 50mm were caught in Lake Ontario in 2016 (Figure

7). This value varied across the period of observation in the 1970s through 1990s, but the sharp decline observed in the mid-2000s corresponds to the increase in Round Goby during the same time period (Figure 7).

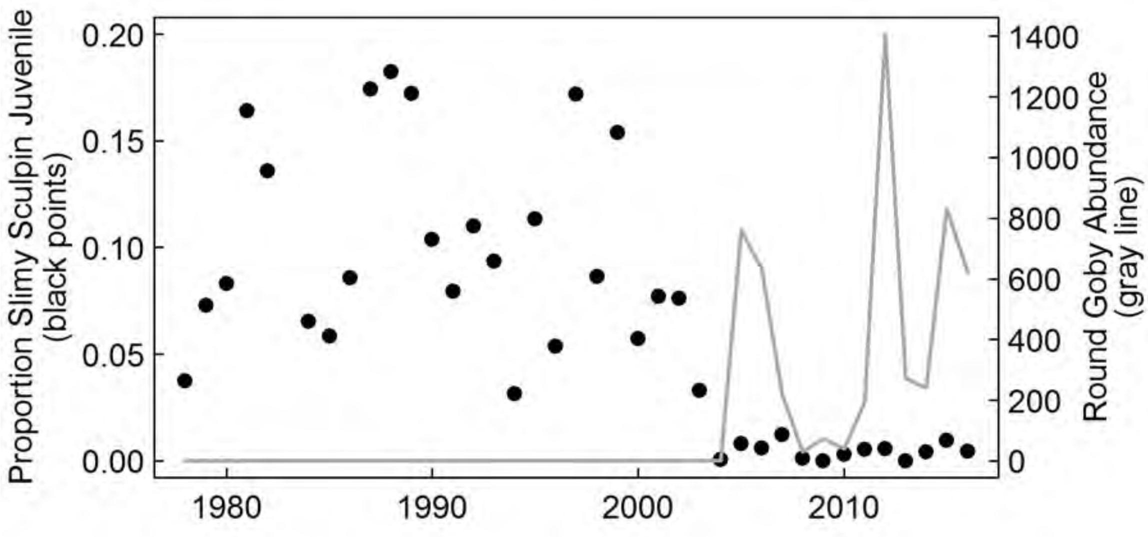


***Figure 7. The proportion of all Lake Ontario Slimy Sculpin caught in bottom trawls where total length was less than 50mm has decreased since the mid- 2000s, coincident with the increased abundance of non-native Round Goby.***


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guidelines for the care and use of fishes by the American Fisheries Society (http://fisheries.org/docs/wp/Guidelines-for-Use-of-Fishes.pdf). Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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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, an American site (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. Peak abundance at Little Galloo Island, in 1996, reached over 8,400 nests. Concerns about the impacts cormorants have on fish populations, other colonial waterbird species, other ecological values and private property followed this population expansion. Little Galloo Island currently supports the largest cormorant, Ring-billed Gull *(Larus delawarensis)* and Caspian Tern (*Sterna caspia*) colonies in New York State.

The New York State Department of Environmental Conservation (NYSDEC) and the U.S. Fish and Wildlife Service (USFWS) began to examine the impacts of cormorants in 1992. In 1998, analyses 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 abundant cormorants on the structure and function of the warmwater fish community, on nesting habitats, and on 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 includes feeding by 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 New York State and managed by NYSDEC. Bass and Calf Islands are privately owned. The islands historically contained several colonial waterbird colonies (Table 1), of which most 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 efforts began on Gull and Bass Islands in 1994. Calf Island was included in removal activities following observation of cormorant nests on the island in 1997. Nest removal 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 nests were culled (Table 2).

Annual treatment of accessible cormorant nests on Little Galloo Island, with food grade vegetable oil, began in spring 1999 using 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. From 1999 through 2015 oil was applied to accessible nests three to five times per season, at roughly two week intervals. Oiling at two week intervals ensured that most nests would be treated at least twice during the incubation period. In 2016 only two oil applications were made because a federal court decision in May vacated the depredation order under which this activity is conducted. Each nest or group of nests treated was marked with spray paint to minimize missed or repeat treatment. Two or three teams, of two to three persons each, completed the oiling 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 effectiveness 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. No culling was conducted in 2015 or 2016. Most culling, when conducted, 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 on site.

In addition to nest removal, oiling and culling activities, the NYSDEC conducted cormorant diet studies from 1992 through 2013, by collecting regurgitated pellet samples at Little Galloo Island from mid-April through mid-October. All samples were analyzed by the USGS Great Lakes Science Center (Johnson et al. 2014).

Colony feeding days for Little Galloo Island cormorants were calculated according to the Casselman-Weseloh model (unpublished, 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

Unless otherwise indicated, the productivity rate for unoiled nests was assumed to be 2.0 chicks fledged per nest (Sullivan et al. 2006).

No correction was made for in-season bird movements or natural mortality.

## Results

Since the nest removal program began on Gull, Bass and Calf Islands in 1994, nesting attempts (including re-nests) on these islands have varied from year to year with a 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. Cormorants have not attempted to nest on Calf Island since 2009 (Table 2.)

In 2016 a total of 149 nests were removed from Gull Island, on the only visit of May 6 (due to the court decision vacating the U.S. Fish and Wildlife Service cormorant depredation order). In most years 5 or 6 nest removal visits were made between May and August. The number of nests removed was much lower than usual (Table 2) since only one visit was made and that visit was early in the nesting season. Cormorants have been culled from Gull Island occasionally in the past but no birds were culled on Gull Island in 2016.

Eggs were oiled on two occasions at Little Galloo Island May 5 and 17, 2016. The peak number of nests oiled on Little Galloo Island was 914 (Table 2). There were 310 unoiled tree and control nests. Peak nest count was 2,161 including ground nests, control subcolonies, tree, and “empty” but apparently occupied, nests (Table 1). Peak nest count was (5%) lower than in 2015. Note that since nest counts conducted during oiling visits were limited to early season visits, the peak nest count in 2016 (Table 1) was the mid-June count used in the Bureau of Wildlife trend report. Hatching success (number of chicks hatched per number of eggs counted) for oiled nests was probably less than 1% but there were a significant number of unoiled ground nests this year.

About 2,490 cormorant chicks were thought to be fledged at Little Galloo Island this year, more than triple the 527 estimated fledged in 2015. Some were from a control (unoiled) subcolony, some from tree nests, and many from untreated ground nests that became active after oiling efforts had ceased.

We estimated that the Little Galloo Island colony generated 934,552 feeding-days in 2016, substantially above the target of 780,000 (Figure 1) and a 15% increase over the 814,662 feeding-days generated in 2015. There were approximately 181,000 additional feeding days attributed to chicks in 2016 relative to 2015. Cormorant feeding days at Little Galloo Island have remained within 10% of target most years since 2006. In 2016, feeding days exceeded the target by 20% due largely to the presence of a large number of chicks. Since feeding day estimates were well above target (Figure 1), management effort will be increased to 2015 levels or higher if the federal regulatory situation allows.

Nest counts for other colonial waterbirds (except Ring-billed Gulls) were conducted in 2015 on three eastern basin islands. Bass Island hasn't supported any colonial waterbird nesting since 2007. Caspian Terns continued to maintain a stable colony on Little Galloo Island. Great Black-backed Gulls have not been detected on any of the islands since 2008. Common Terns nested on Little Galloo Island for the first time in 2013, 14 nests were counted in 2016. Black-crowned Night Herons have not been found on Little Galloo Island since 2008. They continue to be found on Gull Island. (Table 1) but at a much reduced level in 2016, probably due to competition with cormorants for nesting habitat.

## 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.

Through 2003 NYSDEC cormorant management was conducted under individual USFWS permits for each colony. Using techniques available during that period, population objectives were not reached within the five years projected.

The U.S. Fish and Wildlife Service 2003 Federal Public Resource Depredation Order (USFWS 2003) allowed management by NYSDEC without applying for and receiving individual permits. Non-lethal management actions were continued and some lethal control (culling), which was permitted under the Depredation Order, 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 in 2010. The management effort was operated at a maintenance level from 2007-2015 (Figure 1).

In May 2016 a federal court decision vacated an extension of the Public Resource Depredation Order. As a result all cormorant management activities were terminated in May which resulted in a much reduced and less effective management effort this year.

Reduced cormorant population levels at Little Galloo Island, believed to be related to egg oiling, became noticeable in 2002. Johnson et al. (2004) reported a substantial decline in fish consumption at this colony due both to lack of consumption by chicks, and lower numbers of feeding adults resulting from reduced recruitment. The reduction in feeding adults has continued (Johnson et al. 2014). In 2016 the production of numerous chicks resulted in an immediate increase in feeding days. Lacking management intervention, recruitment of breeding adults based on increased chick production can be expected to increase cormorant numbers in this, and possibly other, colonies in coming years.

Impacts on fish populations of recreational interest have thus far declined faster than fish consumption as a whole, because cormorant diet has become dominated by Round Goby (*Neogobius melanostomus*) (Johnson et al. 2014). Through 2015 cormorant population 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). Continuation of this trend is presently uncertain.

Cormorant management activities do not appear to negatively effect and may actually enhance nesting activities for other nesting colonial waterbirds such as Caspian Terns, Common Terns, Herring Gulls and Black-crowned Night Herons. Common Terns were first observed nesting on Little Galloo Island in 2013 and have continued to nest on the island. In 2016 Caspian Terns and Herring Gulls approached the record high nest counts seen in 2014. In the absence of effective cormorant management in 2016, nests of Black-crowned Night Herons on Gull Island declined by about 67% (Table 1).

Many variables in addition to the regulatory environment can influence cormorant management results over time. 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 exceeded emigration and raised the breeding population 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 efforts, 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. When allowed to proceed, efforts undertaken in New York have successfully met objectives for limiting production of cormorants on New York's Lake Ontario eastern basin islands, reducing predation on fishes of interest and protecting other waterbird populations.

Cormorant management, whether implemented locally, regionally, or range-wide, 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 on Bass and Gull Islands are for active nests after management activity and may not match Bureau of Wildlife trend numbers which are taken in mid June.*** *Dash indicates not checked for given species, LGI-Little Galloo Island.*

| Species | Island | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Double-crested Cormorant | LGI | 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 | 2,387 | 2,283 | 2,264 | 2,161 |
| | Gull Island | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 323 |
| | Bass Island | 0 | 0 | 0 | 35 | 12 | 5 | 5 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Ring-billed Gull | LGI | - | - | - | 60,000 | - | - | - | - | 37,500 | - | - | - | 43,324 | - | - | - | - |
| | Gull Island | - | - | - | 0 | - | - | - | - | 0 | - | 0 | - | 0 | 0 | 0 | 0 | 0 |
| | Bass Island | - | - | - | 2,500 | - | - | - | - | 0 | - | - | - | 0 | 0 | 0 | 0 | 0 |
| Herring Gull | LGI | - | - | - | 313 | - | - | 367 | 0 | 375 | 356 | 364 | 459 | 512 | 645 | 979 | 784 | 971 |
| | Gull Island | - | - | - | 42 | - | - | 40 | 67 | 58 | 42 | 89 | 91 | 52 | 89 | 109 | - | 29 |
| | Bass Island | - | - | - | 10 | - | - | 10 | 16 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Great Black-backed Gull | LGI | - | 19 | 15 | 12 | - | - | 4 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Gull Island | - | 0 | 1 | 0 | - | - | 0 | 0 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Bass Island | - | 0 | 0 | 0 | - | - | 0 | 0 | 9 | 0 | - | - | 0 | 0 | 0 | 0 | 0 |
| Caspian Tern | LGI | 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 | 1,848 | 2,436 | 2,084 | 2,354 |
| Black-crowned Night Heron | LGI | 1 | 1 | 1 | 3 | 3 | 4 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Gull Island | 20 | 50 | 24 | 35 | 78 | 81 | 77 | 127 | 78 | 78 | 105 | 151 | 44 | 56 | 79 | 106 | 39 |
| | Bass Island | 36 | 13 | 36 | 47 | 17 | 46 | 32 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Calf Island | - | 0 | - | - | 0 | - | - | - | - | 13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Common Tern | LGI | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 20 | 34 | 30 | 14 |

***Table 2. Number of cormorant nests removed or oiled and cormorant (DCCO) adults culled; nests with no intact eggs were not oiled.*** [2]Cumulative nests removed. Number in ( ) is peak one day count, x-management unnecessary due to landowner activity.

| | | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Little Galloo Island | Peak nests oiled | 4,301 | 3,865 | 3,707 | 3,389 | 3,359 | 2,896 | 2,275 | 2,502 | 1,804 | 2,166 | 1,104 | 2,000 | 1,600 | 1,456 | 1,625 | 1,546 | 914 |
| | Nests removed | 0 | 0 | 0 | 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 | 366 | 150 | 0 | 0 |
| Bass Island [2] | Peak nests oiled | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | Nests removed | 793 (757) | 0 (0) | 986 (279) | 260 (117) | 959 (348) | 935 (600) | 477 (174) | 470 (110) | x | x | x | x | x | x | x | x | x |
| | DCCO culled | - | - | - | - | 167 | 281 | 200 | 124 | x | x | x | x | x | x | x | x | x |
| Gull Island [2] | Peak nests oiled | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | x | x | x | x | x | x | x | x | x |
| | Nests removed | 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) | 1,072 (276) | 603 (235) | 769 (276) | 149 (149) |
| | DCCO culled | - | - | - | - | 3 | 0 | 0 | 20 | 2 | 0 | 0 | 0 | 29 | 0 | 0 | 0 | 0 |
| Calf Island [2] | Peak nests oiled | 0 | 0 | 0 | 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 | 0 | 0 | 0 |
| | DCCO culled | - | - | - | - | 37 | 0 | 0 | 0 | 6 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

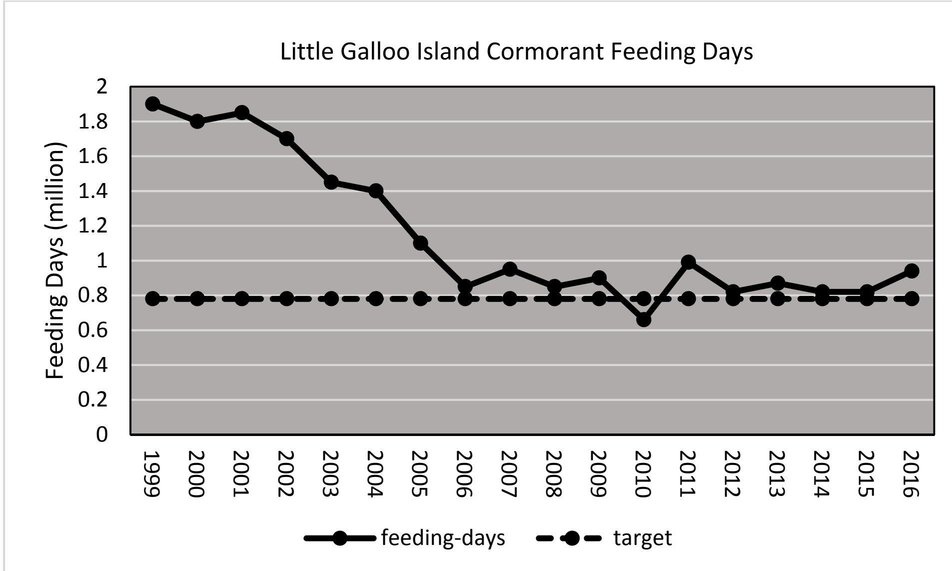


***Figure 1. Trend in cormorant feeding days for the Little Galloo Island colony.***

**Lake Ontario Tributary Creel Survey**
**Fall 2015 – Spring 2016**

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## Introduction

Angler surveys of all the major tributaries to Lake Ontario 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 2015-2016. Prior to the year 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 eastern Lake Ontario tributaries since 1982 (McCullough 2003).

On the Salmon River, this study ran from 1 September 2015 through 15 May 2016, while the previous survey periods were 5 September 2005 through 15 May 2006, 9 September 2006 through 16 May 2007, and 1 September 2011 through 16 May 2012. Surveys on the remaining tributaries covered 15 September 2011 through 29 April 2012, 19 September 2005 through 25 April 2006, 15 September 2006 through 25 April 2007, and 18 September 2015 through 30 April 2016. We plan to repeat this survey every third year hereafter.

## Methods

Data Collection

Four agents surveyed 21 Lake Ontario tributaries (Figure 1) in 2015-2016. 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. For this most recent survey we dropped Slater Creek because the power plant located on its banks closed. That plant produced a warmwater discharge which attracted large numbers of fish and thus anglers. However we again added Little Sandy Creek because of the addition of two new DEC angler parking areas on the stream since the 2011-2012 survey.

We used an instantaneous access site survey design on the Salmon River that duplicated the surveys we did in 2004 and 2005-07. An instantaneous roving design was utilized 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 interviewing technician. The proportion of non-NYS resident participation in the tributary fisheries 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.

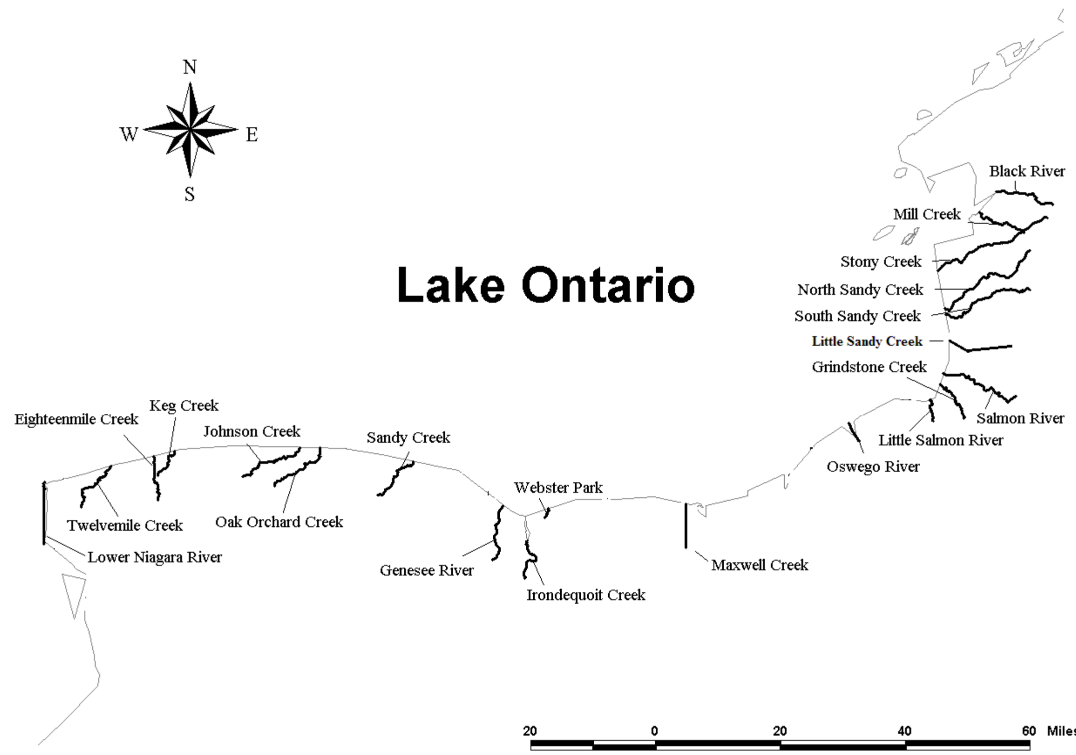


**Figure 1. Lake Ontario tributary creel survey streams for 2011-2012.**

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

Salmon River

On the Salmon River, the agent sampled three randomly selected weekdays and one weekend day each week. She used a staggered shift to cover the morning counts and interviews, the afternoon shift continued until ½ hour after sunset. Twenty-five sites were sampled for vehicle, angler, and 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 anglers 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. The boat counts were multiplied by the mean boat party size specific to that river to estimate the number of boat anglers. The 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 trip 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 2015-2016 was 989,437 angler hours which was down considerably from the 1,582,428 hours in 2011-2012, but was similar to the remaining surveys (999,182 hours in 2005-06 and 910,413 hours for 2006-07) (Table 1). The Salmon River accounted for 74 % of the total with 735,402 angler hours, compared to 59% and 64%, and 68%, of the effort in 2005-06, 2006-07, and 2011-12 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 was 256,894 in 2015-16 which, as with the number of angler hours, was noticeably less than the 409,211 in 2011-12.

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

| | 2005-06 | | | 2006-07 | | | 2011-12 | | | 2015-16 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary | Hours | Trip Length | Trips | 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** | **735,402** | **5.7** | **129,018** |
| 18 Mile Creek | 87,471 | 4.0 | 21,743 | 72,000 | 2.0 | 35,477 | 119,222 | 2.0 | 58,271 | 43,213 | 2.0 | 21,735 |
| Oswego River | 70,078 | 4.2 | 16,834 | 48,789 | 2.5 | 19,707 | 59,091 | 1.9 | 30,993 | 11,326 | 2.2 | 5,221 |
| South Sandy Creek | 26,944 | 3.9 | 6,880 | 22,961 | 1.8 | 12,940 | 56,150 | 1.8 | 31,185 | 20,748 | 1.8 | 11,262 |
| Oak Orchard Creek | 69,941 | 3.6 | 19,581 | 49,029 | 2.0 | 24,278 | 55,738 | 2.1 | 26,149 | 65,249 | 2.1 | 31,312 |
| Maxwell Creek | 17,685 | 3.6 | 4,925 | 24,331 | 1.9 | 13,075 | 44,032 | 1.7 | 25,452 | 14,988 | 1.8 | 8,415 |
| Niagara River | *** | *** | *** | *** | *** | *** | 41,567 | 5.1 | 8,096 | 27,504 | 4.1 | 6,733 |
| Black River | 21,136 | 3.1 | 6,723 | 13,985 | 2.6 | 5,294 | 32,047 | 2.4 | 13,477 | 4,524 | 3.2 | 1,427 |
| Sandy Creek | 15,818 | 3.9 | 4,105 | 16,454 | 2.0 | 8,295 | 21,878 | 1.6 | 14,051 | 14,244 | 1.5 | 9,635 |
| Irondequoit Creek | 14,227 | 2.4 | 6,018 | 13,587 | 1.5 | 9,308 | 17,912 | 1.6 | 11,263 | 13,433 | 1.8 | 7,440 |
| North Sandy Creek | 18,744 | 2.6 | 7,126 | 7,515 | 1.6 | 4,734 | 14,216 | 1.5 | 9,589 | 4,393 | 3.1 | 1,425 |
| Little Sandy Creek | 2,808 | 1.9 | 1,504 | 3,232 | 1.9 | 1,696 | *** | *** | *** | 3,077 | 0.8 | 3,942 |
| Genesee River | 21,596 | 4.3 | 5,040 | 14,815 | 2.4 | 6,065 | 11,677 | 1.9 | 6,121 | 14,721 | 1.9 | 7,839 |
| Johnson Creek | 5,553 | 4.1 | 1,347 | 9,413 | 1.9 | 4,954 | 7,620 | 1.8 | 4,202 | 5,847 | 1.4 | 4,075 |
| Mill Creek | 3,783 | 2.9 | 1,309 | 1,061 | 4.0 | 266 | 6,467 | NA | NA | 199 | NA | NA |
| 12 Mile Creek | 7,386 | 0.7 | 10,387 | 3,949 | 3.4 | 1,159 | 5,692 | 2.7 | 2,137 | 2,013 | 0.6 | 3,321 |
| Little Salmon River | 4,930 | 3.5 | 1,410 | 4,799 | 1.0 | 4,598 | 5,129 | 1.8 | 2,901 | 1,487 | 1.9 | 772 |
| Stony Creek | 1,959 | 4.2 | 463 | 1,568 | 0.9 | 1,659 | 2,875 | 0.6 | 4,792 | 1,745 | NA | NA |
| Webster Park | 2,852 | 1.5 | 1,963 | 4,752 | 1.4 | 3,369 | 2,137 | 1.2 | 1,714 | 236 | 0.6 | 378 |
| Grindstone Creek | 2,070 | 1.4 | 1,455 | 1,759 | 1.7 | 1,046 | 1,379 | 2.3 | 604 | 4,376 | 1.8 | 2,461 |
| Keg Creek | 1,238 | 2.3 | 544 | 4,381 | 4.1 | 1,074 | 283 | NA | NA | 709 | 1.5 | 484 |
| 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 | *** | *** | *** | *** | *** | *** |
| 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** | **1,001,990** | | **218,315** | **913,646** | | **246,532** | **1,582,428** | | **409,211** | **989,437** | | **256,894** |

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

However it was higher than the estimated values for 2005-06 and 2006-07 at 216,811 and 244,836, respectively (Table 1)and slightly less than the 276,000 trips reported in 1984 (NYSDEC 1984). The tributary that showed the greatest decline in effort during 2015-16 was the Oswego River. However, the closure of the Leto Island access on the east side of the river likely contributed to the lower angling pressure.

The Salmon River accounted for 50% of the total trips which is higher than the 44%, 34%, and 39% reported in 2005-06, 2006-07, and 2011-12 respectively. Eighteenmile Creek in Niagara County also accounted for a large share of the effort (21,735 trips) in 2015-2016 (Table 1).

October had by far the highest monthly effort for all the non-Salmon River tributaries in 2015-2016, with an estimated 103,470 angler hours, followed by November (53,101) and December (21,170) (Table 2). This translated to 41% of the total effort occurring in October which is very near the 46 %, 39%, and 40% in 2005-06, 2006-07, and 2011-12 respectively. These percentages were all higher than the 33% reported 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 97,825, compared to 75,985, 83,409, and 112,109 in 2005-06, 2006-07, and 2011-12 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 had a negative effect on the number of angler trips in those years due to more difficult fishing conditions. Additionally, that earlier time period was when gasoline prices first started rising rapidly, so economics likely played a role in the lower effort in 2005 and 2006.

The percentage of the total number of trips on the Salmon River that occurred during the fall season in 2015-2016 was 76% (112,109 of 129,018 trips), which was very consistent with the 1984 (76%), 2005-2006 (77%), and 2011-2012 (71%) surveys (Table 4). In 2006-2007, however, 95% of the trips occurred in the fall season.

The majority of trips on the Salmon River (97,125 trips –75%) in 2015-2016 engaged in shore access fishing in the conventional regulations portion of the river, compared to 76%, 74%, and 82% in the previous studies, respectively (Table 5). The special regulations fly-fishing areas accounted for about 10% of the overall effort in all four of the recent studies (Table 5).

The trend in fishing effort over time for the Salmon River appeared 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. However the Salmon River angler effort returned to the "good old days" level in 2011-2012. Estimates for the tributary fishery (September through April/mid-May) were 1,582,428 angler hours in 2011-2012. The angler effort in the current survey declined to 989,437 hours which is similar to 999,182 and 910,413 hours in the 2005-06 and 2006-07 surveys, respectively (Table 1).

The 2015 open lake boat fishing effort was estimated to have been 879,681 angler hours (Lantry and Eckert 2016). The Salmon River effort estimate in 2015-16 was 84% of the 2015 open water boat effort estimate after greatly exceeding it in 2011-2012. The total fishing effort on all Lake Ontario tributaries in 2015-16 was 109,756 angler hours higher than the open lake estimate. The difference in 2015-2016 was much less than the 684,089 angler hours separating the two angling types in 2011-2012. The Ontario Ministry of Natural Resources and Forestry conducted an angler survey of the tributaries on the north

**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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| Tributary | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips |
| 12 Mile Creek | 548 | 201 | 742 | 575 | 1,245 | ---- | 337 | 301 | 1,178 | 326 | 965 | 561 | 407 | ---- | 193 | 494 |
| 18 Mile Creek | 1,416 | 756 | 11,820 | 5,766 | 5,104 | 3,980 | 1,376 | 955 | 29,000 | 7,274 | 29,140 | 13,186 | 59,740 | 27,419 | 20,674 | 9,892 |
| 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 | ---- | 965 | | 12,875 | 1,756 | 7,209 | 2,704 | 19,494 | 6,601 | 2232 | 645 |
| Catfish Creek | 0 | 0 | 151 | 76 | *** | *** | *** | *** | 2,896 | 824 | 965 | 425 | *** | *** | *** | *** |
| Genesee River | 1,840 | 466 | 3,632 | 3,632 | 4,309 | 2,086 | 2535 | 2243 | 8,831 | 1,866 | 6,093 | 3,605 | 4,764 | 2,208 | 6,146 | 4,328 |
| Grindstone Creek | 40 | 15 | 153 | 76 | 79 | ---- | 650 | ---- | 1,305 | 921 | 696 | 407 | 579 | ---- | 1994 | 1,120 |
| Irondequoit Creek | 434 | 185 | 677 | 594 | 426 | ---- | 233 | 181 | 1,054 | 591 | 907 | 682 | 2,669 | 1,795 | 1,419 | 965 |
| Johnson Creek | 350 | 90 | 1,291 | 676 | 242 | ---- | 273 | 463 | 2,901 | 613 | 3,403 | 1,526 | 4,901 | 3,128 | 2,651 | 1,893 |
| Keg Creek | 0 | 0 | 63 | ---- | 0 | 0 | 0 | 0 | 0 | 0 | 1,087 | 544 | 0 | 0 | 0 | 0 |
| Lindsey Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 41 | 11 | 0 | 0 | *** | *** | *** | *** |
| Little Salmon River | 0 | 0 | 628 | 251 | 148 | 69 | 155 | ---- | 4,251 | 1,027 | 2,526 | 856 | 3,737 | 2,074 | 681 | 227 |
| Little Sandy Creek | 278 | 149 | 378 | 275 | *** | *** | 244 | ---- | 1,472 | 1,282 | 1,438 | 848 | *** | *** | 1790 | 2,295 |
| Marsh Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 73 | 20 | 1,162 | ---- | *** | *** | *** | *** |
| Maxwell Creek | 78 | 52 | 836 | 444 | 38 | ---- | 38 | ---- | 3,587 | 2,609 | 5,126 | 2,465 | 8,151 | 2,946 | 2,030 | 1,194 |
| Mill Creek | 127 | 46 | 0 | 0 | 0 | 0 | 0 | 0 | 2,645 | 710 | 378 | ---- | 3,968 | ---- | 129 | ---- |
| Niagara River | *** | *** | *** | *** | 3,717 | 713 | 3,864 | 805 | *** | *** | *** | *** | 9,558 | 1,625 | 6,249 | 1,407 |
| Ninemile Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 112 | 31 | 1,924 | 789 | *** | *** | *** | *** |
| North Sandy Creek | 501 | 177 | 520 | 533 | 290 | ---- | 100 | ---- | 13,750 | 5,063 | 3,484 | 1,350 | 5,568 | 8,017 | 1237 | 401 |
| Oak Orchard Creek | 1,866 | 537 | 9,625 | 4,695 | 1,787 | 1,521 | 4110 | 3,397 | 38,450 | 9,041 | 24,452 | 10,361 | 20,737 | 6,936 | 31,762 | 14,705 |
| Oswego River | 10,778 | 2,355 | 21,186 | 8,180 | 19,640 | 14,771 | 1366 | ---- | 40,170 | 9,092 | 19,798 | 7,279 | 18,799 | 9,124 | 5497 | 2,244 |
| **Salmon River** | **183,019** | **30,503** | **171,265** | **25,186** | **261,838** | **38,453** | **176,480** | **30,961** | **212,213** | **35,369** | **251,031** | **36,916** | **339,017** | **49,790** | **276,779** | **48,558** |
| Sandy Creek | 83 | 30 | 531 | 531 | 0 | 0 | 198 | ---- | 5,520 | 1,216 | 1,042 | 489 | 6,172 | 4,708 | 4,652 | 4,747 |
| 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 | ---- | 1,094 | ---- | 16,992 | 5,061 | 14,551 | 7,960 | 33,917 | 18,558 | 12989 | 6,872 |
| Sterling Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 1,251 | 198 | 1,073 | 436 | *** | *** | *** | *** |
| Stony Creek | 94 | 34 | 623 | ---- | 301 | ---- | 0 | 0 | 516 | 106 | 200 | ---- | 67 | ---- | 1,030 | ---- |
| Webster Park | 77 | 28 | 163 | 123 | 0 | 0 | 0 | 0 | 453 | 349 | 919 | 585 | 423 | ---- | 117 | ---- |
| **Totals** | **206,830** | **37,476** | **231,713** | **53,220** | **307,457** | **61,594** | **194,016** | **39,306** | **404,674** | **86,537** | **382,937** | **96,125** | **542,752** | **144,928** | **380,249** | **101,987** |

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

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

| | November | | | | | | | | December | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| Tributary | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips |
| 12 Mile Creek | 497 | 150 | 493 | 288 | 677 | ---- | 29 | 54 | 63 | 21 | 247 | ---- | 199 | 89 | 33 | ---- |
| 18 Mile Creek | 37,689 | 6,989 | 23,453 | 10,424 | 32,668 | 14,647 | 8,734 | 4,159 | 4,549 | 899 | 4,219 | 2,402 | 8,192 | 9,071 | 3,472 | 1,622 |
| 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 | 550 | 167 | 145 | 50 | 320 | 124 | 161 | 42 | 430 | ---- |
| Catfish Creek | 798 | 319 | 503 | 151 | *** | *** | *** | *** | 0 | 0 | 124 | ---- | *** | *** | *** | *** |
| Genesee River | 3,333 | 814 | 482 | 482 | 880 | 860 | 1,694 | 878 | 643 | 124 | 1,059 | 460 | 93 | ---- | 823 | 310 |
| Grindstone Creek | 341 | 103 | 572 | 260 | 158 | 47 | 1,339 | ---- | 0 | 0 | 46 | ---- | 0 | 0 | 84 | ---- |
| Irondequoit Creek | 731 | 418 | 1,214 | 971 | 1,483 | 872 | 1,820 | 1,368 | 225 | 225 | 591 | 586 | 1,288 | 1,041 | 2,102 | 1,157 |
| Johnson Creek | 927 | 415 | 2,448 | 1,149 | 1,094 | ---- | 1,446 | 1,147 | 121 | ---- | 690 | ---- | 471 | ---- | 160 | 49 |
| Keg Creek | 346 | 104 | 762 | 318 | 0 | 0 | 0 | 0 | 32 | 25 | 489 | ---- | 0 | 0 | 0 | 0 |
| Lindsey Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Little Salmon River | 83 | 25 | 209 | ---- | 90 | ---- | 401 | 208 | 0 | 0 | 171 | 114 | 35 | ---- | 54 | ---- |
| Little Sandy Creek | 36 | 12 | 152 | ---- | *** | *** | 305 | ---- | 56 | 23 | 72 | 289 | *** | *** | 66 | ---- |
| Marsh Creek | 0 | 0 | 76 | ---- | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Maxwell Creek | 5,469 | 1,054 | 7,221 | 3,099 | 11,761 | 10,629 | 3,456 | 2,810 | 1,165 | 373 | 2,935 | 1,640 | 5,377 | 2,671 | 2,668 | 1,399 |
| Mill Creek | 656 | 605 | 258 | 265 | 184 | ---- | 0 | 0 | 0 | 0 | 0 | 0 | 25 | ---- | 25 | ---- |
| Niagara River | *** | *** | *** | *** | 11,781 | 2,879 | 6,004 | 1,486 | *** | *** | *** | *** | 3,447 | 843 | 3,898 | 1,175 |
| Ninemile Creek | 870 | 176 | 646 | 394 | *** | *** | *** | *** | 0 | 0 | 179 | 105 | *** | *** | *** | *** |
| North Sandy Creek | 2,539 | 826 | 1,682 | 1,150 | 2,631 | 1,710 | 612 | ---- | 270 | 64 | 939 | 845 | 2,578 | 1,726 | 309 | ---- |
| Oak Orchard Creek | 21,538 | 6,522 | 10,241 | 5,020 | 18,278 | ---- | 15,941 | 6,901 | 993 | 415 | 2,130 | 1,653 | 5,366 | 3,211 | 3,497 | 1,826 |
| Oswego River | 9,449 | 2,988 | 3,327 | 1,592 | 11,042 | 3,116 | 1,938 | 2,692 | 1,452 | 422 | 1,648 | 881 | 2,502 | 1,022 | 504 | ---- |
| **Salmon River** | **61,418** | **10,236** | **44,752** | **6,581** | **145,522** | **21,372** | **104,347** | **18,306** | **23,220** | **3,870** | **36,783** | **5,409** | **59,603** | **8,754** | **31,453** | **5,518** |
| Sandy Creek | 6,409 | 1,568 | 2,569 | 1,359 | 9,737 | 6,141 | 6,225 | 4,178 | 342 | 105 | 617 | 258 | 2,143 | 765 | 1,554 | 609 |
| 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 | 2,580 | 1,132 | 294 | 196 | 1,001 | ---- | 2,719 | 1,887 | 1,336 | 4,625 |
| Sterling Creek | 678 | 130 | 336 | 117 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Stony Creek | 165 | 50 | 96 | 165 | 180 | ---- | 27 | ---- | 0 | 0 | 150 | 295 | 173 | ---- | 114 | ---- |
| Webster Park | 921 | 625 | 1,642 | 821 | 825 | 686 | 0 | 0 | 129 | 83 | 380 | 200 | 437 | 582 | 41 | 66 |
| **Totals** | **162,283** | **36,408** | **109,035** | **37,355** | **256,435** | **67,547** | **157,448** | **45,486** | **34,700** | **7,172** | **55,327** | **15,505** | **94,808** | **31,704** | **52,623** | **18,355** |

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

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

| | January | | | | | | | | February | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| Tributary | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips |
| 12 Mile Creek | 225 | 82 | 144 | ---- | 189 | 50 | 54 | 145 | 0 | 0 | 0 | 0 | 213 | ---- | 181 | ---- |
| 18 Mile Creek | 3,254 | 1,308 | 164 | ---- | 3,250 | 1,662 | 2,478 | 1,469 | 3,255 | 974 | 95 | ---- | 3,104 | 2,641 | 1,481 | 961 |
| 4 Mile Creek | *** | *** | 0 | 0 | *** | *** | *** | *** | *** | *** | 0 | 0 | *** | *** | *** | *** |
| Bear Creek | 125 | 45 | 0 | 0 | *** | *** | *** | *** | 55 | 37 | 0 | 0 | *** | *** | *** | *** |
| Black River | 203 | 160 | 225 | 2 | 860 | ---- | 0 | 0 | 108 | 53 | 80 | ---- | 393 | ---- | 22 | ---- |
| Catfish Creek | 103 | 38 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Genesee River | 50 | 66 | 48 | 24 | 87 | 44 | 514 | 177 | 452 | 108 | 1,748 | 692 | 73 | 43 | 0 | 0 |
| Grindstone Creek | 50 | 18 | 23 | ---- | 0 | 0 | 80 | ---- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Irondequoit Creek | 882 | 302 | 245 | 119 | 714 | 354 | 1,374 | 767 | 465 | 140 | 273 | ---- | 2,190 | 829 | 1,666 | 500 |
| Johnson Creek | 373 | 78 | 337 | ---- | 228 | 99 | 128 | 116 | 65 | 26 | 65 | ---- | 286 | ---- | 428 | 122 |
| Keg Creek | 179 | 57 | 0 | 0 | 50 | ---- | 0 | 0 | 170 | 67 | 0 | 0 | 0 | 0 | 317 | 514 |
| Lindsey Creek | 0 | 0 | 46 | ---- | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Little Salmon River | 25 | 9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 188 | ---- | 0 | 0 | 0 | 0 |
| Little Sandy Creek | 33 | 11 | 296 | ---- | *** | *** | 0 | 0 | 0 | 0 | 98 | ---- | *** | *** | 0 | 0 |
| Marsh Creek | 199 | 72 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Maxwell Creek | 1,172 | 341 | 1,388 | 632 | 2,784 | 1,146 | 1,077 | 538 | 1,048 | 1,048 | 0 | 0 | 6,705 | 2,728 | 2,018 | 1,016 |
| Mill Creek | 48 | 24 | 18 | ---- | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 46 | ---- |
| Niagara River | *** | *** | *** | *** | 3,017 | 1,469 | 2,160 | 654 | *** | *** | *** | *** | 1,247 | 213 | 1,523 | 374 |
| Ninemile Creek | 52 | 19 | 55 | ---- | | | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| North Sandy Creek | 493 | 307 | 393 | 262 | 340 | ---- | 468 | ---- | 482 | 191 | 0 | 0 | 1,009 | ---- | 162 | ---- |
| Oak Orchard Creek | 3,245 | 818 | 513 | ---- | 1,180 | 493 | 1,622 | 994 | 1,019 | 319 | 65 | ---- | 1,776 | 1,087 | 2,229 | 965 |
| Oswego River | 1,146 | 291 | 742 | 311 | 1,734 | ---- | 206 | ---- | 675 | 218 | 203 | ---- | 1,593 | 749 | 120 | ---- |
| **Salmon River** | **19,682** | **3,280** | **18,598** | **2,735** | **38,760** | **5,692** | **22,981** | **4,032** | **12,158** | **2,026** | **7,399** | **1,088** | **52,498** | **7,710** | **21,701** | **3,807** |
| Sandy Creek | 508 | 161 | 84 | ---- | 614 | 245 | 72 | 19 | 303 | 88 | 0 | 0 | 1,075 | 450 | 896 | 499 |
| 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 | ---- | 700 | ---- | 52 | 20 | 0 | 0 | 1,454 | 635 | 139 | ---- |
| Sterling Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Stony Creek | 0 | 0 | 0 | ---- | 33 | ---- | 0 | 0 | 110 | 44 | 0 | 0 | 0 | 0 | 63 | ---- |
| Webster Park | 135 | 41 | 151 | 130 | 0 | 0 | 0 | 0 | 101 | 101 | 28 | ---- | 205 | 75 | 0 | 0 |
| **Totals** | **33,755** | **8,334** | **24,654** | **5,143** | **54,386** | **11,253** | **33,914** | **8,910** | **21,420** | **6,039** | **10,559** | **1,780** | **73,820** | **17,159** | **32,993** | **8,758** |

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

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

| | March | | | | | | | | April | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| Tributary | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips | Hours | Trips |
| 12 Mile Creek | 1,641 | 2,051 | 0 | 0 | 1,397 | ---- | 877 | ---- | 3,234 | 6,063 | 1,358 | ---- | 1,365 | 1,050 | 309 | ---- |
| 18 Mile Creek | 6,311 | 1,681 | 0 | 0 | 4,017 | 1,678 | 3,015 | 1,429 | 8,943 | 2,257 | 3,408 | ---- | 3,104 | 980 | 1,693 | 1,564 |
| 4 Mile Creek | *** | *** | 0 | 0 | *** | *** | *** | *** | **** | **** | 0 | 0 | *** | *** | *** | *** |
| Bear Creek | 94 | 38 | 228 | ---- | *** | *** | *** | *** | 325 | 217 | 914 | ---- | *** | *** | *** | *** |
| Black River | 929 | 348 | 684 | 363 | 3,414 | ---- | 136 | ---- | 2,303 | 762 | 503 | 251 | 2,458 | 1,542 | 191 | 86 |
| Catfish Creek | 47 | 19 | 113 | ---- | *** | *** | *** | *** | 249 | 101 | 86 | ---- | *** | *** | *** | *** |
| Genesee River | 2,276 | 653 | 883 | 409 | 347 | 197 | 265 | ---- | 4,171 | 1,361 | 869 | ---- | 1,124 | ---- | 2,744 | ---- |
| Grindstone Creek | 59 | 24 | 0 | 0 | 442 | 204 | 136 | ---- | 151 | 106 | 271 | ---- | 121 | ---- | 93 | ---- |
| Irondequoit Creek | 1,592 | 935 | 1,221 | 1,039 | 1,811 | 1,622 | 1,569 | 701 | 8,856 | 3,242 | 8,459 | 5,372 | 7,331 | 4,924 | 3,251 | 1,576 |
| Johnson Creek | 208 | 83 | 57 | ---- | 399 | 182 | 519 | 325 | 606 | 247 | 1,122 | ---- | 0 | 0 | 327 | 151 |
| Keg Creek | 252 | 71 | 0 | 0 | 0 | 0 | 224 | 134 | 258 | 190 | 1,980 | ---- | 234 | ---- | 168 | 128 |
| Lindsey Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 289 | ---- | *** | *** | *** | *** |
| Little Salmon River | 136 | 55 | 259 | ---- | 385 | 385 | 55 | ---- | 376 | 215 | 521 | ---- | 735 | ---- | 141 | ---- |
| Little Sandy Creek | 343 | 183 | 271 | 167 | *** | *** | 308 | ---- | 589 | 240 | 608 | 209 | *** | *** | 365 | ---- |
| Marsh Creek | 242 | 98 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Maxwell Creek | 3,760 | 1,384 | 2,789 | 1,077 | 8,179 | 4,424 | 2,645 | 1,113 | 1,007 | 289 | 4,036 | 1,666 | 1,037 | 571 | 1,057 | 208 |
| Mill Creek | 0 | | 0 | 0 | 1,628 | ---- | 0 | 0 | 307 | 283 | 407 | 70 | 662 | ---- | 0 | 0 |
| Niagara River | *** | *** | *** | *** | 3,677 | 800 | 2,045 | 423 | *** | *** | *** | *** | 5,122 | 1,600 | 2,316 | 506 |
| Ninemile Creek | 94 | 99 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 981 | ---- | *** | *** | *** | *** |
| North Sandy Creek | 621 | 242 | 183 | 53 | 1,388 | 592 | 507 | ---- | 1,201 | 667 | 314 | 292 | 411 | 658 | 1,052 | ---- |
| Oak Orchard Creek | 3,328 | 1,044 | 0 | 0 | 4,273 | 1,706 | 4,705 | 2,555 | 2,872 | 850 | 1,740 | 2,319 | 2,343 | 567 | 2,210 | 907 |
| Oswego River | 3,508 | 1,031 | 1,314 | 791 | 2,680 | 1,709 | 743 | 216 | 2,889 | 853 | 571 | 317 | 1,101 | 1,218 | 953 | 1,203 |
| **Salmon River** | **38,385** | **6,398** | **25,461** | **3,744** | **85,184** | **12,511** | **38,035** | **6,673** | **51,564** | **8,594** | **24,230** | **5,409** | **87,777** | **12,891** | **58,854** | **10,325** |
| Sandy Creek | 1,237 | 424 | 1,132 | 681 | 1,732 | 1,139 | 541 | 301 | 1,416 | 626 | 667 | 304 | 405 | 374 | 105 | 34 |
| 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 | 731 | ---- | 4,115 | 975 | 607 | ---- | 2,889 | 1,677 | 1,180 | ---- |
| Sterling Creek | 320 | 151 | 89 | ---- | *** | *** | *** | *** | 0 | 0 | 368 | ---- | *** | *** | *** | *** |
| Stony Creek | 553 | 222 | 157 | ---- | 1,060 | ---- | 415 | ---- | 522 | 167 | 343 | 181 | 1,061 | ---- | 95 | ---- |
| Webster Park | 537 | 537 | 998 | 932 | 247 | ---- | 38 | 0 | 499 | 203 | 470 | 528 | 0 | 0 | 40 | ---- |
| **Totals** | **69,670** | **18,917** | **37,087** | **9,901** | **126,414** | **29,042** | **57,509** | **13,870** | **99,807** | **30,446** | **56,109** | **17,266** | **119,281** | **28,051** | **77,144** | **16,688** |

---- = 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 | 2015-2016 |
|---|---|---|---|---|
| Sept. week 1 | *** | *** | 9,352 | 7,829 |
| Sept. week 2 | 19,987 | 7,385 | 27,585 | 10,644 |
| Sept. week 3 | 33,341 | 29,781 | 42,486 | 26,627 |
| Sept. week 4 | 54,461 | 42,766 | 68,376 | 46,270 |
| Sept. week 5 | | | 114,039 | 85,110 |
| Sept. Total | **107,789** | **79,932** | **261,838** | **176,480** |
| Oct. week 1 | 75,230 | 91,334 | 142,962 | 107,513 |
| Oct. week 2 | 98,942 | 110,372 | 96,748 | 90,188 |
| Oct. week 3 | 62,876 | 89,264 | 63,751 | 49,145 |
| Oct. week 4 | 36,225 | 39,763 | 35,556 | 29,933 |
| Oct. week 5 | 14,170 | 11,631 | | |
| Oct. Total | **287,443** | **342,364** | **339,017** | **276,779** |
| Nov. week 1 | 21,585 | 8,963 | 42,144 | 34,844 |
| Nov. week 2 | 16,978 | 12,493 | 42,942 | 29,167 |
| Nov. week 3 | 14,291 | 8,456 | 31,042 | 21,243 |
| Nov. week 4 | 8,564 | 14,841 | 29,394 | 19,094 |
| Nov. Total | **61,418** | **44,753** | **145,522** | **104,347** |
| December | 23,220 | 36,783 | 59,603 | 31,453 |
| January | 19,682 | 18,598 | 38,760 | 22,981 |
| February | 12,158 | 7,399 | 52,498 | 21,701 |
| March | 38,385 | 25,461 | 85,184 | 38,035 |
| April | 51,564 | 24,230 | 87,777 | 58,854 |
| May (through mid-month) | 4,114 | 15,747 | 7,118 | 4,772 |
| **Totals** | **605,773** | **595,267** | **1,077,317** | **735,402** |

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

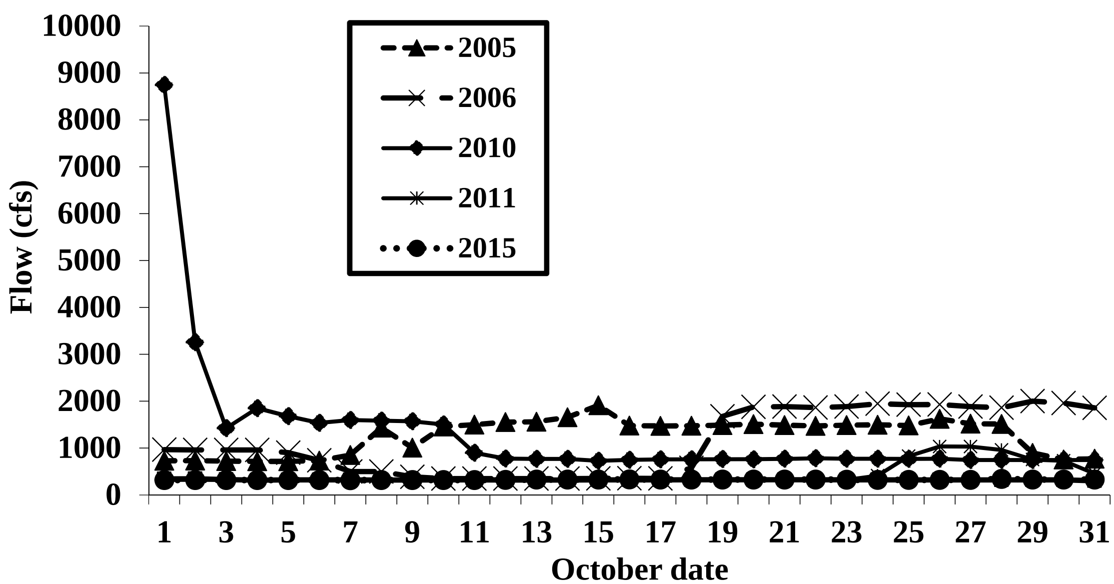


**Figure 2. October water releases from the Lighthouse Hill Reservoir on the Salmon River by year (Brookfield Power Co. records).**

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

| Year | Dates | Angler trips | Chinook salmon Catch | Chinook salmon Harvest | Steelhead Catch | Steelhead 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 |
| 2015 | Sept 1 to Nov 30 | 101,465 | 23,940 | 12,305 | 11,334 | 1,401 |
| 2015-2016 | Sept 1 to May 15 | 129,018 | 23,940 | 12,305 | 25,170 | 3,405 |

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

| Fishing type | 2005-2006 Effort (angler hours) | 2005-2006 Mean trip length | 2005-2006 Est. angler trips | 2006-2007 Effort (angler hours) | 2006-2007 Mean trip length | 2006-2007 Est. angler trips | 2011-2012 Effort (angler hours) | 2011-2012 Mean trip length | 2011-2012 Est. angler trips | 2015-2016 Effort (angler hours) | 2015-2016 Mean trip length | 2015-2016 Est. angler trips |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Shore access (conv. regs.) | 449,520 | 6 | 74,966 | 436,096 | 6.8 | 64,607 | 842,074 | 6.5 | 129,351 | 579,036 | 6.0 | 97,125 |
| Drift boat | 42,598 | 7.7 | 5,520 | 35,213 | 7.7 | 4,549 | 88,720 | 7.4 | 11,973 | 56,674 | 7.2 | 7,898 |
| Special regs. Fly | 66,476 | 6.2 | 10,819 | 57,300 | 6.5 | 8,788 | 96,665 | 6.6 | 14,646 | 73,096 | 6.2 | 11,745 |
| Estuary boat | 9,368 | 4.6 | 2,032 | 10,407 | 6.3 | 1,657 | 16,503 | 5.9 | 2,778 | 9,731 | 4.7 | 2,066 |
| Tribs | 37,809 | 5.8 | 6,551 | 56,251 | 6.5 | 8,614 | 33,354 | 4.9 | 6,779 | 16,865 | 4.4 | 3,843 |
| **Total** | **605,772** | **6.1** | **98,959** | **595,267** | **6.8** | **87,539** | **1,077,316** | **6.8** | **158,219** | **735,402** | **5.7** | **129,204** |

shore of the lake in 2014-2015. They reported an estimated 239,716 angler hours on their side of the lake as a comparison (OMNRF 2015). However they have much different seasonal angling regulations so a direct comparison isn't appropriate. Their Lake Ontario tributaries are only open from the 4th Saturday in April until September 30th.

The tributary estimate of 256,894 trips in 2015-2016 (Table 1) was more than four times the estimated open lake boat trips in 2015 (53,154) (Lantry and Eckert 2016). In 2005-2006 the number of tributary angling trips was very similar to the number of angler trips in the 2005 open lake boat fishery. However, in the subsequent surveys the tributary fishery has had consistently higher effort than on the open lake.

*Interviews*
A total of 9,968 interviews were obtained during 2015-2016, up from 6,225, 6,516, and 8,953 in the previous surveys, respectively (Table 6). On the Salmon River, parties of anglers associated with a specific vehicle or boat were interviewed. The interviews from the other tributaries were obtained from individual anglers. The Salmon River accounted for 41% of the total number of interviews. Five tributaries had over 200 interviews completed (Table 6).

<u>Catch and Harvest</u>
*Chinook Salmon*
Eighteen of 21 tributaries surveyed had reported catches of Chinook salmon. The estimated catch and harvest of Chinook salmon on all tributaries surveyed in 2015 was 43,589 and 13,740 (Table 7). The catch of Chinooks was markedly less than the 2005, 2006, and 2011 estimates of 170,441 and 152,155, and 126,259 fish respectively. The harvest followed the same pattern of sharp decline from the 49,363, 55,634, and 45,612 estimated in 2005, 2006, and 2011 respectively. Overall, tributary anglers harvested 32% of Chinooks caught. The Salmon River accounted for 55% (23,940) of the catch and 47% (12,305) 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 2010 surveys (Table 4). The harvest rate jumped back up to 51% in 2015, likely due to the poor fishing and limited catches. In comparison, the open lake fishery harvested 59.4% (catch = 58,870; harvest = 34,951) of all Chinooks caught in 2015 (Lantry and Eckert 2016).

Eighty-two percent of the Chinook catch in all the tributaries occurred in October, with September and November trailing far behind at less than 10% respectively (Table 8). For the Salmon River it was 80% and 11% in October and September, respectively. The salmon run typically starts earlier in the Salmon River than the other tributaries, often seeing substantial numbers of fish over Labor Day weekend. The peak catches on the Salmon River in 2015 were during the first week in October (Figure 3).

As in past surveys on the Salmon River, the conventional regulations section yielded by far the most number of fish caught and harvested (17,922 and 9,461 respectively) (Table 9).

The general trend of increasing release rates observed in more recent tributary surveys may be related to the ban on snagging, which was phased out during the mid-1990s and an increase in the popularity of catch and release fishing in the tributaries. The top waters for Chinook salmon angling following the Salmon River were Oak Orchard, North Sandy, Little Sandy, Eighteenmile, and South Sandy creeks. Eight of the 21 tributaries had an estimated catch of 1,000 or more Chinook salmon (Table 7). This is down from the 11 of 21 tributaries with catches over a thousand in 2011.

*Coho Salmon*
Coho salmon were a smaller component of the tributary fishery in 2015 only being caught in eight of the 21 tributaries surveyed and totaling 6,061 fish (Table 10). While this result was similar to the 5,804 fish estimated to have been caught in 2005, it is far below

the 2006 and 2011 estimates of 18,047 and 30,857 fish, respectively. This compares to the 1984 study where an estimated 13,831 Coho were caught and 10,608 harvested (NYSDEC 1984). The Salmon River accounted for 95% of the catch (5,738) and 89% of the Coho harvest (2,307) in 2015. Johnson Creek was the only other tributary in 2015 to have more than 100 fish estimated to have been caught (140) (Table 10). The release rates for Coho salmon increased on the tributaries from 23% in 1984 to 74% in 2006, but declined to 66% and 57% in 2011 and 2015, respectively. As with the Chinooks, the poor fishing and low Coho catches likely contributed to the increased harvest rate in 2015. In comparison, the 2015 open lake boat fishery had an estimated catch and harvest of 4,260 and 2,078 Coho salmon, respectively (Lantry and Eckert 2016). October had the highest monthly catch of Coho (Table 11).

*Steelhead*

Steelhead is the primary species sought by post-salmon run tributary anglers. This fishery gains momentum 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 48,893 in 2015-2016, which is far below the estimated 170,642 caught in 2011-2012 (Table 12). The 2005-2006 and 2006-2007 surveys yielded 77,153 and 56,488 steelhead caught, respectively (Table 12). The estimated catch in the 1984 survey was 90,037 (NYSDEC 1984). The Salmon River had by far the highest estimated number of steelhead caught with 25,170 fish, which is well below the estimated 96,398 fish caught in 2011-2012 (Table 12). However the current survey result was slightly higher than the 2005-2006 and 2006-2007 estimates of just over 20,000 fish caught each year. Oak Orchard, Eighteenmile, Maxwell, and Sandy creeks as well as the Niagara River all had over 2,000 fish estimated to have been caught in 2015-2016 (Table 12). The peak steelhead catches were in November (9,576) and April (8,342) (Table 13). This pattern is similar to prior results; however the steelhead catch remained high through the entire winter in 2011-2012 because of the mild winter and near ideal fishing conditions. The estimated catch for February 2016 was only 232 fish for all the surveyed tributaries (Table 13).

The May (1st through 15th) Salmon River steelhead catch was much lower in 2016 than in either 2007 or 2012 (438 versus 1,295 and 1,281, respectively), but slightly higher than in 2006 (363) (Table 14).

Increasing release rates in recent years (88 % in 2015-2016) are a result of anglers' desire to conserve steelhead to maintain the quality of the fishery.

The open lake boat fishery caught (17,509) and harvested (9,212) steelhead/rainbow trout in 2015 (Lantry and Eckert 2016). The release rate was 47%, far lower than on the tributaries.

*Brown trout*

Twelve of 21 tributaries surveyed had reported catches of brown trout in this study. For all tributaries surveyed, estimated brown trout catches were 18,182 in 2015-2016, well below the previous lowest estimated catch of 39,065 in 2006-2007 (Table 15). The harvest was estimated to have been 3,512, which was less than half of the previous lowest estimated harvest of 8,342 in 2011-2012 (Table 15). Catch (5,023) of brown trout from Oak Orchard Creek was higher than for any other tributary in 2015-2016. Irondequoit Creek had the highest harvest at 817 fish, which is considerably lower than past results from that creek (Table 15). Irondequoit and Sandy creeks both had over 4,000 brown trout caught in 2015-2016 (Table 15). Brown trout on the Salmon River were fairly scarce in 2015-2016, with an estimate of only 372 being caught. This was a drastic decline from the 6,604 fish caught in 2011-2012 (Table 15).

**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 trip type | | | 2015-2016 trip type | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary | Completed | Incompeted | Total | Completed | Incompeted | Total | Completed | Incompeted | Total | Completed | Incompeted | Total |
| 12 Mile Creek | 2 | 13 | 15 | 2 | 31 | 33 | 5 | 88 | 93 | 8 | 33 | 41 |
| 18 Mile Creek | 90 | 375 | 465 | 33 | 188 | 221 | 151 | 546 | 697 | 894 | 487 | 1,381 |
| 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 | 14 | 57 | 72 |
| Catfish Creek | 22 | 32 | 54 | 14 | 23 | 37 | *** | *** | *** | *** | *** | *** |
| Genesee River | 144 | 34 | 178 | 84 | 56 | 140 | 41 | 70 | 111 | 69 | 57 | 131 |
| Grindstone Creek | 3 | 14 | 17 | 11 | 16 | 27 | 4 | 20 | 24 | 7 | 9 | 16 |
| Irondequoit Creek | 81 | 22 | 103 | 78 | 114 | 192 | 57 | 116 | 173 | 71 | 126 | 199 |
| Johnson Creek | 21 | 24 | 45 | 8 | 62 | 70 | 14 | 64 | 78 | 61 | 82 | 143 |
| Keg Creek | 9 | 31 | 40 | 2 | 27 | 29 | 0 | 3 | 3 | 12 | 27 | 39 |
| Little Salmon River | 26 | 36 | 62 | 21 | 65 | 86 | 14 | 66 | 80 | 4 | 4 | 8 |
| Lindsey Creek | 0 | 0 | 0 | 0 | 1 | 1 | *** | *** | *** | *** | *** | *** |
| Little Sandy Creek | 17 | 61 | 78 | 35 | 72 | 107 | *** | *** | *** | 5 | 3 | 8 |
| Marsh Creek | 0 | 0 | 0 | 0 | 0 | 0 | *** | *** | *** | *** | *** | *** |
| Maxwell Creek | 55 | 123 | 178 | 226 | 320 | 546 | 139 | 185 | 324 | 113 | 146 | 259 |
| Mill Creek | 18 | 38 | 56 | 7 | 3 | 10 | 0 | 54 | 54 | 0 | 0 | 0 |
| Niagara River | *** | *** | *** | *** | *** | *** | 251 | 213 | 464 | 886 | 736 | 1,622 |
| Ninemile Creek | 11 | 8 | 19 | 21 | 101 | 122 | *** | *** | *** | *** | *** | *** |
| North Sandy Creek | 84 | 46 | 130 | 56 | 52 | 108 | 33 | 75 | 108 | 1 | 2 | 3 |
| Oak Orchard Creek | 201 | 45 | 246 | 34 | 160 | 194 | 93 | 139 | 232 | 771 | 755 | 1,526 |
| Oswego River | 256 | 626 | 882 | 328 | 818 | 1,146 | 69 | 1,059 | 1,128 | 17 | 140 | 158 |
| **Salmon River** | **1,944** | **1,106** | **3,050** | **911** | **1,812** | **2,723** | **3,124** | **1,288** | **4,412** | **2,802** | **1,242** | **4,044** |
| Sandy Creek | 112 | 60 | 172 | 55 | 74 | 129 | 95 | 93 | 188 | 88 | 72 | 162 |
| 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 | 17 | 140 | 158 |
| Sterling Creek | 11 | 10 | 21 | 2 | 33 | 35 | *** | *** | *** | *** | *** | *** |
| Stony Creek | 8 | 27 | 35 | 10 | 17 | 27 | 3 | 22 | 25 | 0 | 7 | 7 |
| Webster Park | 37 | 24 | 61 | 27 | 45 | 72 | 12 | 32 | 44 | 1 | 2 | 3 |
| **Totals** | **3,297** | **2,928** | **6,225** | **2,133** | **4,383** | **6,516** | **4,249** | **4,704** | **8,953** | **5,841** | **4,127** | **9,968** |

* - 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.

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

| | Overall | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.237 | 14,764 | 0.211 | 13,606 | 0.100 | 9,703 | 0.091 | 2,799 | 0.007 | 436 | 0.049 | 3,187 | 0.022 | 2,106 | 0.037 | 1,150 |
| 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 | 0.083 | 318 | 0.313 | 5,467 | 0.233 | 2,842 | 0.082 | 2,029 | 0.043 | 163 |
| 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 | 0.100 | 1,036 | 0.067 | 936 | 0.106 | 1,089 | 0.048 | 478 | 0.090 | 932 |
| Grindstone Creek | 0.293 | 522 | 0.04 | 56 | 0.529 | 431 | 0.052 | 206 | 0.042 | 76 | 0.04 | 56 | 0.000 | 0 | 0.052 | 206 |
| Irondequoit Creek | 0.045 | 99 | 0.014 | 39 | 0.064 | 292 | 0.011 | 38 | 0 | 0 | 0.014 | 39 | 0.007 | 33 | 0.007 | 25 |
| Johnson Creek | 0.267 | 1,117 | 0.227 | 1,623 | 0.082 | 508 | 0.095 | 426 | 0.185 | 772 | 0.074 | 527 | 0.025 | 153 | 0.061 | 276 |
| 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 | 0.000 | 0 | 0.181 | 786 | 0.09 | 302 | 0.276 | 1,095 | 0.000 | 0 |
| Little Sandy Creek | 0.212 | 379 | 0.14 | 275 | ** | ** | 0.763 | 1,784 | 0.09 | 160 | 0.14 | 275 | ** | ** | 0.763 | 1,784 |
| Marsh Creek | ---- | ---- | ---- | ---- | ** | ** | ** | ** | 0 | 0 | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0.044 | 398 | 0.035 | 460 | 0.124 | 2,466 | 0.038 | 222 | 0.013 | 121 | 0.018 | 236 | 0.015 | 305 | 0.036 | 209 |
| 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 | 0.040 | 649 | ** | ** | ** | ** | 0.026 | 642 | 0.025 | 403 |
| 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 | 1.297 | 2,585 | 0.122 | 1,939 | 0.115 | 652 | 0.015 | 125 | 1.297 | 2,585 |
| Oak Orchard Creek | 0.113 | 6,829 | 0.427 | 18,943 | 0.237 | 9,674 | 0.119 | 6,190 | 0.012 | 741 | 0.143 | 6,340 | 0.056 | 2,299 | 0.066 | 3,413 |
| Oswego River | 0.131 | 7,987 | 0.085 | 3,749 | 0.083 | 4,088 | 0.118 | 1,035 | 0.065 | 3,928 | 0.038 | 1,690 | 0.024 | 1,212 | 0.073 | 640 |
| **Salmon River** | **0.185** | **89,448** | **0.192** | **96,088** | **0.115** | **86,184** | **0.041** | **23,940** | **0.054** | **25,998** | **0.067** | **33,530** | **0.042** | **31,915** | **0.021** | **12,305** |
| Sandy Creek | 0.148 | 1,759 | 0.031 | 127 | 0.095 | 1,506 | 0.084 | 929 | 0.068 | 806 | 0.003 | 14 | 0.056 | 884 | 0.062 | 691 |
| 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 | 0.074 | 1,242 | 0.226 | 4,785 | 0.162 | 3,369 | 0.039 | 1,747 | 0.064 | 1,073 |
| Sterling Creek | 0.458 | 873 | 0.284 | 400 | ** | ** | | | 0.043 | 83 | 0.122 | 172 | ** | ** | ** | ** |
| Stony Creek | 0.176 | 136 | 0 | 0 | 0.000 | 0 | 0.178 | 189 | 0.136 | 106 | 0 | 0 | 0.000 | 0 | 0.178 | 189 |
| 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** | | **43,589** | | **49,363** | | **55,634** | | **45,612** | | **26,045** |

* = 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 in September by month, tributary, and year.**

| | September | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.299 | 424 | 0.102 | 1,211 | 0.007 | 35 | 0.097 | 134 | 0.021 | 30 | 0.009 | 101 | 0.007 | 35 | 0.048 | 66 |
| Bear Creek | 0 | 0 | ---- | ---- | ** | ** | ** | ** | 0 | 0 | ---- | ---- | ** | ** | ** | ** |
| Black River | 0.701 | 1,746 | 0.356 | 1,293 | 0.000 | 0 | 0.000 | 0 | 0.176 | 439 | 0.167 | 606 | 0.000 | 0 | 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 | 0.082 | 208 | 0 | 0 | 0.05 | 180 | 0.024 | 104 | 0.082 | 208 |
| Grindstone Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Irondequoit Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Keg Creek | 0 | 0 | ---- | ---- | 0.000 | 0 | ---- | ---- | 0 | 0 | ---- | ---- | 0.000 | 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 | 0.000 | 0 |
| Little Sandy Creek | 0.307 | 85 | 0.114 | 43 | ** | ** | ---- | ---- | 0.307 | 85 | 0.114 | 43 | ** | ** | 0.000 | 0 |
| Marsh Creek | ---- | ---- | ---- | ---- | ** | ** | ** | ** | ---- | ---- | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0 | 0 | 0.007 | 6 | ---- | ---- | ---- | ---- | 0 | 0 | 0.007 | 6 | ---- | ---- | 0.000 | 0 |
| Mill Creek | 0.316 | 40 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Niagara River | ** | ** | ** | ** | 0.061 | 226 | 0.044 | 171 | ** | ** | ** | ** | 0.058 | 214 | 0.030 | 116 |
| 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 | 0.000 | 0 |
| Oak Orchard Creek | 0.55 | 1,026 | 0.809 | 7,784 | 0.227 | 406 | 0.041 | 171 | 0.026 | 49 | 0.115 | 1,106 | 0.028 | 51 | 0.024 | 97 |
| Oswego River | 0.23 | 2,479 | 0.081 | 1,718 | 0.096 | 1,891 | 0.000 | 0 | 0.102 | 1,098 | 0.029 | 614 | 0.022 | 426 | 0.000 | 0 |
| **Salmon River** | **0.215** | **39,431** | **0.118** | **20,228** | **0.072** | **18,915** | **0.030** | **2,715** | **0.046** | **8,425** | **0.029** | **4,917** | **0.022** | **5,834** | **0.016** | **1,438** |
| Sandy Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 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 | ---- | ---- | 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 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| **Totals** | | **47,675** | | **32,984** | | **21,757** | | **3,397** | | **10,458** | | **7,902** | | **6,678** | | **1,925** |

* = 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 tributary, month, and year.**

| | October | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.115 | 3,342 | 0.271 | 7,907 | 0.089 | 5,322 | 0.112 | 2,323 | 0.014 | 398 | 0.088 | 2,574 | 0.027 | 1,627 | 0.050 | 1,038 |
| 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 | 0.135 | 301 | 0.371 | 4,777 | 0.291 | 2,098 | 0.101 | 1,960 | 0.068 | 153 |
| 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 | 0.117 | 720 | 0.106 | 933 | 0.149 | 905 | 0.044 | 208 | 0.102 | 630 |
| Grindstone Creek | 0.4 | 522 | 0.081 | 56 | 0.800 | 463 | 0.067 | 134 | 0.058 | 75 | 0.081 | 56 | 0.000 | 0 | 0.067 | 134 |
| Irondequoit Creek | 0.094 | 99 | 0.043 | 39 | 0.084 | 225 | 0.000 | 0 | 0 | 0 | 0.043 | 39 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0.385 | 1,117 | 0.402 | 1,368 | 0.102 | 500 | 0.117 | 311 | 0.266 | 771 | 0.155 | 527 | 0.031 | 150 | 0.063 | 167 |
| 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 | 0.000 | 0 | 0.185 | 788 | 0.084 | 212 | 0.289 | 1,079 | 0.000 | 0 |
| Little Sandy Creek | 0.197 | 290 | 0.161 | 232 | ** | ** | 0.872 | 1,561 | 0.048 | 70 | 0.161 | 232 | ** | ** | 0.872 | 1,561 |
| Marsh Creek | ---- | ---- | ---- | ---- | ** | ** | ** | ** | ---- | ---- | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0.079 | 282 | 0.076 | 388 | 0.498 | 4,059 | 0.143 | 291 | 0.02 | 71 | 0.042 | 213 | 0.069 | 560 | 0.126 | 255 |
| 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 | 0.064 | 397 | ** | ** | ** | ** | 0.037 | 353 | 0.018 | 114 |
| 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 | 1.297 | 1,604 | 0.141 | 1,936 | 0.181 | 632 | 0.065 | 364 | 1.297 | 1,604 |
| Oak Orchard Creek | 0.147 | 5,650 | 0.424 | 10,378 | 0.354 | 7,339 | 0.157 | 4,999 | 0.018 | 678 | 0.214 | 5,222 | 0.079 | 1,643 | 0.088 | 2,784 |
| Oswego River | 0.127 | 5,084 | 0.099 | 1,957 | 0.101 | 1,900 | 0.094 | 515 | 0.065 | 2,622 | 0.054 | 1,078 | 0.037 | 696 | 0.049 | 271 |
| **Salmon River** | **0.205** | **43,114** | **0.256** | **64,143** | **0.164** | **55,703** | **0.058** | **19,170** | **0.075** | **15,812** | **0.099** | **24,824** | **0.061** | **20,784** | **0.029** | **9,786** |
| Sandy Creek | 0.271 | 1,498 | 0.112 | 116 | 0.366 | 2,259 | 0.306 | 1,425 | 0.146 | 808 | 0.013 | 14 | 0.231 | 1,429 | 0.204 | 949 |
| 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 | 0.142 | 1,848 | 0.262 | 4,458 | 0.2 | 2,917 | 0.110 | 3,717 | 0.102 | 1,319 |
| Sterling Creek | 0.537 | 671 | 0.373 | 400 | ** | ** | | | 0.025 | 31 | 0.16 | 171 | ** | ** | ** | ** |
| Stony Creek | 0.264 | 136 | ---- | ---- | 0.000 | 0 | 0.184 | 189 | 0.205 | 106 | ---- | ---- | 0.000 | 0 | 0.148 | 153 |
| Webster Park | 0.435 | 197 | 0.563 | 518 | 0.000 | 0 | 0.000 | 0 | 0.153 | 69 | 0.07 | 64 | 0.000 | 0 | 0.000 | 0 |
| **Totals** | | **101,987** | | **100,235** | | **91,823** | | **35,790** | | **36,015** | | **42,371** | | **35,193** | | **20,916** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.292 | 10,990 | 0.192 | 4,503 | 0.138 | 4,513 | 0.043 | 372 | 0 | 0 | 0.022 | 511 | 0.017 | 566 | 0.004 | 36 |
| Bear Creek | 0.066 | 31 | 0 | 0 | ** | ** | ** | ** | 0.066 | 31 | 0 | 0 | ** | ** | ** | ** |
| Black River | 0.121 | 252 | 0.223 | 296 | 0.102 | 318 | 0.000 | 0 | 0.121 | 252 | 0.103 | 137 | 0.021 | 64 | 0.000 | 0 |
| Catfish Creek | 0.467 | 372 | 0 | 0 | ** | ** | ** | ** | 0.405 | 323 | 0 | 0 | ** | ** | ** | ** |
| Genesee River | 0.043 | 142 | ---- | ---- | 0.372 | 327 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.327 | 288 | 0.000 | 0 |
| 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 | 0.024 | 43 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.016 | 29 |
| Johnson Creek | 0 | 0 | 0.104 | 254 | 0.000 | 0 | 0.094 | 136 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.074 | 106 |
| 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 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Little Sandy Creek | 0.112 | 4 | 0 | 0 | ** | ** | 0.000 | 0 | 0.112 | 4 | 0 | 0 | ** | ** | 0.000 | 0 |
| Marsh Creek | ---- | ---- | ---- | ---- | ** | ** | ** | ** | ---- | ---- | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0.021 | 116 | 0.009 | 69 | 0.059 | 696 | 0.021 | 73 | 0.009 | 49 | 0.002 | 14 | 0.006 | 75 | 0.021 | 73 |
| 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 | 0.008 | 46 | ** | ** | ** | ** | 0.007 | 86 | 0.001 | 7 |
| 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 * | 0.052 | 822 | 0 | 0 | 0 | 0 | 0 * | 0 * | 0.028 | 452 |
| Oswego River | 0.043 | 405 | 0.022 | 74 | 0.022 | 247 | 0.268 | 519 | 0.023 | 215 | 0.002 | 8 | 0.005 | 52 | 0.188 | 364 |
| **Salmon River** | **0.026** | **1,668** | **0.094** | **4,195** | **0.009** | **1,347** | **0.007** | **694** | **0.004** | **240** | **0.023** | **1,009** | **0.002** | **350** | **0.004** | **370** |
| Sandy Creek | 0.041 | 264 | 0.004 | 11 | 0.006 | 62 | 0.021 | 133 | 0 | 0 | 0 | 0 | 0.006 | 62 | 0.000 | 0 |
| 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 | 0.022 | 57 | 0 | 0 | 0.083 | 245 | 0.006 | 26 | 0.022 | 57 |
| 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 | 0.000 | 0 | 0 | 0 | 0.125 | 205 | 0.049 | 41 | 0.000 | 0 |
| **Totals** | | **15,524** | | **11,450** | | **7,940** | | **2,895** | | **1,356** | | **2,579** | | **1,610** | | **1,494** |

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

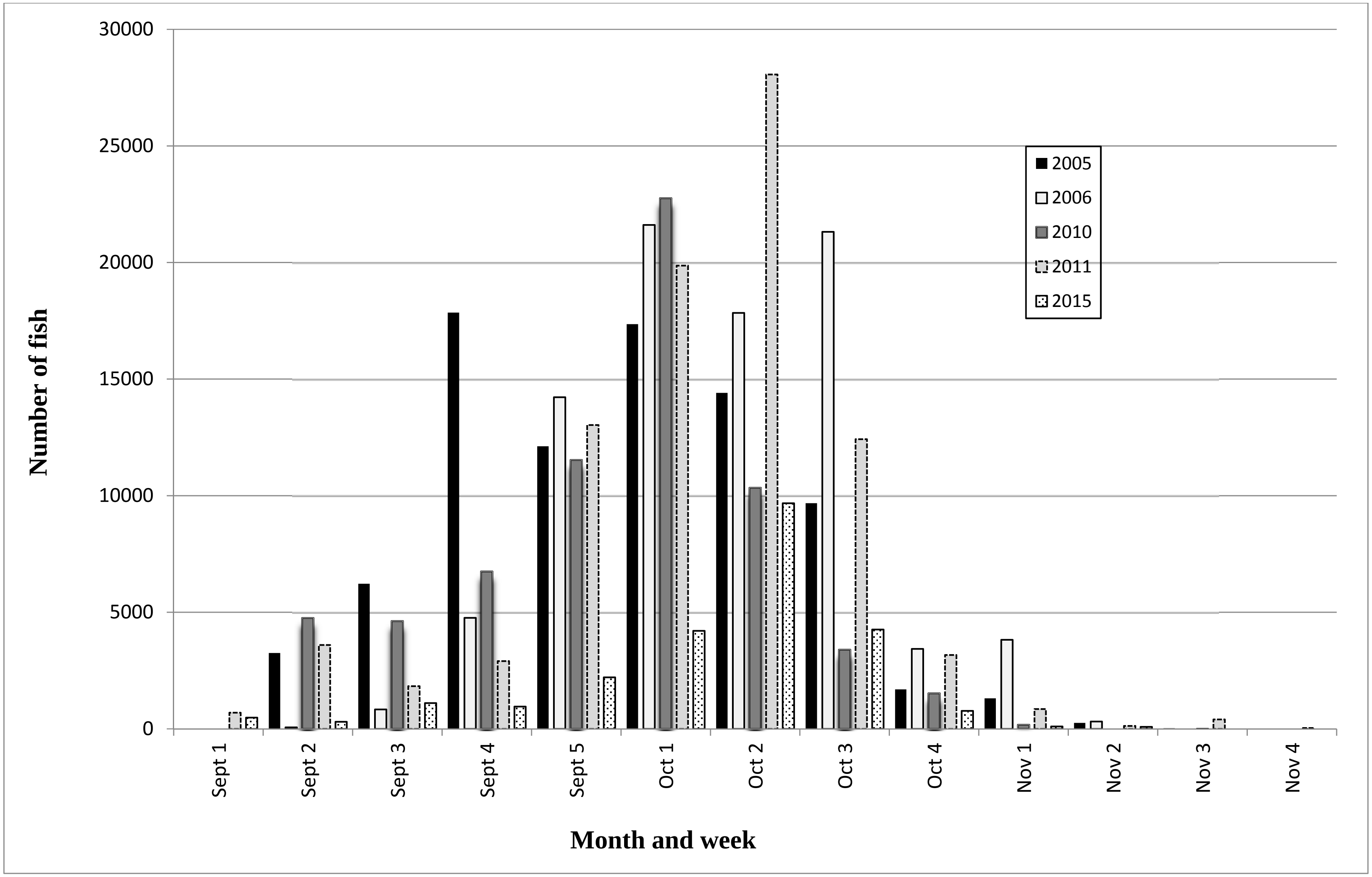


**Figure 3. Estimated Chinook salmon catch on the Salmon River by month, week, and year.**

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

| | | 2005-2006 | | | | 2006-2007 | | | | 2011-2012 | | | | 2015-2016 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 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 | 0.036 | 17,922 | 0.019 | 9,461 |
| | Drift boat | 0.096 | 4,089 | 0.027 | 1,152 | 0.042 | 1,470 | 0.021 | 732 | 0.057 | 1,849 | 0.026 | 839 | 0.043 | 921 | 0.027 | 585 |
| | Special regs. Fly | 0.076 | 5,071 | 0.000 | 0 | 0.049 | 2,832 | 0.000 | 22 | 0.099 | 5,766 | 0.000 | 0 | 0.061 | 3,056 | 0.002 | 100 |
| | Estuary boat | 0.008 | 76 | 0.007 | 65 | 0.455 | 4,736 | 0.117 | 1,216 | 0.058 | 954 | 0.043 | 703 | 0.045 | 426 | 0.045 | 426 |
| | 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 | 0.089 | 1,297 | 0.086 | 1,241 |
| | 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 | 0.041 | 23,940 | 0.021 | 12,305 |
| 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 | 0.024 | 13,793 | 0.003 | 1,882 |
| | 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 | 0.127 | 7,175 | 0.026 | 1,485 |
| | Special regs. Fly | 0.075 | 5,018 | 0.000 | 4 | 0.051 | 2,905 | 0.002 | 122 | 0.147 | 14,224 | 0.000 | 14 | 0.057 | 4,142 | 0.000 | 0 |
| | Estuary boat | 0.000 | 0 | 0.000 | 0 | 0.072 | 746 | 0.000 | 0 | 0.055 | 908 | 0.002 | 28 | 0.003 | 25 | 0.003 | 25 |
| | Tributaries | 0.017 | 651 | 0.006 | 231 | 0.008 | 473 | 0.003 | 185 | 0.033 | 1,099 | 0.004 | 133 | 0.000 | 0 | 0.000 | 0 |
| | 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 | 0.034 | 25,335 | 0.005 | 3,427 |
| 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 | 0.003 | 2,133 | 0.000 | 154 |
| Coho salmon | All types | 0.010 | 5,834 | 0.004 | 2,253 | 0.023 | 13,649 | 0.005 | 2,720 | 0.039 | 42,285 | 0.014 | 14,748 | 0.010 | 5,738 | 0.004 | 2,307 |
| Atlantic salmon | All types | 0.000 | 295 | 0.000 | 0 | 0.000 | 232 | 0.000 | 0 | 0.001 | 614 | 0.000 | 11 | 0.000 | 272 | 0.000 | 37 |

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

The release rate of brown trout for all tributaries was 81%, which is close to the 84% found in 2011-2012. Both the most recent values were a noticeable increase from the 74% and 68% in the 2005-2006 and 2006-2007 surveys, respectively. The Salmon River release rate (93%) was higher, but similar to past results (88%, 81%, and 89% in 2005-2006, 2006-2007, and 2011-2012, respectively).

November had the highest monthly catch for all the tributaries (6,657), which is consistent with prior results (Table 16). On the Salmon River, November had the highest brown trout catch (635), followed closely by October with an estimated 518 fish caught (Table 16).

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 2015 open lake boat fishery were 20,780 and 12,590, respectively. (Lantry and Eckert 2012). The boat fishery release rate was 39%, compared to the 81% for the tributary anglers.

<u>Angler residency</u>

Fifty-nine percent of the anglers or parties surveyed on the Salmon River were non-New York State residents, which is virtually identical to the previous two studies (Table 17). The other "high use" tributaries (Oswego River, Oak Orchard, South Sandy, and Eighteenmile creeks) ranged from 42 to 51% non-residents. By contrast, non-residents comprised approximately 0% and 40% 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.

## Acknowledgments

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

| | Overall | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0 | 0 | 0.032 | 2,062 | 0.011 | 1,041 | 0.000 | 7 | 0 | 0 | 0.013 | 829 | 0.002 | 176 | 0.000 | 7 |
| Bear Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Black River | 0 | 0 | 0.003 | 36 | 0.004 | 98 | 0.007 | 26 | 0 | 0 | 0.003 | 36 | 0.001 | 15 | 0.007 | 26 |
| Catfish Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Genesee River | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Grindstone Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Irondequoit Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0.008 | 35 | 0.01 | 75 | 0.000 | 0 | 0.031 | 140 | 0.008 | 35 | 0 | 0 | 0.000 | 0 | 0.031 | 140 |
| 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 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.003 | 10 | 0.000 | 0 |
| Little Sandy Creek | 0 | 0 | 0 | 0 | ** | ** | 0.000 | 0 | 0 | 0 | 0 | 0 | ** | ** | 0.000 | 0 |
| Marsh Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0.007 | 63 | 0.002 | 25 | 0.010 | 189 | 0.005 | 28 | 0.005 | 47 | 0.001 | 10 | 0.002 | 49 | 0.003 | 16 |
| Mill Creek | 0 | 0 | 0 | 0 | 0.007 | 29 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- |
| Niagara River | ** | ** | ** | ** | 0.001 | 34 | 0.003 | 51 | ** | ** | ** | ** | 0.001 | 20 | 0.003 | 51 |
| Ninemile Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| North Sandy Creek | 0.01 | 151 | 0 | 0 | 0.003 | 29 | 0.000 | 0 | 0.003 | 55 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Oak Orchard Creek | 0 | 0 | 0.025 | 1,126 | 0.002 | 85 | 0.000 | 13 | 0 | 0 | 0.015 | 660 | 0.000 | 0 | 0.000 | 0 |
| Oswego River | 0.001 | 59 | 0.002 | 105 | 0.001 | 33 | 0.001 | 8 | 0 | 19 | 0.001 | 42 | 0.000 | 6 | 0.001 | 8 |
| **Salmon River** | **0.012** | **5,659** | **0.029** | **14,513** | **0.039** | **29,295** | **0.010** | **5,738** | **0.005** | **2,177** | **0.006** | **3,002** | **0.014** | **10,218** | **0.004** | **2,307** |
| Sandy Creek | 0.003 | 39 | 0.006 | 24 | 0.000 | 0 | 0.005 | 50 | 0 | 0 | 0.006 | 24 | 0.000 | 0 | 0.002 | 27 |
| 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Sterling Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Stony Creek | 0 | 0 | 0.02 | 18 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0.02 | 18 | 0.000 | 0 | 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** | | **6,061** | | **2,383** | | **4,645** | | **10,507** | | **2,582** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0 | 0 | 0.011 | 127 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0.011 | 127 | 0.000 | 0 | 0.000 | 0 |
| Bear Creek | 0 | 0 | ---- | ---- | ** | ** | ** | ** | 0 | 0 | ---- | ---- | ** | ** | ** | ** |
| Black River | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Catfish Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Genesee River | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.016 | 64 | ** | ** | ** | ** | 0.002 | 7 | 0.016 | 64 |
| 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 | 0.000 | 0 |
| Oswego River | 0 | 0 | 0.004 | 82 | 0.001 | 14 | 0.000 | 0 | 0 | 0 | 0.002 | 50 | 0.000 | 0 | 0.000 | 0 |
| **Salmon River** | **0.022** | **4,002** | **0.065** | **11,095** | **0.062** | **16,314** | **0.002** | **208** | **0.007** | **1,331** | **0.011** | **1,911** | **0.016** | **4,303** | **0.001** | **97** |
| 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 | ---- | ---- | ---- | ---- | 0.000 | 0 | 0 | 0 | ---- | ---- | ---- | ---- | 0.000 | 0 |
| Webster Park | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- |
| **Totals** | | **4,002** | | **11,523** | | **16,442** | | **272** | | **1,331** | | **2,088** | | **4,309** | | **160** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0 | 0 | 0.047 | 1,364 | 0.015 | 872 | 0.000 | 0 | 0 | 0 | 0.024 | 713 | 0.003 | 156 | 0.000 | 0 |
| Bear Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Black River | 0 | 0 | 0.005 | 38 | 0.004 | 83 | 0.011 | 25 | 0 | 0 | 0.005 | 38 | 0.000 | 0 | 0.011 | 25 |
| Catfish Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Genesee River | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Grindstone Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Irondequoit Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0.012 | 35 | 0.022 | 75 | 0.000 | 0 | 0.000 | 0 | 0.012 | 35 | 0 | 0 | 0.000 | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.003 | 11 | 0.000 | 0 |
| Little Sandy Creek | 0 | 0 | 0 | 0 | ** | ** | 0.000 | 0 | 0 | 0 | 0 | 0 | ** | ** | 0.000 | 0 |
| Marsh Creek | ---- | ---- | ---- | ---- | ** | ** | ** | ** | ---- | ---- | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0.013 | 46 | 0.002 | 8 | 0.000 | 0 | 0.004 | 9 | 0.013 | 46 | 0.002 | 8 | 0.000 | 0 | 0.000 | 0 |
| Mill Creek | 0 | 0 | 0 | 0 | 0.065 | 256 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- |
| Niagara River | ** | ** | ** | ** | 0.002 | 19 | 0.000 | 0 | ** | ** | ** | ** | 0.001 | 12 | 0.000 | 0 |
| Ninemile Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| North Sandy Creek | 0.011 | 149 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0.004 | 51 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Oak Orchard Creek | 0 | 0 | 0.037 | 903 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0.027 | 660 | 0.000 | 0 | 0.000 | 0 |
| Oswego River | 0.001 | 26 | 0.001 | 19 | 0.001 | 19 | 0.001 | 8 | 0 | 0 | 0 | 2 | 0.000 | 6 | 0.001 | 8 |
| **Salmon River** | **0.007** | **1,558** | **0.008** | **2,099** | **0.038** | **12,771** | **0.015** | **4,903** | **0.004** | **844** | **0.003** | **808** | **0.016** | **5,420** | **0.006** | **1,959** |
| Sandy Creek | 0.007 | 41 | 0.023 | 24 | 0.014 | 86 | 0.007 | 33 | 0 | 0 | 0.023 | 24 | 0.000 | 0 | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Sterling Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Stony Creek | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Webster Park | 0.048 | 22 | 0.026 | 23 | 0.000 | 0 | 0.000 | 0 | 0.048 | 22 | 0.026 | 23 | 0.000 | 0 | 0.000 | 0 |
| **Totals** | | **1,905** | | **4,591** | | **14,117** | | **4,977** | | **1,026** | | **2,277** | | **5,605** | | **1,991** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0 | 0 | 0.024 | 567 | 0.001 | 32 | 0.009 | 77 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.005 | 43 |
| Bear Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Black River | 0 | 0 | 0 | 0 | 0.005 | 15 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.005 | 15 | 0.000 | 0 |
| Catfish Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Genesee River | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.073 | 105 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.073 | 105 |
| 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 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Little Sandy Creek | 0 | 0 | 0 | 0 | ** | ** | 0.000 | 0 | 0 | 0 | 0 | 0 | ** | ** | 0.000 | 0 |
| Marsh Creek | ---- | ---- | ---- | ---- | ** | ** | ** | ** | ---- | ---- | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0.003 | 16 | 0.002 | 14 | 0.019 | 223 | 0.007 | 26 | 0 | 0 | 0 | 0 | 0.005 | 57 | 0.007 | 26 |
| Mill Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- |
| Niagara River | ** | ** | ** | ** | 0.000 | 0 | 0.000 | 0 | ** | ** | ** | ** | 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 | 0.001 | 11 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Oswego River | 0.002 | 18 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0.002 | 18 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| **Salmon River** | **0.004** | **245** | **0.013** | **599** | **0.008** | **1,213** | **0.003** | **269** | **0.001** | **83** | **0.001** | **29** | **0.004** | **514** | **0.001** | **107** |
| Sandy Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.011 | 66 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.006 | 37 |
| 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.016 | 14 | 0.000 | 0 |
| **Totals** | | **302** | | **1,199** | | **1,529** | | **554** | | **101** | | **47** | | **599** | | **317** |

* = 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**

| | Overall | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num |
| 4 Mile Creek | ** | ** | 0 | 0 | ** | ** | ** | ** | ** | ** | 0 | 0 | ** | ** | ** | ** |
| 12 Mile Creek | 0 | 0 | 0.027 | 106 | 0.005 | 30 | 0.007 | 13 | 0 | 0 | 0.022 | 88 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.25 | 21,828 | 0.164 | 11,836 | 0.183 | 21,834 | 0.084 | 3,621 | 0.049 | 4,298 | 0.042 | 3,048 | 0.005 | 601 | 0.005 | 198 |
| 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 | 0.001 | 3 | 0.019 | 396 | 0.015 | 205 | 0.023 | 729 | 0.000 | 0 |
| Catfish Creek | 0.01 | 38 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Genesee River | 0.401 | 8,666 | 0.203 | 3,015 | 0.005 | 63 | 0.105 | 1,538 | 0.03 | 651 | 0.008 | 113 | 0.000 | 0 | 0.000 | 0 |
| Grindstone Creek | 0 | 0 | 0.011 | 19 | 0.055 | 76 | 0.000 | 0 | 0 | 0 | 0.011 | 19 | 0.000 | 0 | 0.000 | 0 |
| Irondequoit Creek | 0.1 | 1426 | 0.037 | 500 | 0.270 | 4,832 | 0.050 | 672 | 0.041 | 580 | 0.002 | 30 | 0.008 | 145 | 0.002 | 24 |
| Johnson Creek | 0.016 | 90 | 0.124 | 1,164 | 0.410 | 3,128 | 0.235 | 1,373 | 0.012 | 65 | 0.051 | 478 | 0.003 | 21 | 0.018 | 107 |
| Keg Creek | 0.152 | 189 | 0.248 | 1,086 | 0.000 | 0 | 0.080 | 57 | 0.152 | 189 | 0.028 | 122 | 0.000 | 0 | 0.007 | 5 |
| Lindsey Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Little Salmon River | 0 | 0 | 0.004 | 21 | 0.002 | 10 | 0.000 | 0 | 0 | 0 | 0.004 | 21 | 0.002 | 10 | 0.000 | 0 |
| Little Sandy Creek | 0.023 | 65 | 0.087 | 281 | ** | ** | 0.000 | 0 | 0.003 | 9 | 0.007 | 23 | ** | ** | 0.000 | 0 |
| Marsh Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Maxwell Creek | 0.125 | 2,213 | 0.105 | 2,553 | 0.305 | 13,413 | 0.176 | 2,645 | 0.076 | 1,347 | 0.034 | 821 | 0.022 | 977 | 0.024 | 354 |
| 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 | 0.095 | 2,613 | ** | ** | ** | ** | 0.028 | 1,163 | 0.030 | 822 |
| North Sandy Creek | 0.143 | 2,688 | 0.098 | 737 | 0.192 | 2,723 | 0.000 | 0 | 0.047 | 872 | 0.031 | 231 | 0.007 | 101 | 0.000 | 0 |
| Oak Orchard Creek | 0.139 | 9,707 | 0.131 | 6,442 | 0.104 | 5,789 | 0.132 | 8,611 | 0.023 | 1,603 | 0.048 | 2,329 | 0.001 | 55 | 0.013 | 834 |
| Oswego River | 0.035 | 2,433 | 0.032 | 1,562 | 0.082 | 4,851 | 0.033 | 368 | 0.014 | 950 | 0.014 | 697 | 0.015 | 910 | 0.007 | 74 |
| **Salmon River** | **0.034** | **20,705** | **0.036** | **21,489** | **0.089** | **96,398** | **0.034** | **25,170** | **0.004** | **2,713** | **0.007** | **3,869** | **0.008** | **8,608** | **0.005** | **3,405** |
| Sandy Creek | 0.088 | 1,392 | 0.058 | 955 | 0.075 | 1,645 | 0.155 | 2,208 | 0.023 | 365 | 0.001 | 18 | 0.001 | 28 | 0.014 | 200 |
| 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 | 0.000 | 2 | 0.008 | 214 | 0.003 | 69 | 0.007 | 383 | 0.000 | 2 |
| Sterling Creek | 0.01 | 23 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| Stony Creek | 0.19 | 372 | 0.117 | 183 | 0.000 | 0 | 0.000 | 0 | 0.129 | 252 | 0.039 | 61 | 0.000 | 0 | 0.000 | 0 |
| Webster Park | 0.238 | 678 | 0.223 | 1,062 | 0.134 | 286 | 0.000 | 0 | 0.079 | 227 | 0.029 | 136 | 0.034 | 73 | 0.000 | 0 |
| **Total** | | **77,153** | | **56,488** | | **170,642** | | **48,893** | | **15,763** | | **12,790** | | **15,142** | | **6,023** |

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

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

| | September | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num |
| 4 Mile Creek | *** | *** | ---- | ---- | *** | *** | *** | *** | ** | ** | ---- | ---- | *** | *** | *** | *** |
| 12 Mile Creek | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0 | 0 | 0.011 | 128 | 0.041 | 207 | 0.048 | 66 | 0 | 0 | 0 | 0 | 0.020 | 103 | 0.000 | 0 |
| Bear Creek | 0 | 0 | ---- | ---- | *** | *** | *** | *** | 0 | 0 | ---- | ---- | *** | *** | *** | *** |
| Black River | 0 | 0 | 0 | 0 | 0.086 | 183 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Catfish Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Genesee River | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.194 | 45 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.004 | 15 | *** | *** | *** | *** | 0.001 | 4 | 0.004 | 15 |
| 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 | 0.007 | 30 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Oswego River | 0.006 | 65 | 0.009 | 192 | 0.001 | 22 | 0.000 | 0 | 0 | 0 | 0.004 | 80 | 0.000 | 0 | 0.000 | 0 |
| **Salmon River [1]** | **0.007** | **1,256** | **0.01** | **1,637** | **0.008** | **2,152** | **0.002** | **167** | **0** | **71** | **0.001** | **216** | **0.002** | **594** | **0.000** | **0** |
| 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 | ---- | ---- | ---- | ---- | 0.000 | 0 | 0 | 0 | ---- | ---- | ---- | ---- | 0.000 | 0 |
| Webster Park | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- |
| **Totals** | | **1,670** | | **2,106** | | **2,721** | | **323** | | **85** | | **351** | | **702** | | **15** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num | Rate* | Num |
| 4 Mile Creek | *** | *** | ---- | ---- | *** | *** | *** | *** | *** | *** | ---- | ---- | *** | *** | *** | *** |
| 12 Mile Creek | 0 | 0 | 0.018 | 18 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.027 | 796 | 0.151 | 4,403 | 0.014 | 856 | 0.028 | 584 | 0.008 | 239 | 0.037 | 1,073 | 0.005 | 291 | 0.006 | 127 |
| Bear Creek | 0 | 0 | 0.924 | 452 | *** | *** | *** | *** | 0 | 0 | 0.422 | 206 | *** | *** | *** | *** |
| Black River | 0 | 0 | 0 | 0 | 0.012 | 225 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.002 | 45 | 0.000 | 0 |
| Catfish Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Genesee River | 0.011 | 93 | 0.046 | 279 | 0.000 | 0 | 0.006 | 35 | 0.005 | 47 | 0.014 | 85 | 0.000 | 0 | 0.000 | 0 |
| Grindstone Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Irondequoit Creek | 0.056 | 59 | 0 | 0 | 0.123 | 329 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0 | 0 | 0.142 | 482 | 0.005 | 24 | 0.097 | 256 | 0 | 0 | 0.098 | 334 | 0.000 | 0 | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.003 | 11 | 0.000 | 0 |
| Little Sandy Creek | 0 | 0 | 0 | 0 | *** | *** | 0.000 | 0 | 0 | 0 | 0 | 0 | *** | *** | 0.000 | 0 |
| Marsh Creek | ---- | ---- | ---- | ---- | *** | *** | *** | *** | ---- | ---- | ---- | ---- | *** | *** | *** | *** |
| Maxwell Creek | 0.026 | 93 | 0.024 | 124 | 0.096 | 779 | 0.055 | 112 | 0.014 | 51 | 0.015 | 76 | 0.019 | 152 | 0.009 | 19 |
| 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 | 0.046 | 286 | *** | *** | *** | *** | 0.004 | 43 | 0.030 | 187 |
| North Sandy Creek | 0.054 | 745 | 0.013 | 44 | 0.121 | 675 | 0.000 | 0 | 0.011 | 149 | 0.011 | 40 | 0.000 | 0 | 0.000 | 0 |
| Oak Orchard Creek | 0.024 | 904 | 0.09 | 2,200 | 0.035 | 717 | 0.016 | 497 | 0.006 | 226 | 0.027 | 662 | 0.000 | 0 | 0.005 | 149 |
| Oswego River | 0.004 | 160 | 0.027 | 542 | 0.012 | 226 | 0.000 | 0 | 0.003 | 128 | 0.011 | 223 | 0.001 | 24 | 0.000 | 0 |
| **Salmon River** | **0.004** | **929** | **0.012** | **2,950** | **0.030** | **10,062** | **0.012** | **1,102** | **0.001** | **223** | **0.003** | **856** | **0.003** | **1,176** | **0.001** | **105** |
| Sandy Creek | 0.015 | 81 | 0.085 | 89 | 0.072 | 443 | 0.022 | 100 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.007 | 34 |
| 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.004 | 126 | 0.000 | 0 |
| Sterling Creek | 0 | 0 | 0 | 0 | *** | *** | *** | *** | 0 | 0 | 0 | 0 | *** | *** | *** | *** |
| Stony Creek | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Webster Park | 0.336 | 152 | 0.242 | 223 | 0.210 | 89 | 0.000 | 0 | 0.132 | 60 | 0.082 | 76 | 0.159 | 67 | 0.000 | 0 |
| **Totals** | | **4,012** | | **11,966** | | **14,817** | | **2,972** | | **1,123** | | **3,715** | | **1,934** | | **621** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.060 | 2 | 0.000 | 0 | 0.179 | 88 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.181 | 6,814 | 0.293 | 6,867 | 0.048 | 1,581 | 0.044 | 380 | 0.017 | 659 | 0.084 | 1,963 | 0.007 | 225 | 0.006 | 50 |
| 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 | 0.000 | 0 | 0.034 | 46 | 0.000 | 0 | 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 | 0.105 | 178 | 0.021 | 71 | ---- | ---- | 0.000 | 0 | 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 | 0.130 | 237 | 0.000 | 0 | 0.025 | 31 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0.000 | 0 | 0.278 | 681 | 0.000 | 0 | 0.049 | 71 | 0.000 | 0 | 0.059 | 144 | 0.000 | 0 | 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 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Little Sandy Creek | 0.112 | 4 | 0.125 | 19 | ** | ** | 0.000 | 0 | 0.056 | 2 | 0.125 | 19 | ** | ** | 0.000 | 0 |
| Marsh Creek | ---- | ---- | ---- | ---- | ** | ** | ** | ** | ---- | ---- | ---- | ---- | ** | ** | ** | ** |
| Maxwell Creek | 0.052 | 286 | 0.126 | 907 | 0.296 | 3,480 | 0.200 | 693 | 0.014 | 77 | 0.024 | 170 | 0.034 | 401 | 0.045 | 156 |
| 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 | 0.064 | 382 | ** | ** | ** | ** | 0.043 | 509 | 0.020 | 123 |
| 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 | 0.089 | 1,420 | 0.007 | 159 | 0.163 | 1,672 | 0.000 | 0 | 0.009 | 151 |
| Oswego River | 0.109 | 1,033 | 0.087 | 290 | 0.089 | 987 | 0.064 | 123 | 0.010 | 99 | 0.026 | 85 | 0.005 | 57 | 0.018 | 34 |
| **Salmon River** | **0.084** | **5,169** | **0.102** | **4,554** | **0.144** | **20,983** | **0.049** | **5,109** | **0.009** | **575** | **0.015** | **687** | 0.010 | 1,522 | **0.007** | **732** |
| Sandy Creek | 0.032 | 204 | 0.086 | 222 | 0.121 | 1,178 | 0.150 | 931 | 0.000 | 0 | 0.007 | 19 | 0.000 | 0 | 0.008 | 49 |
| 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 | 0.019 | 48 | 0.000 | 0 | 0.000 | 0 | 0.012 | 52 | 0.019 | 48 |
| 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 | 0.000 | 0 | 0.047 | 44 | 0.037 | 60 | 0.110 | 91 | 0.000 | 0 |
| **Totals** | | **23,639** | | **18,307** | | **33,488** | | **9,576** | | **1,924** | | **5,162** | | **2,997** | | **1,345** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0.103 | 433 | 0.180 | 1,476 | 0.295 | 1,023 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.016 | 57 |
| Bear Creek | 0.000 | 0 | ---- | ---- | ** | ** | ** | ** | 0.000 | 0 | ---- | ---- | ** | ** | ** | ** |
| Black River | 0.000 | 0 | 0.613 | 197 | 0.090 | 15 | 0.000 | 0 | 0.000 | 0 | 0.499 | 160 | 0.000 | 0 | 0.000 | 0 |
| Catfish Creek | 0.000 | 0 | ---- | ---- | ** | ** | ** | ** | 0.000 | 0 | ---- | ---- | ** | ** | ** | ** |
| Genesee River | 0.579 | 372 | 1.273 | 1,348 | 0.000 | 0 | 0.536 | 441 | 0.019 | 12 | 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 | 0.054 | 12 | 0.187 | 110 | 0.416 | 535 | 0.038 | 81 | 0.000 | 0 | 0.000 | 0 | 0.021 | 27 | 0.000 | 0 |
| Johnson Creek | 0.000 | 0 | ---- | ---- | 0.152 | 72 | 0.194 | 31 | 0.000 | 0 | ---- | ---- | 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 | 0.387 | 1,032 | 0.028 | 39 | 0.094 | 277 | 0.024 | 129 | 0.015 | 39 |
| 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 | 0.215 | 836 | ** | ** | ** | ** | 0.000 | 0 | 0.099 | 386 |
| North Sandy Creek | 0.000 | 0 | 0.357 | 335 | 0.576 | 1,486 | 0.000 | 0 | 0.000 | 0 | 0.173 | 163 | 0.000 | 0 | 0.000 | 0 |
| Oak Orchard Creek | 0.557 | 554 | 0.181 | 385 | 0.142 | 762 | 0.336 | 1,174 | 0.000 | 0 | 0.000 | 0 | 0.012 | 63 | 0.002 | 7 |
| Oswego River | 0.053 | 77 | 0.143 | 236 | 0.124 | 311 | 0.113 | 57 | 0.003 | 5 | 0.072 | 118 | 0.000 | 0 | 0.048 | 24 |
| **Salmon River** | **0.116** | **2,692** | **0.139** | **5,125** | **0.188** | **11,182** | **0.077** | **2,425** | **0.012** | **272** | **0.011** | **418** | **0.013** | **775** | **0.007** | **222** |
| Sandy Creek | 0.154 | 52 | 0.127 | 78 | 0.277 | 593 | 0.195 | 303 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.009 | 14 |
| 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 | 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 | 0.000 | 0 | 0.000 | 0 |
| **Totals** | | **4,476** | | **10,696** | | **21,566** | | **7,403** | | **371** | | **1,182** | | **1,016** | | **748** |

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

**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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.000 | 0 | ---- | ---- | 0.107 | 347 | 0.199 | 492 | 0.000 | 0 | ---- | ---- | 0.009 | 29 | 0.003 | 8 |
| 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 | 0.124 | 63 | 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 | 0.148 | 131 | 0.000 | 0 | 0.220 | 157 | 0.092 | 127 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0.000 | 0 | 0.000 | 0 | 0.497 | 113 | 0.685 | 88 | 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 | 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 | 0.336 | 362 | 0.006 | 7 | 0.038 | 53 | 0.000 | 0 | 0.083 | 89 |
| Mill Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | ---- | ---- | 0.000 | 0 | ---- | ---- | 0.000 | 0 | ---- | ---- |
| Niagara River | ** | ** | ** | ** | 0.237 | 714 | 0.146 | 316 | ** | ** | ** | ** | 0.000 | 0 | 0.042 | 91 |
| 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 | 0.106 | 172 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.012 | 19 |
| 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** | **0.081** | **1,850** | **0.012** | **293** | **0.007** | **139** | **0.015** | **568** | **0.011** | **255** |
| Sandy Creek | 0.370 | 188 | 0.027 | 2 | 0.120 | 74 | 0.188 | 14 | 0.000 | 0 | 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** | | **3,484** | | **318** | | **269** | | **597** | | **463** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.151 | 224 | 0.033 | 107 | ---- | ---- | 0.005 | 15 | 0.010 | 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 | 0.000 | 0 | 0.009 | 16 | 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 | 0.025 | 12 | ---- | ---- | 0.199 | 437 | 0.089 | 148 | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 1.071 | 70 | ---- | ---- | 0.233 | 67 | 0.580 | 249 | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Keg Creek | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 1.167 | 370 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.167 | 53 |
| 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 | 0.209 | 421 | 0.000 | 0 | 0.000 | 0 | 0.031 | 206 | 0.013 | 25 |
| 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 | 0.168 | 256 | ** | ** | ** | ** | 0.049 | 62 | 0.120 | 182 |
| 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 | 0.194 | 432 | 0.027 | 28 | ---- | ---- | 0.006 | 11 | 0.006 | 13 |
| Oswego River | 0.010 | 7 | 0.104 | 21 | 0.087 | 138 | 0.000 | 0 | 0.000 | 0 | 0.104 | 21 | 0.042 | 66 | 0.000 | 0 |
| **Salmon River** | **0.064** | **773** | **0.058** | **426** | **0.175** | **9,185** | **0.061** | **1,411** | **0.008** | **97** | **0.007** | **53** | 0.014 | 744 | **0.010** | **240** |
| Sandy Creek | 0.000 | 0 | 0.000 | 0 | 0.262 | 281 | 0.110 | 99 | 0.000 | 0 | 0.000 | 0 | 0.035 | 37 | 0.000 | 0 |
| 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** | | **232** | | **91** | | **1,141** | | **232** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.488 | 3,082 | 0.000 | 0 | 0.161 | 646 | 0.077 | 231 | 0.000 | 0 | 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 | 0.000 | 0 | 0.040 | 137 | 0.000 | 0 |
| Catfish Creek | 0.000 | 0 | ---- | ---- | ** | ** | ** | ** | 0.000 | 0 | ---- | ---- | ** | ** | ** | ** |
| Genesee River | 0.613 | 1,396 | 0.521 | 460 | 0.000 | 0 | 0.000 | 0 | 0.032 | 73 | 0.013 | 11 | 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 | 0.062 | 75 | 0.134 | 242 | 0.088 | 139 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.013 | 21 |
| Johnson Creek | 0.114 | 24 | ---- | ---- | 0.252 | 100 | 0.427 | 221 | 0.000 | 0 | ---- | ---- | 0.068 | 27 | 0.000 | 0 |
| Keg Creek | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.164 | 37 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.014 | 3 |
| 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 | 0.243 | 644 | 0.028 | 106 | 0.034 | 95 | 0.023 | 185 | 0.036 | 94 |
| Mill Creek | 0.000 | 0 | 0.000 | 0 | 0.180 | 294 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| Niagara River | ** | ** | ** | ** | 0.135 | 495 | 0.186 | 381 | ** | ** | ** | ** | 0.129 | 476 | 0.090 | 185 |
| 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 | 0.197 | 929 | 0.041 | 136 | 0.000 | 0 | 0.000 | 0 | 0.033 | 154 |
| Oswego River | 0.098 | 342 | 0.119 | 156 | 0.129 | 345 | 0.034 | 25 | 0.011 | 40 | 0.062 | 81 | 0.023 | 63 | 0.000 | 0 |
| **Salmon River** | **0.072** | **2,761** | **0.076** | **1,930** | **0.164** | **30,370** | **0.070** | **2,679** | **0.012** | **461** | **0.019** | **472** | **0.013** | **1,140** | **0.013** | **509** |
| Sandy Creek | 0.281 | 347 | 0.302 | 341 | 0.106 | 184 | 0.141 | 76 | 0.050 | 61 | 0.000 | 0 | 0.000 | 0 | 0.026 | 14 |
| 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** | | **5,362** | | **1,044** | | **694** | | **2,221** | | **981** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.882 | 7,889 | ---- | ---- | 0.051 | 158 | 0.077 | 231 | 0.019 | 171 | ---- | ---- | 0.000 | 0 | 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 | 0.000 | 0 | 0.125 | 288 | 0.000 | 0 | 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 | 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 | 0.088 | 139 | 0.013 | 114 | 0.000 | 0 | 0.056 | 409 | 0.013 | 21 |
| Johnson Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.427 | 221 | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Keg Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.164 | 37 | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.014 | 3 |
| 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 | 0.243 | 644 | 0.027 | 27 | 0.029 | 115 | 0.098 | 102 | 0.036 | 94 |
| 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 | 0.186 | 381 | ** | ** | ** | ** | 0.085 | 438 | 0.090 | 185 |
| 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 | 0.197 | 929 | 0.023 | 65 | 0.000 | 0 | 0.000 | 0 | 0.033 | 154 |
| Oswego River | 0.014 | 42 | 0.079 | 45 | 0.000 | 0 | 0.034 | 25 | 0.006 | 16 | 0.045 | 26 | 0.000 | 0 | 0.000 | 0 |
| **Salmon River** | **0.102** | **5,254** | **0.079** | **1,916** | **0.151** | **13,242** | **0.096** | **5,659** | **0.014** | **710** | **0.022** | **544** | **0.018** | **1,615** | **0.013** | **742** |
| Sandy Creek | 0.150 | 213 | 0.335 | 223 | 0.000 | 0 | 0.141 | 76 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.026 | 14 |
| 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** | | **8,342** | | **1,576** | | **829** | | **2,602** | | **1,214** |

* = 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 | | 2016 | | 2006 | | 2007 | | 2012 | | 2016 | |
| Species | Rate | Num | Rate | Num | Rate | Num | Rate | Num | Rate | Num | Rate | Num | Rate | Num | Rate | Num |
| Steelhead | 0.088 | 363 | 0.081 | 1,281 | 0.182 | 1,295 | 0.092 | 438 | 0.013 | 55 | 0.031 | 485 | 0.012 | 85 | 0.013 | 64 |
| Brown trout | 0.008 | 31 | 0 | 0 | 0.012 | 88 | 0.006 | 30 | 0 | 0 | 0 | 0 | 0.000 | 3 | 0.001 | 5 |

**Table 15. Estimated catch and harvest and their respective rates (fish/angler hour) for brown trout by tributary and year**

| | Overall | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.010 | 41 | 0.002 | 10 | 0.000 | 0 | 0.000 | 0 | 0.010 | 41 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.319 | 27,863 | 0.207 | 14,968 | 0.045 | 5,368 | 0.043 | 1,872 | 0.058 | 5,079 | 0.085 | 6,141 | 0.007 | 825 | 0.011 | 472 |
| 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 | 0.000 | 0 | 0.075 | 1,576 | 0.008 | 108 | 0.006 | 194 | 0.000 | 0 |
| 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 | 0.000 | 0 | 0.021 | 452 | 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 | 0.000 | 0 | 0.000 | 0 |
| Irondequoit Creek | 0.510 | 7,251 | 0.487 | 6,620 | 0.344 | 6,165 | 0.343 | 4,610 | 0.146 | 2,079 | 0.103 | 1,399 | 0.107 | 1,923 | 0.061 | 817 |
| Johnson Creek | 0.051 | 283 | 0.112 | 1,053 | 0.001 | 4 | 0.004 | 21 | 0.028 | 155 | 0.090 | 843 | 0.000 | 0 | 0.000 | 0 |
| Keg Creek | 0.137 | 170 | 0.228 | 1,000 | 0.000 | 0 | 0.000 | 0 | 0.137 | 170 | 0.031 | 136 | 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 | 0.005 | 23 | 0.009 | 49 | 0.000 | 0 | 0.000 | 0 | 0.005 | 23 | 0.000 | 0 | 0.000 | 0 |
| Little Sandy Creek | 0.005 | 15 | 0.000 | 0 | ** | ** | 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 | 0.188 | 3,324 | 0.105 | 2,549 | 0.235 | 10,330 | 0.060 | 893 | 0.081 | 1,435 | 0.037 | 905 | 0.037 | 1,616 | 0.028 | 420 |
| 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 | 73 | ** | ** | ** | ** | 0.003 | 137 | 0.002 | 43 |
| 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 | 0.042 | 186 | 0.028 | 533 | 0.006 | 42 | 0.000 | 0 | 0.042 | 186 |
| Oak Orchard Creek | 0.059 | 4,093 | 0.070 | 3,444 | 0.048 | 2,649 | 0.077 | 5,023 | 0.022 | 1,539 | 0.027 | 1,327 | 0.008 | 429 | 0.007 | 484 |
| Oswego River | 0.040 | 2,830 | 0.012 | 565 | 0.151 | 8,899 | 0.037 | 414 | 0.015 | 1,074 | 0.005 | 250 | 0.029 | 1,734 | 0.030 | 339 |
| **Salmon River** | **0.016** | **9,804** | **0.005** | **3,238** | **0.006** | **6,604** | **0.003** | **372** | **0.002** | **1,177** | **0.001** | **613** | **0.001** | **711** | **0.000** | **27** |
| Sandy Creek | 0.323 | 5,112 | 0.231 | 3,801 | 0.433 | 9,479 | 0.303 | 4,317 | 0.042 | 662 | 0.006 | 99 | 0.031 | 678 | 0.034 | 490 |
| 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 | 0.016 | 338 | 0.002 | 61 | 0.000 | 0 | 0.000 | 0 | 0.008 | 172 |
| 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 | 0.000 | 0 | 0.056 | 110 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| Webster Park | 0.193 | 551 | 0.183 | 867 | 0.066 | 142 | 0.267 | 63 | 0.084 | 241 | 0.033 | 157 | 0.045 | 96 | 0.267 | 63 |
| **Total** | | **68,313** | | **39,065** | | **52,897** | | **18,182** | | **17,746** | | **12,345** | | **8,342** | | **3,512** |

**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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.033 | 47 | 0.022 | 256 | 0.016 | 81 | 0.020 | 27 | 0.033 | 47 | 0.000 | 0 | 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 | 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 | 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 | 0.000 | 0 | 0.429 | 290 | 0.110 | 47 | 0.000 | 0 |
| Johnson Creek | 0.624 | 219 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.258 | 90 | 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 | 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 | 0.015 | 59 | ** | ** | ** | ** | 0.001 | 4 | 0.015 | 59 |
| 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 | 0.005 | 19 | 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 | 0.000 | 0 | 0.003 | 54 | 0.004 | 82 | 0.000 | 0 |
| **Salmon River** | **0.008** | **1,435** | **0.009** | **1,548** | **0.004** | **950** | **0.002** | **204** | **0.001** | **189** | **0.003** | **488** | **0.000** | **123** | **0.001** | **48** |
| 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 | 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** | | **309** | | **326** | | **832** | | **256** | | **107** |

* = 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.**

| | October | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Catch | | | | | | | | Harvest | | | | | | | |
| | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.027 | 796 | 0.161 | 4,686 | 0.088 | 5,239 | 0.050 | 1,030 | 0.008 | 239 | 0.057 | 1,676 | 0.023 | 1,345 | 0.018 | 380 |
| 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 | 0.000 | 0 | 0.114 | 1,471 | 0.015 | 107 | 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 | 0.016 | 96 | 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 | 0.000 | 0 | 0.000 | 0 |
| Irondequoit Creek | 0.145 | 153 | 0.130 | 118 | 0.436 | 1,163 | 0.111 | 158 | 0.105 | 110 | 0.000 | 0 | 0.029 | 78 | 0.000 | 0 |
| Johnson Creek | 0.000 | 0 | 0.057 | 193 | 0.005 | 24 | 0.000 | 0 | 0.000 | 0 | 0.057 | 193 | 0.000 | 0 | 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 | 0.000 | 0 | 0.000 | 0 |
| Little Sandy Creek | 0.000 | 0 | 0.000 | 0 | ** | ** | 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 | 0.026 | 53 | 0.003 | 9 | 0.033 | 167 | 0.055 | 445 | 0.026 | 53 |
| 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 | 0.003 | 18 | ** | ** | ** | ** | 0.005 | 47 | 0.002 | 15 |
| 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 | 0.000 | 0 | 0.000 | 0 |
| Oak Orchard Creek | 0.019 | 748 | 0.022 | 542 | 0.082 | 1,702 | 0.031 | 999 | 0.000 | 0 | 0.022 | 537 | 0.014 | 290 | 0.011 | 362 |
| Oswego River | 0.007 | 261 | 0.010 | 201 | 0.016 | 308 | 0.001 | 8 | 0.003 | 129 | 0.004 | 72 | 0.007 | 135 | 0.001 | 8 |
| **Salmon River** | **0.004** | **982** | **0.003** | **630** | **0.004** | **1,241** | **0.002** | **518** | **0.001** | **194** | **0.000** | **93** | **0.000** | **98** | **0.000** | **43** |
| Sandy Creek | 0.037 | 203 | 0.171 | 179 | 0.162 | 1,000 | 0.135 | 630 | 0.015 | 81 | 0.043 | 45 | 0.042 | 257 | 0.058 | 271 |
| 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 | 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 | 0.555 | 251 | 0.119 | 110 | 0.452 | 191 | 0.000 | 0 | 0.308 | 140 | 0.000 | 0 | 0.293 | 124 | 0.000 | 0 |
| **Totals** | | **6,210** | | **7,492** | | **12,852** | | **3,413** | | **2,588** | | **3,032** | | **2,697** | | **1,131** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0.083 | 41 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.618 | 23,299 | 0.417 | 9,782 | 0.184 | 5,999 | 0.094 | 818 | 0.041 | 1,539 | 0.191 | 4,482 | 0.035 | 1,156 | 0.020 | 177 |
| 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 | 0.000 | 0 | 0.012 | 38 | 0.000 | 0 |
| 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 | ---- | ---- | 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 | 0.560 | 1,018 | 0.000 | 0 | 0.000 | 0 | 0.020 | 30 | 0.136 | 247 |
| Johnson Creek | 0.000 | 0 | 0.351 | 860 | 0.000 | 0 | 0.056 | 80 | 0.000 | 0 | 0.265 | 648 | 0.000 | 0 | 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 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| Little Sandy Creek | 0.000 | 0 | 0.000 | 0 | ** | ** | 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 | 0.214 | 740 | 0.053 | 292 | 0.036 | 257 | 0.071 | 838 | 0.127 | 438 |
| 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 | 0.003 | 21 | ** | ** | ** | ** | 0.002 | 25 | 0.001 | 3 |
| 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 | 0.066 | 1,046 | 0.022 | 477 | 0.077 | 786 | 0.000 | 0 | 0.014 | 226 |
| Oswego River | 0.117 | 1,105 | 0.002 | 8 | 0.219 | 2,415 | 0.055 | 107 | 0.012 | 111 | 0.002 | 8 | 0.055 | 612 | 0.019 | 37 |
| **Salmon River** | **0.033** | **2,015** | **0.005** | **208** | **0.008** | **1,173** | **0.006** | **635** | **0.003** | **184** | **0.000** | **0** | **0.001** | **201** | **0.000** | **11** |
| Sandy Creek | 0.610 | 3,910 | 0.529 | 1,360 | 1.025 | 9,980 | 0.673 | 4,189 | 0.029 | 188 | 0.021 | 54 | 0.114 | 1,110 | 0.077 | 477 |
| 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 | 0.189 | 487 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.123 | 317 |
| 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 | 0.000 | 0 | 0.067 | 109 | 0.194 | 160 | 0.000 | 0 |
| **Totals** | | **35,108** | | **17,025** | | **26,494** | | **6,657** | | **3,065** | | **6,657** | | **4,170** | | **6,657** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0 | 0 | 0.056 | 235 | 0.138 | 1,127 | 0.100 | 346 | 0 | 0 | 0 | 0 | 0.005 | 43 | 0.009 | 31 |
| Bear Creek | 0 | 0 | ---- | ---- | ** | ** | ** | ** | 0 | 0 | ---- | ---- | ** | ** | ** | ** |
| Black River | 0 | 0 | 0.133 | 43 | 0.048 | 8 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 |
| Catfish Creek | 0 | 0 | ---- | ---- | ** | ** | ** | ** | 0 | 0 | ---- | ---- | ** | ** | ** | ** |
| Genesee River | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.443 | 930 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.063 | 132 |
| Johnson Creek | 0 | 0 | ---- | ---- | 0.049 | 23 | 0.000 | 0 | 0 | 0 | ---- | ---- | 0.000 | 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 | 0.078 | 208 | 0.056 | 78 | 0.026 | 77 | 0.037 | 200 | 0.006 | 15 |
| Mill Creek | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- | 0 | 0 | 0 | 0 | 0.000 | 0 | ---- | ---- |
| Niagara River | ** | ** | ** | ** | 0.038 | 131 | 0.000 | 0 | ** | ** | ** | ** | 0.000 | 0 | 0.000 | 0 |
| Ninemile Creek | 0 | 0 | 0 | 0 | ** | ** | ** | ** | 0 | 0 | 0 | 0 | ** | ** | ** | ** |
| North Sandy Creek | 0 | 0 | 0 | 0 | 0.025 | 64 | 0.750 | 232 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.750 | 232 |
| Oak Orchard Creek | 0 | 0 | 0.249 | 531 | 0.084 | 452 | 0.244 | 854 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.014 | 47 |
| Oswego River | 0.226 | 329 | 0.032 | 54 | 0.107 | 268 | 0.369 | 186 | 0.029 | 43 | 0.019 | 31 | 0.009 | 23 | 0.312 | 157 |
| **Salmon River** | **0.064** | **1,493** | **0.013** | **483** | **0.014** | **823** | **0.006** | **188** | **0.009** | **210** | **0** | **13** | **0.001** | **42** | **0.000** | **0** |
| Sandy Creek | 0.077 | 26 | 0.564 | 348 | 0.375 | 804 | 0.274 | 426 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.000 | 0 | 0 | 0 | 0 | 0 | 0.000 | 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 | 0.800 | 33 | 0 | 0 | 0 | 0 | 0.000 | 0 | 0.800 | 33 |
| **Totals** | | **2,168** | | **2,460** | | **5,284** | | **3,403** | | **341** | | **143** | | **308** | | **647** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | ---- | ---- | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.030 | 74 | 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 | 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 | 0.245 | 337 | 0.018 | 16 | 0.000 | 0 | 0.000 | 0 | 0.012 | 16 |
| Johnson Creek | 0.000 | 0 | 0.000 | 0 | 0.027 | 6 | 0.000 | 0 | 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 | 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 | 0.024 | 26 | 0.018 | 21 | 0.077 | 107 | 0.008 | 23 | 0.000 | 0 |
| Mill Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | ---- | ---- | 0.000 | 0 | ---- | ---- | 0.000 | 0 | ---- | ---- |
| Niagara River | ** | ** | ** | ** | 0.000 | 0 | 0.007 | 15 | ** | ** | ** | ** | 0.000 | 0 | 0.005 | 12 |
| 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 | 0.085 | 137 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.009 | 14 |
| 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** | **0.002** | **45** | **0.003** | **50** | **0.000** | **0** | **0.000** | **9** | **0.000** | **0** |
| Sandy Creek | 0.476 | 242 | 0.511 | 43 | 0.172 | 106 | 0.410 | 30 | 0.000 | 0 | 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** | | **662** | | **113** | | **126** | | **120** | | **1,825** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | ---- | ---- | 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 | 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 | 0.151 | 251 | 0.000 | 0 | ---- | ---- | 0.016 | 36 | 0.070 | 116 |
| Johnson Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 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 | 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 | 0.022 | 44 | 0.014 | 15 | 0.000 | 0 | 0.029 | 194 | 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 | ** | ** | ** | ** | 0.078 | 98 | 0.002 | 3 | ** | ** | ** | ** | 0.025 | 31 | 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 | 0.343 | 346 | ---- | ---- | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | ---- | ---- |
| Oak Orchard Creek | 0.000 | 0 | ---- | ---- | 0.012 | 22 | 0.108 | 240 | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 0.003 | 8 |
| Oswego River | 0.231 | 156 | 0.000 | 0 | 0.121 | 193 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.015 | 24 | 0.000 | 0 |
| **Salmon River** | **0.022** | **267** | **0.005** | **38** | **0.005** | **258** | **0.002** | **39** | **0.005** | **63** | **0.001** | **5** | **0.000** | **6** | **0.000** | **3** |
| Sandy Creek | 0.331 | 100 | 0.000 | 0 | 0.144 | 154 | 0.267 | 239 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.267 | 239 |
| 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** | | **817** | | **78** | | **5** | | **291** | | **366** |

* = 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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | 0.000 | 0 |
| 18 Mile Creek | 0.077 | 484 | 0.000 | 0 | 0.017 | 67 | 0.029 | 87 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.006 | 17 |
| 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 | 0.000 | 0 | 0.008 | 29 | 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 | 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 | 0.151 | 237 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 |
| Johnson Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 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 | 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 | 0.000 | 0 | 0.044 | 123 | 0.003 | 28 | 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 | ** | ** | ** | ** | 0.036 | 133 | 0.005 | 10 | ** | ** | ** | ** | 0.036 | 133 | 0.003 | 7 |
| 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 | 0.052 | 246 | 0.014 | 45 | 0.000 | 0 | 0.004 | 15 | 0.000 | 0 |
| Oswego River | 0.038 | 133 | 0.052 | 68 | 0.164 | 439 | 0.000 | 0 | 0.004 | 16 | 0.033 | 43 | 0.024 | 64 | 0.000 | 0 |
| **Salmon River** | **0.025** | **962** | **0.005** | **127** | **0.012** | **1,022** | **0.003** | **118** | **0.003** | **134** | **0.000** | **8** | **0.002** | **155** | **0.000** | **0** |
| Sandy Creek | 0.217 | 269 | 1.588 | 1,798 | 0.093 | 161 | 0.108 | 58 | 0.050 | 61 | 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 | 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** | | **756** | | **297** | | **221** | | **424** | | **24** |

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

**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 | | 2015-2016 | | 2005-2006 | | 2006-2007 | | 2011-2012 | | 2015-2016 | |
| | Rate* | Num | Rate* | Num | 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 | 0.000 | 0 | ---- | ---- | 0.019 | 60 | 0.006 | 10 | 0.000 | 0 | ---- | ---- | 0.019 | 60 | 0.000 | 0 |
| 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 | 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 | 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 | 0.297 | 964 | 0.168 | 1,486 | 0.131 | 1,110 | 0.261 | 1,914 | 0.168 | 547 |
| Johnson Creek | 0.000 | 0 | ---- | ---- | 0.000 | 0 | 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 | ---- | ---- | ** | ** | ** | ** |
| 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 | 0.000 | 0 | 0.042 | 171 | 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 | ** | ** | ** | ** | 0.003 | 14 | 0.003 | 6 | ** | ** | ** | ** | 0.000 | 0 | 0.001 | 3 |
| 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 | 0.044 | 97 | 0.000 | 0 | 0.000 | 0 | 0.000 | 0 | 0.007 | 15 |
| Oswego River | 0.029 | 84 | 0.054 | 31 | 0.000 | 0 | 0.032 | 30 | 0.029 | 84 | 0.011 | 7 | 0.000 | 0 | 0.032 | 30 |
| **Salmon River** | **0.033** | **1,725** | **0.003** | **80** | **0.006** | **547** | **0.002** | **98** | **0.003** | **142** | **0.001** | **15** | 0.001 | 79 | **0.000** | **14** |
| Sandy Creek | 0.112 | 159 | 0.113 | 75 | 0.000 | 0 | 0.000 | 0 | 0.020 | 28 | 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 | 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** | | **1,205** | | **1,740** | | **1,327** | | **2,053** | | **610** |

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

**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 | | | | 2015-2016 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tributary | Interviews | NYS | non-NYS | %Non | 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** | **4,044** | **1,646** | **2,398** | **59** |
| Oswego River | 882 | 514 | 368 | 42 | 1,147 | 582 | 565 | 49 | 1,128 | 761 | 367 | 33 | 158 | 89 | 69 | 44 |
| 18 Mile Creek | 246 | 154 | 92 | 37 | 221 | 148 | 73 | 33 | 697 | 463 | 234 | 34 | 1381 | 801 | 580 | 42 |
| S. Sandy Creek | 103 | 43 | 60 | 58 | 121 | 65 | 56 | 46 | 345 | 156 | 189 | 55 | 40 | 21 | 19 | 48 |
| Oak Orchard Cr. | 179 | 102 | 77 | 43 | 194 | 121 | 73 | 38 | 232 | 193 | 39 | 17 | 1526 | 748 | 778 | 51 |
| **Totals** | **4,357** | **1,989** | **2,368** | **54** | **4,279** | **1,940** | **2,339** | **55** | **6,814** | **3,354** | **3,460** | **51** | **7,149** | **3,305** | **3,844** | **54** |
| *Medium-use tribs* | | | | | | | | | | | | | | | | |
| Niagara River | * | * | * | * | * | * | * | * | 464 | 332 | 132 | 28 | 1623 | 1300 | 323 | 20 |
| Black River | 78 | 66 | 12 | 15 | 173 | 137 | 36 | 21 | 370 | 295 | 75 | 20 | 72 | 43 | 29 | 40 |
| Maxwell Creek | 465 | 334 | 131 | 28 | 546 | 368 | 178 | 33 | 324 | 284 | 40 | 12 | 259 | 222 | 37 | 14 |
| Sandy Creek | 130 | 74 | 56 | 43 | 129 | 101 | 28 | 22 | 188 | 134 | 54 | 29 | 162 | 111 | 51 | 31 |
| Irondequoit Creek | 151 | 151 | 0 | 0 | 192 | 188 | 4 | 2 | 173 | 171 | 2 | 1 | 199 | 194 | 5 | 3 |
| Genesee River | 172 | 160 | 12 | 7 | 140 | 134 | 6 | 4 | 111 | 109 | 2 | 2 | 131 | 123 | 8 | 6 |
| North Sandy Cr. | 90 | 42 | 48 | 53 | 108 | 48 | 60 | 56 | 108 | 42 | 66 | 61 | 3 | 2 | 1 | 33 |
| **Totals** | **1,038** | **719** | **319** | **31** | **1,217** | **853** | **364** | **30** | **1,738** | **1,367** | **371** | **21** | **2,449** | **1,995** | **454** | **19** |
| *Low-use tribs* | | | | | | | | | | | | | | | | |
| 12 Mile Creek | 16 | 13 | 3 | 19 | 33 | 30 | 3 | 9 | 93 | 90 | 3 | 3 | 41 | 41 | 0 | 0 |
| Little Salmon R. | 62 | 32 | 30 | 48 | 86 | 44 | 42 | 49 | 80 | 50 | 30 | 38 | 8 | 6 | 2 | 25 |
| Johnson Creek | 50 | 37 | 13 | 26 | 70 | 49 | 21 | 30 | 78 | 49 | 29 | 37 | 143 | 106 | 37 | 26 |
| Mill Creek | 56 | 26 | 30 | 54 | 10 | 8 | 2 | 20 | 54 | 40 | 14 | 26 | 0 | NA | NA | NA |
| Webster Park | 54 | 38 | 16 | 30 | 72 | 63 | 9 | 13 | 48 | 48 | 0 | 0 | 3 | 3 | 0 | 0 |
| Stony Creek | 19 | 6 | 13 | 68 | 27 | 18 | 9 | 33 | 25 | 3 | 22 | 88 | 7 | 7 | 0 | 0 |
| Grindstone Creek | 17 | 11 | 6 | 35 | 27 | 12 | 15 | 56 | 24 | 21 | 3 | 13 | 16 | 9 | 7 | 44 |
| Keg Creek | 21 | 17 | 4 | 19 | 29 | 12 | 17 | 59 | 3 | 3 | 0 | 0 | 39 | 34 | 5 | 13 |
| Little Sandy Cr. | 64 | 23 | 41 | 64 | 107 | 64 | 43 | 40 | * | * | * | * | 8 | 8 | 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 | * | * | * | * | * | * | * | * |
| 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** | **405** | **304** | **101** | **25** | **265** | **214** | **51** | **19** |
| **Overall total** | **6,186** | **3,300** | **2,886** | **46.7** | **6,501** | **3,579** | **2,922** | **44.9** | **8,957** | **5,025** | **3,932** | **44** | **9,863** | **5,514** | **4,349** | **44** |

* = Not sampled

## Appendix 1. Calculations and Formulas

**Effort estimates for the Salmon River**

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 Non-Salmon River 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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**Acoustic Assessment of Pelagic Planktivores, 2016**

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Alewife (*Alosa pseudoharengus*) and Rainbow Smelt (*Osmerus mordax*) are the most abundant pelagic planktivores in Lake Ontario (Weidel et al 2017), and the most important prey for salmon and trout, making up greater than 90% of the diet of the top predator, Chinook salmon (Lantry 2001, Brandt 1986), and supporting a multimillion dollar sportfishery. Alewife are also important prey for warm water predators, notably Walleye (*Sander vitreus*). Abundance of Alewife and smelt has declined since the 1980s, likely due to reduced nutrient loading, proliferation of invasive dreissenid mussels, and predation by stocked salmon and trout. Cisco (*Coregonus artedi*), a native planktivore, historically dominated the offshore pelagic prey fish of Lake Ontario, but their populations were severely reduced in the mid-20$^{th}$ century due to overfishing and competition with Alewife and smelt. Remnant populations of Cisco still exist, mostly in the eastern basin, and Cisco produce periodic strong year classes once or twice per decade (Owens et al 2003, most recently in 2012 and 2014 (OMNRF, 2017).

Hydroacoustic assessments of Lake Ontario prey fish have been conducted since 1991 with a standardized mid-summer survey initiated in 1997. The survey is conducted jointly by the Ontario Ministry of Natural Resources and Forestry (OMNRF) and the New York State Department of Environmental Conservation (NYSDEC). Results from the hydroacoustic survey complement information obtained in spring bottom trawling surveys (Weidel et al. 2017) and provide whole-lake indices of abundance for Alewife, Rainbow Smelt and *Mysis* (Watkins et al. 2015). In addition, the results provide insights into the midsummer distribution of these species.

The hydroacoustic survey indexes pelagic preyfish abundance, and like other assessments, this survey employs a fairly consistent approach. Increasingly, however, there is strong interest by Great Lakes scientists in knowing the total abundance and biomass of prey fish (and predators) for understanding and modeling predator-prey balance. This information is important for fisheries managers when making decisions regarding stocking levels (Murry et al 2010). As with other assessment gears (e.g. bottom trawls), making the transition from relative to absolute abundance with acoustics requires rigorous testing of assumptions of gear catchability. Bottom trawling has its own assumptions and unknowns regarding gear catchability and we are currently addressing these with our OMNRF and U.S. Geological Survey (USGS) partners (e.g., Weidel and Walsh 2013).

We have also been exploring the "catchability" of hydroacoustic gear. Experimental sampling with vertical gillnets and upward looking hydroacoustics conducted during 2008-2014 identified some limitations to using the traditional down-looking hydroacoustic approach for achieving accurate, whole-lake estimates of Alewife abundance. Increasing evidence indicates that Alewife can be oriented near the surface at night and potentially undetectable with traditional down-looking acoustics because vessel draft, transducer depth, and acoustic "cone" area create a near-field acoustic "blind-spot" in the first four meters (13.1 ft) of surface water (Connerton and Holden 2015). In addition, the sound and/or vibration of the research vessel may cause surface-oriented Alewife to scatter or dive which affects fish target strength (TS), detectability and ultimately abundance estimates (Thorne 1983). NYSDEC and OMNRF have been experimentally towing submersible acoustic equipment suspended away from the boat hull in deep water with the transducer aimed upward to detect fish near the surface. Results of upward looking acoustics conducted from 2010-2014 suggested that an average of 50% of the Alewife are near the surface during the survey and undetected by downlooking acoustic methods (Connerton and Holden 2015). The values for Alewife reported herein do not include a conversion factor to account for this unmeasured biomass and thus should be treated as an index of abundance between years and not as a whole lake population estimate.

We also continue to explore other potential biases of this survey. For example, the hydroacoustic survey samples most depths in proportion to the Lake area except for shallow habitats (<40m, Figure 2). This may potentially bias the Alewife estimate low if significant numbers of Alewife occupy these habitats and the measured densities are highly variable. Although the survey has certain limitations for sampling inside of 10m due to vessel draft, additional sampling is possible from 10-40m. In 2016, we sampled additional areas over 10-40m bottom depths to test whether increased sampling in shallow water would significantly change the survey estimate. We present the results of those analysis in this report.

Native Cisco has previously been a minor component in midwater trawling conducted during the hydroacoustic survey from 1991-2005. Recent evidence of strong Cisco year classes in 2012 and 2014 by OMNRF trawling of juveniles (OMNRF 2017), and increasing catches of adult Cisco during bottom trawling by USGS and NYSDEC suggests that Cisco may be increasing and becoming a more important part of the Lake Ontario fish community. Adult Cisco are still relatively rare in existing surveys and these surveys do not target this species which is generally a pelagic fish. In 2016, NYSDEC and USGS conducted midwater trawling along with hydroacoustics in eastern portions of Lake Ontario as a pilot effort to evaluate methods for assessment of native Coregonid species (Cisco and Bloater [*Coregonus hoyi*]). We present the preliminary results of those efforts in this report.

## 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. In 2005 we modified the fixed transect design to include a statistically preferable random element. Five fixed, cross-lake corridors approximately 15 km wide were established (Figure 1) based on logistical constraints, but within these corridors, transects were selected at random. A single east-west offset was randomly chosen each year, determining the relative position of all transects within their respective corridors, and thus the survey is systematic with a random start. The randomly chosen offset in 2016 was 9, meaning that transects were offset 0.9 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.

The 2016 hydroacoustic survey was conducted from July 22-31 using two research vessels (R/V), OMNRF's R/V Ontario Explorer and NYSDEC's R/V Seth Green. Acoustic data 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 (32.8 ft) depth contour on one end of the transect, and continued across the lake to the 10 m depth contour on the opposite end or one hour before sunrise. A temperature profile was measured hourly at points along each transect.

Hydroacoustic data were stratified by thermal layer (2 layers, upper: ≥10°C (50°F) to surface, and lower: <10°C to 100 m (328 ft) bottom depth) and geographic zone (6 zones: NW, SW, N-Central, S-Central, SE, NE), and whole-lake abundance estimates were calculated as the area-weighted average of these zones. The data were processed with Echoview software (Myriax Inc. version 6.1) using -64 decibels (dB) volume backscattering strength and target strength thresholds. Targets in the lower layer were assumed to be smelt, and targets in the upper layer were assumed to be Alewife. This assumption was confirmed by historical midwater trawling data collected from 2000 to 2004 which showed a thermal separation between the two primary species of interest, Alewife and Rainbow smelt (also see Schaner and LaPan 2003). Midwater tows in depths where water temperatures were 9°C or warmer were dominated by catches of Alewife (95% total catch weight of prey fish species) whereas tows in depths at temperatures below 9°C captured mostly Rainbow Smelt (84%).

In 2014 and 2015, Connerton and Holden (2016) explored alternative methods for analyzing hydroacoustic survey data to refine estimates of whole-lake abundance. Three analytical approaches were compared for each species and data were reanalyzed for the entire time series. In general, results produced by the three methods for Rainbow Smelt were well correlated with each other, were reasonably correlated with spring bottom trawls ($r^2$=0.68), and most of the differences between the methods' results were attributed to varying TS thresholds employed by each method (Connerton and Holden 2016). The favored method from this analysis included targets ranging from -52 to -39 decibels (dB) (which represents the Rainbow Smelt size distribution (60-250 mm or 2.4-9.8 in total length [TL]) typically observed in Lake Ontario (Weidel et al. 2015). The favored approach also used a bootstrapping procedure to iteratively estimate the average density based on 500m transect intervals, and to estimate more robust confidence intervals compared with the traditional area weighted approach (AW) for smelt which produced a standard deviation based on six lake areas (Connerton and Holden 2016).

For Alewife, the traditional analysis method split the scaled, integrated voltage estimates of total target abundance in the upper layer into 1 dB target strength (TS) bins according to results of single target analysis. This produced a histogram typically with three modes (e.g., Figure 3) assumed to be: 1. Zooplankton, *Mysis* and larval fish; 2. A mix of larval Alewife, smelt and other fish, and possibly larger, diving fish exhibiting lower target strengths); and 3. Yearling and older Alewife (YAO) (Schaner and LaPan 2003). The abundances of YAO Alewife were apportioned from the resulting target strength histograms by fitting normal curves to the three modes using a solver routine (SR) and then by calculating the proportions of each curve relative to the total target strength frequency distribution (Schaner and LaPan 2003). Histograms were processed to identify the proportions of targets in the mode at or around -40 dB, and typically included the proportion of the targets from -45dB to -28dB which were assumed to be YAO Alewife (Warner et al. 2002, Love 1977). The solver routine, however, was sensitive to the approximation of initial starting conditions and the distribution of non-fish targets, and the results could be affected by user judgment which made it difficult to apply a standard method annually. Connerton and Holden (2016) instead favored using a new TS range (i.e., -50 to -35 dB) which better corresponded to Alewife sizes encountered in Lake Ontario (240 mm or 9.4 in TL) when compared with the traditional method (-45 to -28 dB), and because research has shown that in-situ Alewife target strength (Brookings and Rudstam 2009) can vary depending on fish orientation (e.g. if Alewife dive to avoid the vessel). Two new methods were evaluated in 2015 including 1). The bootstrapping method (as with smelt above) using TS thresholds -50 to -35, and 2) using the area weighted approach but eliminating the SR step, and using the new TS thresholds. Although the SR method index showed the best correlation ($r^2$=0.57) with the spring bottom trawling index using results from 1997-2015 (Connerton and Holden 2016), in 2016 the bottom trawling survey's analyses methods and resulting index time series underwent significant changes (Weidel et al 2017). New discoveries regarding the catchability of age-1 and age-2 Alewife by the bottom trawl, and the distribution of Alewife in New York vs Ontario waters raised new questions about potential biases of that survey (Weidel et al 2017).

For this 2016 report, we applied the area weighted and bootstrapping methods to estimate the Alewife abundance index for the entire time series, and the bootstrapping method for the Rainbow smelt time series. We initially used TS thresholds of -52 to -39 dB for Rainbow smelt, and -50 to -35 dB for Alewife, however, we ultimately used an upper TS threshold of -39 dB for Alewife too (see results below).

To test whether increased sampling in shallow areas appreciably changed the survey estimate in 2016, five additional hydroacoustic transects at five locations were conducted spanning 131 km over 10-40m bottom depth (Figures 1 and 2). We compared abundance of Alewife with and without the extra sampling using analytical hydroacoustic methods described above and the bootstrapping approach for deriving estimates.

To assess the distribution and abundance of Coregonids, midwater trawling and hydroacoustic sampling was conducted by USGS *RV Kaho* and NYSDEC *RV Seth Green* at eight locations (41 total trawls) using a French midwater trawl ($57m^2$ [613.5 $ft^2$] net opening). Tows were 5 or 10 minutes duration and tows generally occurred above, within or below the metalimnion as determined by nightly temperature profiles, and/or temperature loggers on the net's headrope and footrope. All fish were sorted, counted and weighed by species, and subsamples for length frequency were taken on all species. All Cisco were frozen and later processed for length, weight, gonadosomatic index, diet, and samples of tissue were archived for future genetic, isotope and fatty acid analysis.

## Results and Discussion

Midwater trawling in 2016 showed some vertical overlap of Alewife and Rainbow Smelt (Figure 4), but overall, results supported the survey's historical assumption of thermal separation between Alewife and smelt at 10C. Biological samples from midwater trawls suggested that the previous upper target strength level for Alewife (i.e., -35 dB) was generally too high based on the size distribution within the catch. This had the potential to incorrectly categorize larger species like Ciscoes that were abundant at several transects, as either Alewife or Rainbow Smelt. Based on analysis of the length frequency distribution of Alewife, Rainbow smelt and Cisco (Figure 5) caught in trawls and the published relationship between fish size and target strength, the maximum target strength defining Alewife was lowered to -39 dB (no Alewife or smelt captured were greater than 200mm) and historical index values were recalculated. Targets ranging from -39 to -35 dB were assigned to Cisco and densities of Cisco were estimated based on hydroacoustic and midwater trawl catches in lake areas where Cisco were present.

Cisco

Catches of Cisco were geographically confined to the eastern portions of the survey area (Figure 6). No Ciscoes were caught by midwater trawling at Hamlin, Pultneyville, Sodus or Fairhaven. Currently spawning populations are known to exist only in Chaumont Bay and the Bay of Quinte in the eastern basin, Loss of historical spawning populations currently limits Cisco lakewide distribution (Fitzsimons and O'Gorman 2004). Ongoing restoration stocking in Sodus and Irondequoit Bay by USGS aims to restore historical spawning populations to other areas of Lake Ontario. Predation of larval Cisco by Alewife may also limit Cisco to eastern areas where Alewife densities in spring are relatively low. More research and assessment is needed to understand Cisco distribution and survival bottlenecks in Lake Ontario.

Mean catch per trawl of Cisco was more variable between trawls than between acoustic transects (Figure 7). Acoustic estimates however have the benefit of greater spatial range and the ability to sample the entire water column simultaneously. Despite those differences, overall density estimates between methods provided similar results. Midwater trawl catches estimated a mean density of 36 fish per hectare compared with acoustics that either estimated mean densities of 25 fish per ha, using data from the entire night's acoustic transect, or 51 fish per ha, if acoustic data was limited specifically to the same area and water column the midwater trawls were conducted. Both midwater trawls and acoustics suggested that peak Cisco abundance was within a fairly narrow bottom depth range peaking between 25 and 40m (82 annd 131 ft, Figure 8). No Cisco were captured or acoustically detected outside of 75m. Cisco were concentrated at water temperatures ranging from 10-15C which is consistent with temperatures where Cisco are commonly caught in OMNRF Community Index Gill Netting (OMNRF 2017).

Alewife

YAO Alewife abundance in 2016 based on the area-weighted method (805 million) increased 214% relative to 2015 and was 44% higher than the previous 10-year average (Figure 9). The increase in population is likely explained by increases in the age-1 population of Alewife. Differences between target strength distributions over the most recent years, where recruitment to age 1 in 2014 and 2015 was low, supports this assumption (Figure 3). These results would correspond also with spring bottom trawl results which caught a moderate level of age-1 fish in 2016 (Weidel et al 2017). Alewife were spatially distributed throughout the lake (Figure 10) but showed a bimodal distribution with bottom depth (Figure 11). Distribution of Alewife during the survey, however varies from year to year. Previous analyses found no discernable consistent geographic patterns in Alewife distribution in 2013-2014 (Connerton et al. 2014), nor any consistent regional trends from 2006-2014 (Holden et al. 2014). Distribution of Alewife may be more related to recent physical (e.g., weekly prevailing winds) and biological factors (e.g. zooplankton blooms) but more research is needed in this area and we are currently exploring other factors to explain their distribution.

The additional shallow transects resulted in a marginally higher population estimate (bootstrapped estimate=663 million, 95% confidence interval 601 – 729 million), but this was not statistically different than the population estimate derived from regular transects (bootstrapped estimate=578 million, 95% confidence interval 501 – 664 million). The size distribution (inferred by target strength distribution) did not indicate differences in size structure between shallow areas and regular transect sampling.

Rainbow Smelt

Rainbow smelt abundance in 2016 (25.4 million, 95% confidence interval 19-34 million) declined by 15% relative to 2015 (Figure 12), and was 68% of the previous 10-year average. The highest concentrations of Rainbow Smelt were found over bottom depths shallower than 75m (246 ft Figure 14). Midwater trawl catches supported this limited distribution (Figure 14). The highest densities of Rainbow Smelt were distributed along the southern shore during the survey in 2016 (Figure 13). Previous analysis suggested that Rainbow smelt were most abundant in eastern portions of the Lake in most years (Holden and Connerton 2014).

Hydroacoustics remains an important method for indexing midsummer pelagic preyfish abundance. In addition, midwater trawling has shown to be a useful method for informing species apportionment of this survey's acoustic data. Although the Lake Ontario offshore pelagic fish community is currently dominated by Alewife and Rainbow Smelt, and our previous methods for assigning species to acoustic targets using temperature seemed adequate, Cisco is a present and perhaps growing species of importance. For example, if we expand the Cisco densities measured in 2016 to the whole lake (assuming zeros from Fairhaven westward), it roughly comes to about 4 million fish lakewide which represents about 20% of smelt densities, and exceeds smelt biomass since the average size of Cisco is greater.

While hydroacoustics has its challenges, research has also identified new opportunities- including estimating the abundance of other important animals in the Lake Ontario foodweb like *Mysis* (Watkins et al. 2015), zooplankton (Holbrook et al. 2006), and now Cisco. This report is the first to estimate Cisco densities in Lake Ontario. Our results support previous conclusions of Owens et al. (2003) who proposed that Cisco are mainly restricted to eastern portions of the Lake. Now that efforts are underway for rehabilitation of Cisco (and Bloater) in other areas of the Lake, more work is needed to develop a lakewide Coregonid assessment for evaluating rehabilitation success. We will continue to work towards improving the application of this technology for informing fisheries managers about the status of the Lake Ontario pelagic food web.

## Acknowledgements

The USGS data associated with this report have not received final approval by the U.S. Geological Survey and are currently under review. The Great Lakes Science Center (GLSC) is committed to complying with the Office of Management and Budget data release requirements and providing the public with high quality scientific data. We plan to make all USGS research vessel data collected between 1958 and 2016 publicly available from the GLSC website later in 2017. The anticipated citation will be http://doi.org/10.5066/F75M63X0. Please direct any immediate questions to our Information Technology Specialist, Scott Nelson, at snelson@usgs.gov. All USGS sampling and handling of fish during research are carried out in accordance with guidelines for the care and use of fishes by the American Fisheries Society (http://fisheries.org/docs/wp/Guidelines-for-Use-of-Fishes.pdf). Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

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***Figure 1. The Lake Ontario lake-wide prey fish survey uses cross-lake hydroacoustic transects (2016 transects shown in light grey). In 2016, additional hydroacoustic sampling was conducted in five shallow areas (grey lines), and/or midwater trawling was conducted at eight locations (black lines). At starred locations, both trawling for Cisco and hydroacoustic sampling in shallow areas was conducted.***

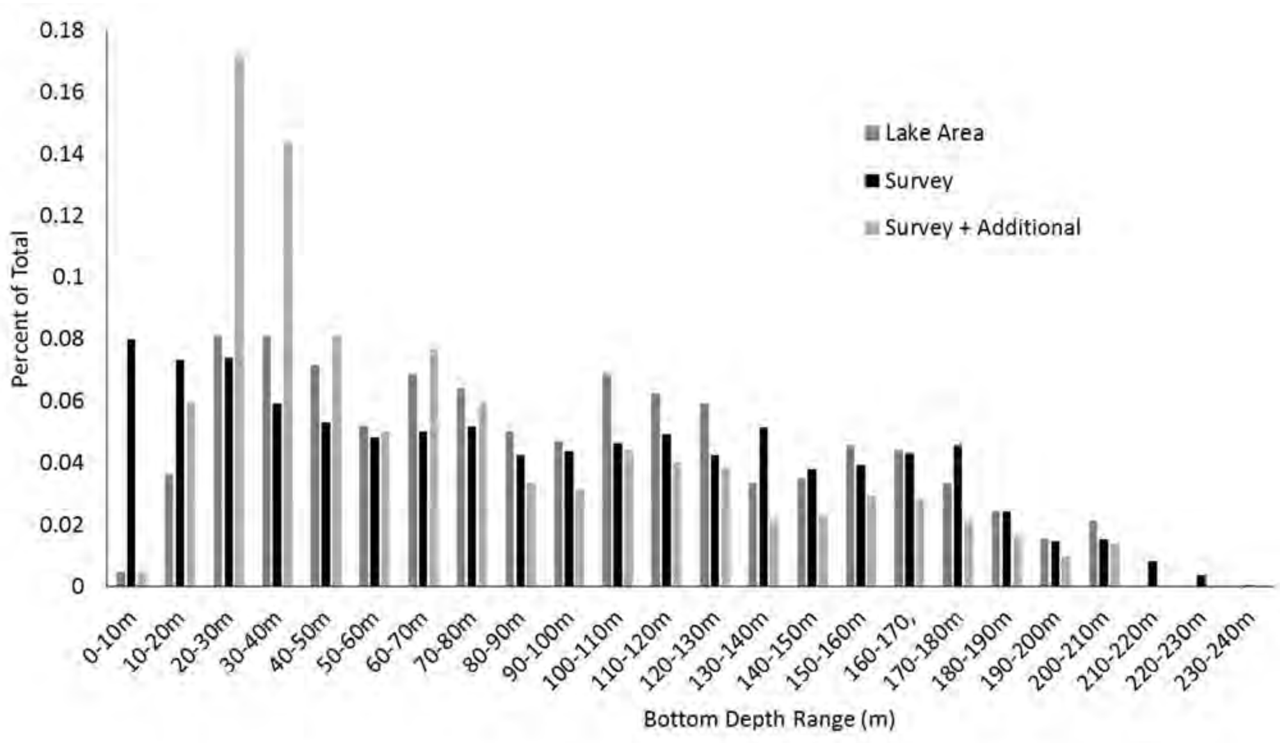



***Figure 2. Distribution of survey depths (based on 500 m intervals) across the traditional survey transects and including the additional nearshore sampling transects relative to lake area by depth.***

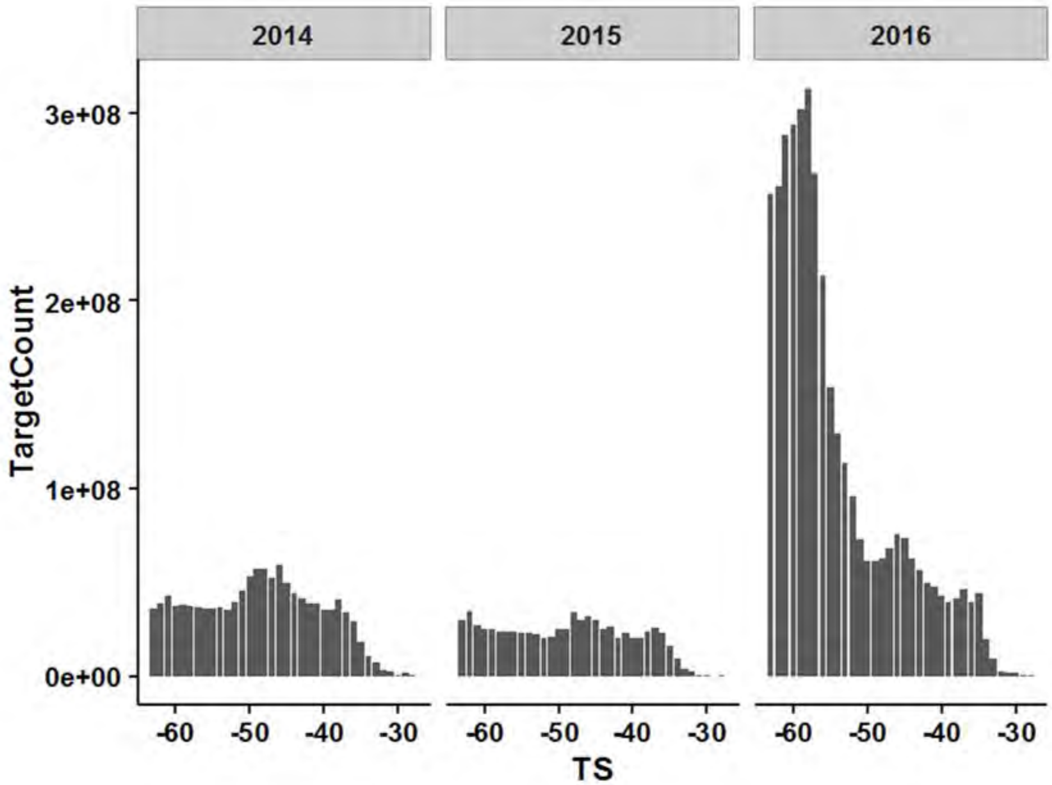



*Figure 3. Target strength frequency histograms of single targets detected in the upper layer during summer hydroacoustic surveys conducted in July 2014, 2015, and 2016.*

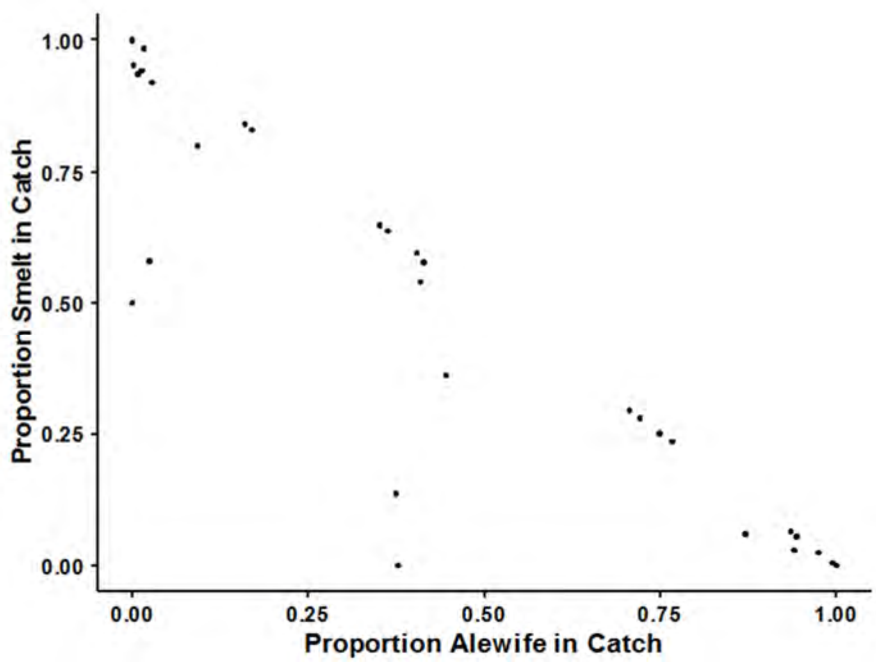



*Figure 4. Proportion of Alewife and Rainbow Smelt weight contributing to the total catch weight within each midwater trawl.*

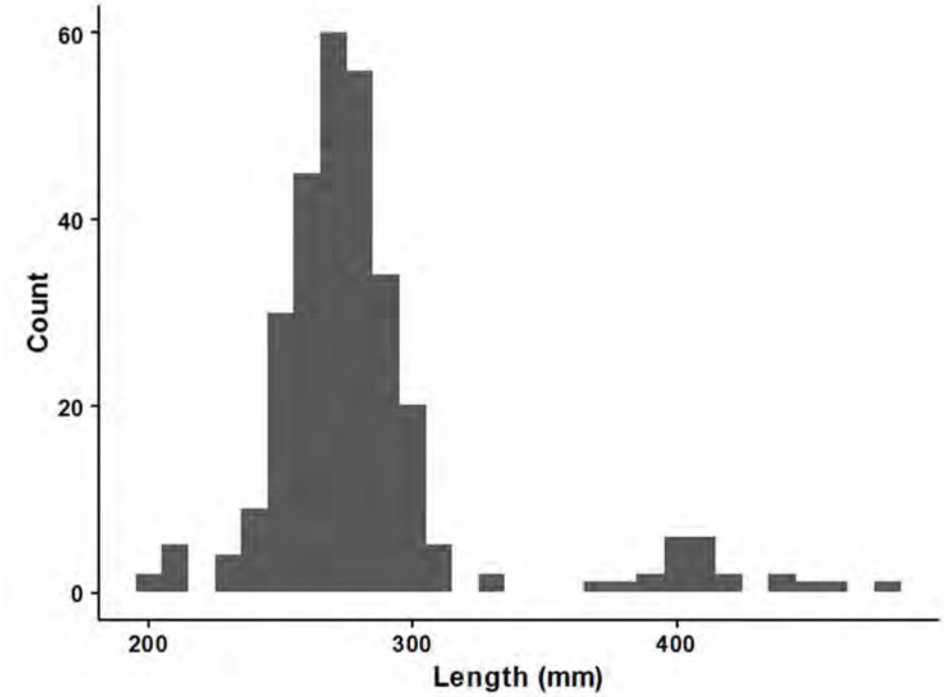



***Figure 5. Length frequency of Cisco caught in midwater trawling in 2016.***

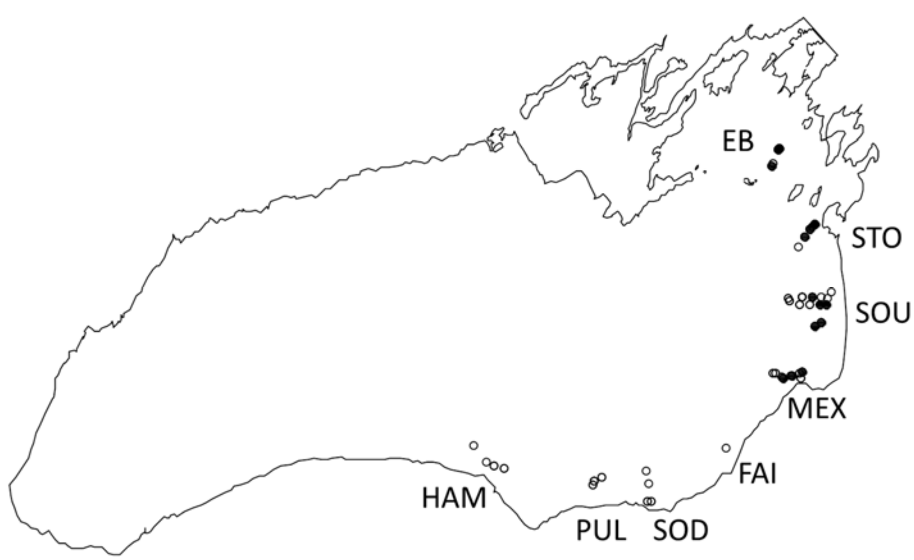
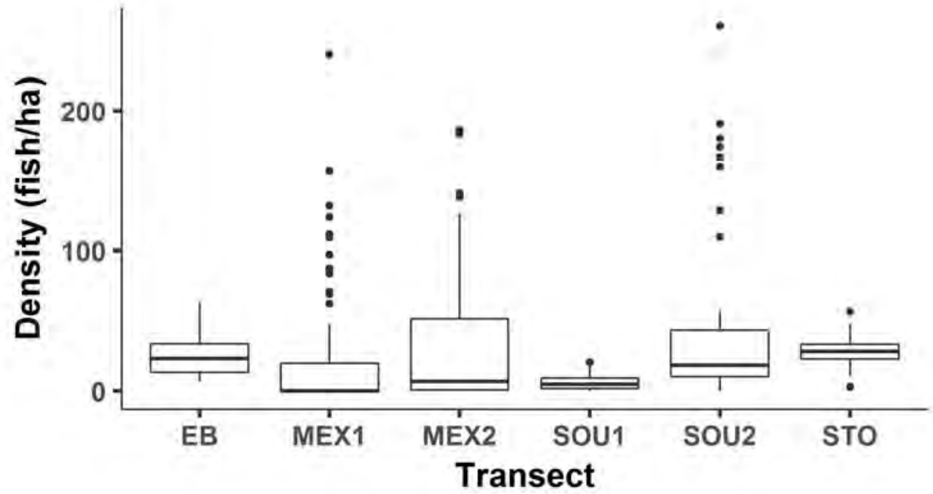



***Figure 6. Distribution of Cisco caught during midwater trawling in July, 2016. Paired acoustics and trawling was conducted at Hamlin (HAM), Pultneyville (PUL), Sodus (SOD), Fairhaven (FAI), Mexico (MEX), Southwicks (SOU), Stony (STO), and eastern basin sites (EB). Open circles are trawl locations where no Cisco were caught and closed circles are locations where Cisco were caught.***



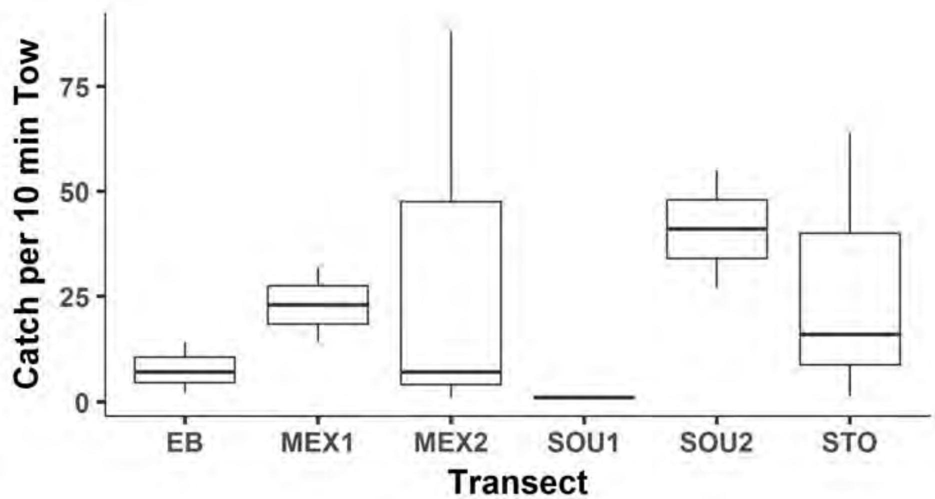
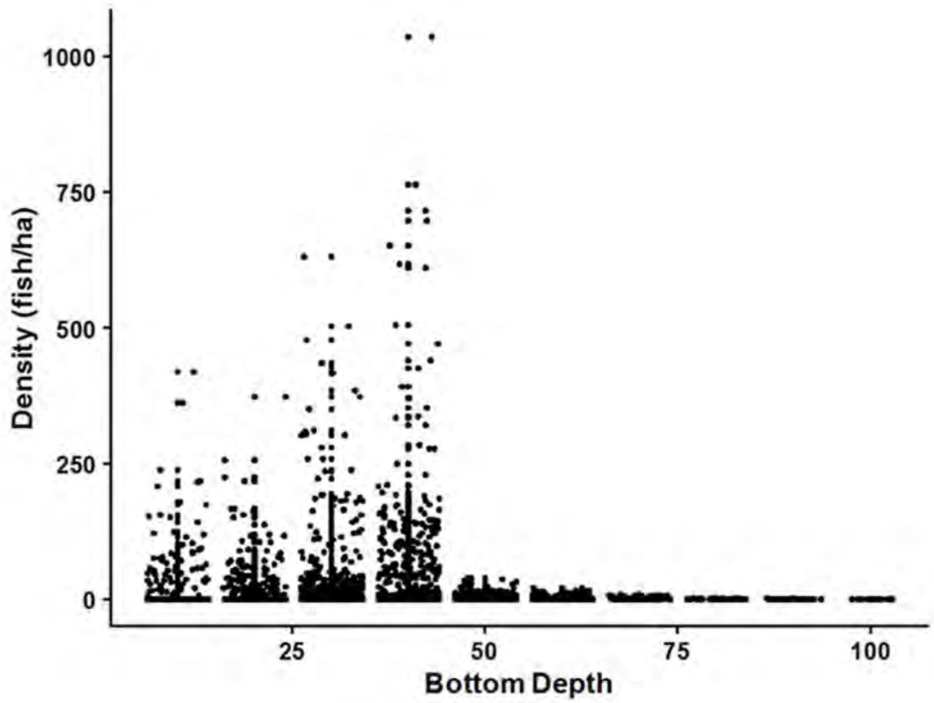




***Figure 7. Variability in Cisco density determined by acoustics (fish/ha) and trawling (catch per 10 min tow) between transect areas. Boxes indicate 50% of the sample. Line within the box indicated the median catch. Whiskers extend to 1.5 times the interquartile range. Extreme values beyond 1.5 times the quantile range are indicated by single points.***



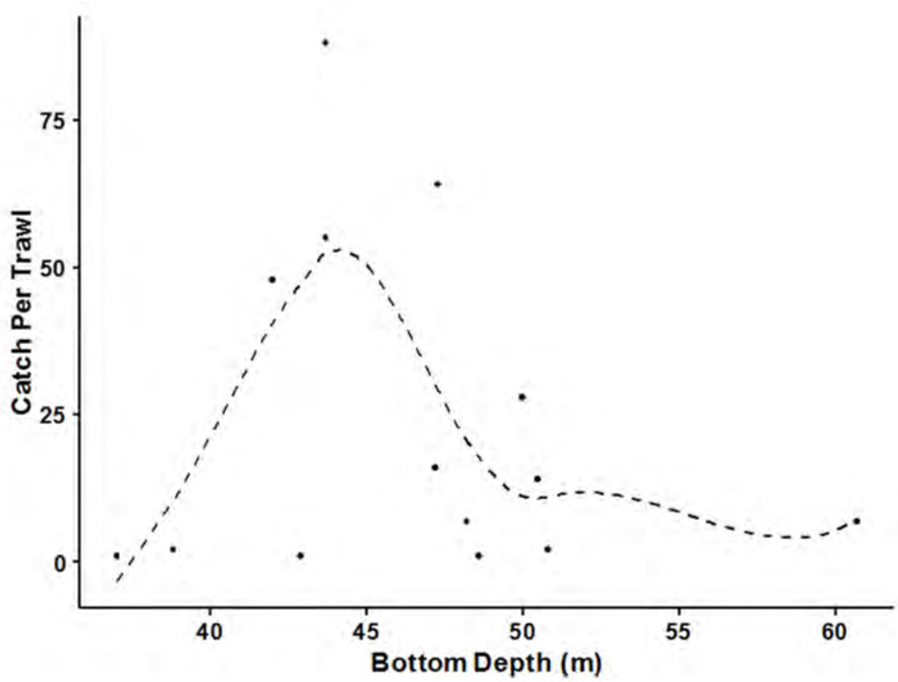




*Figure 8. Relative distribution of Cisco relative to bottom depth determined by acoustics (fish/ha) and midwater trawls (catch per trawl). Acoustic data have been exported in 5 m depth bins and then horizontally jittered for plotting.*

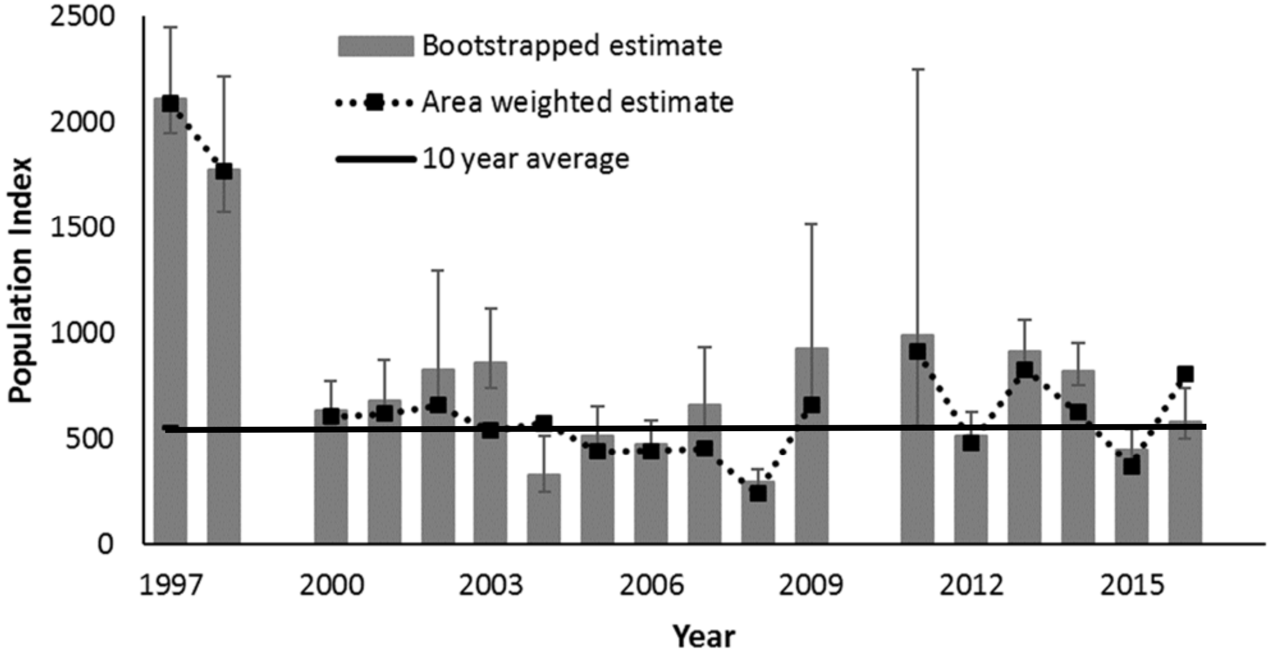



***Figure 9. Abundance (in millions of fish) of yearling-and-older Alewife in Lake Ontario from 1997-2016 as determined by the area weighted and bootstrapping methods. No acoustic survey was conducted in 1999 and 2010. The 10-year average is based on the area-weighted abundance index.***

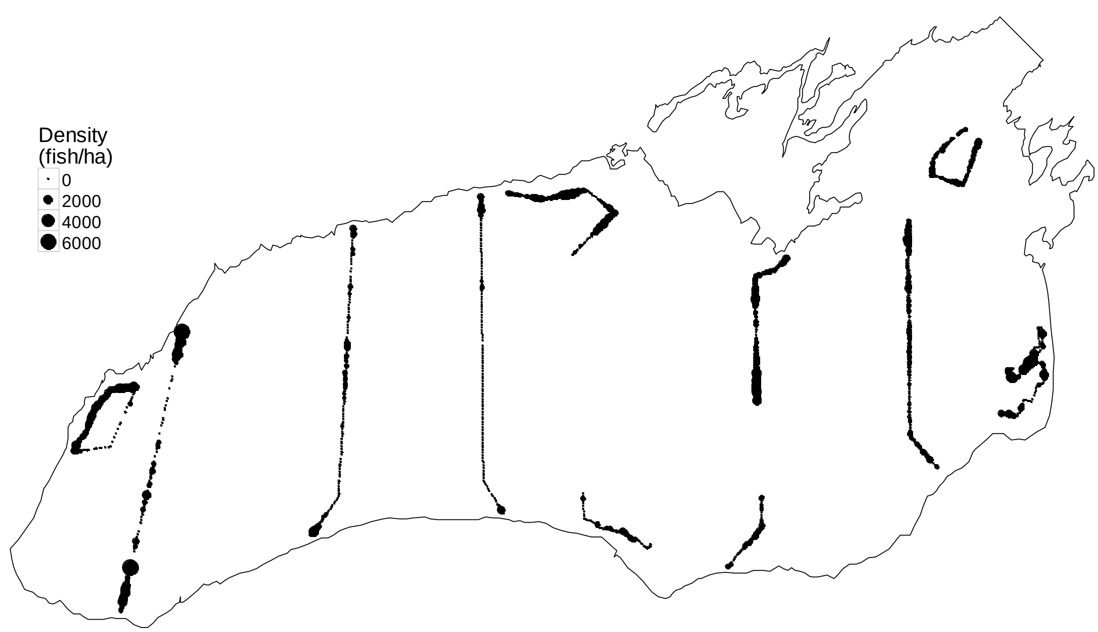



***Figure 10. Relative distribution (fish/ha) of Alewife observed during the hydroacoustic survey in July 2016.***

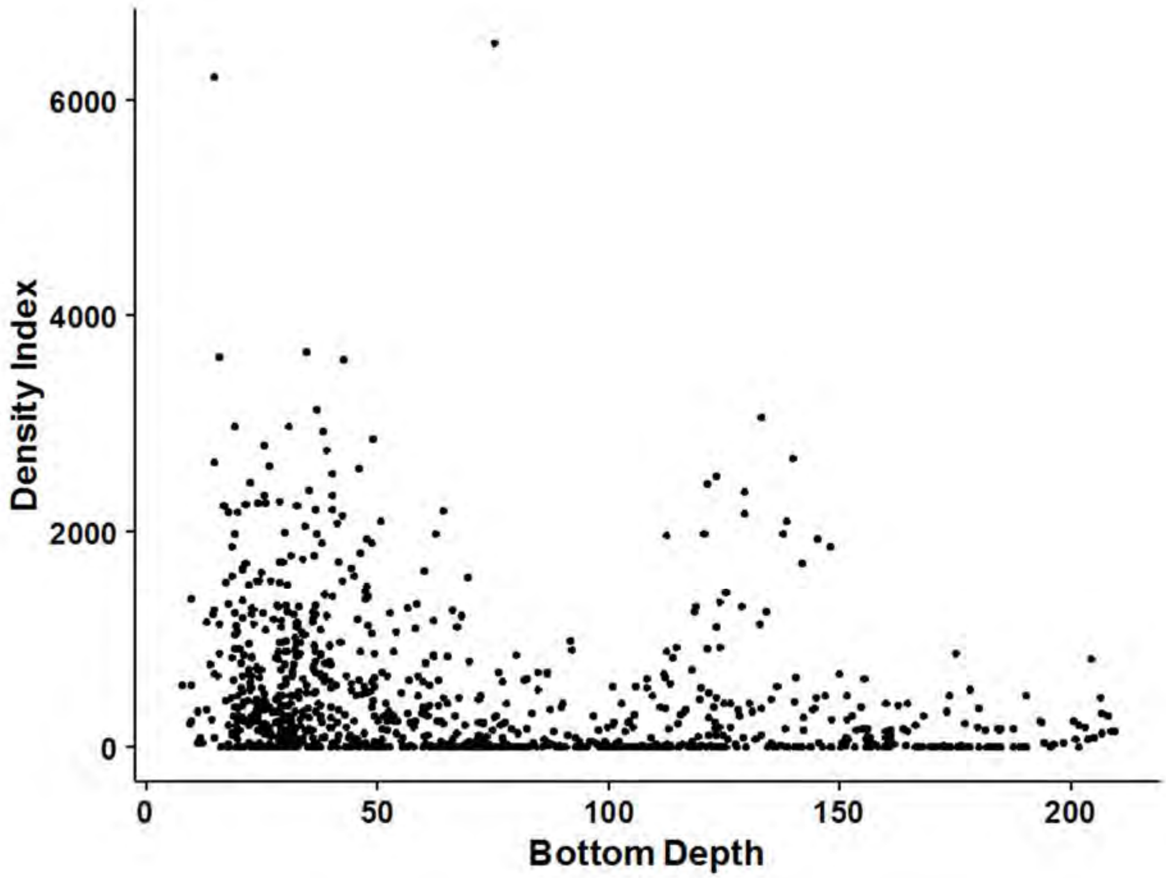



***Figure 11. Distribution of Alewife (fish per ha) relative to bottom depth as determined by acoustics.***

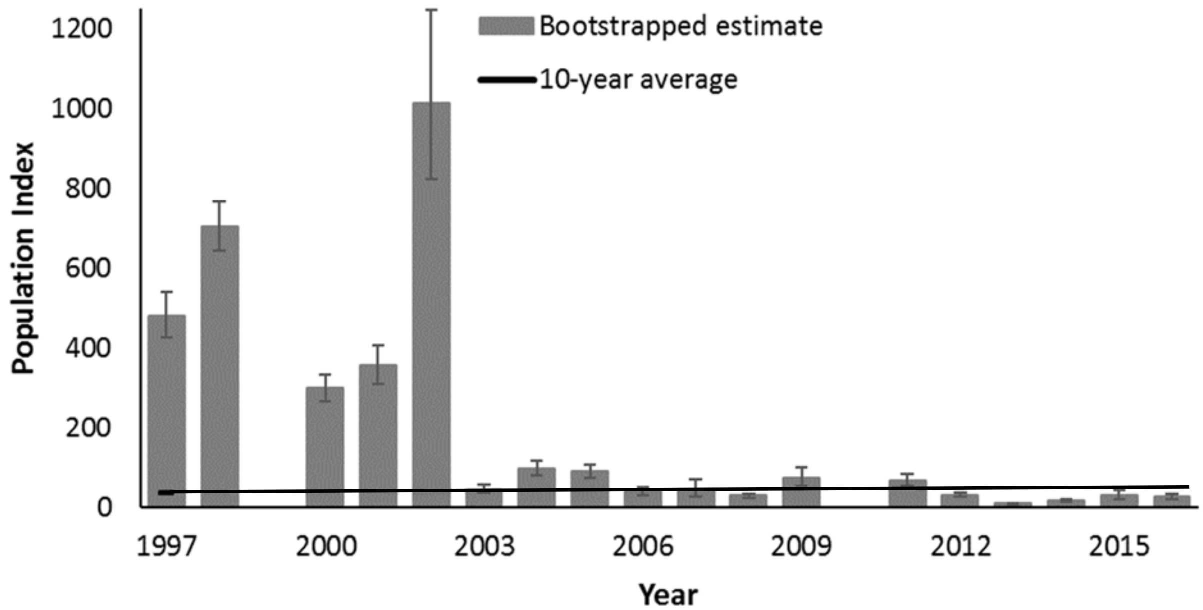



***Figure 12. Abundance (in millions of fish) of yearling-and-older Rainbow smelt in Lake Ontario from 1997-2016 as determined by the bootstrapping method. No acoustic survey was conducted in 1999 and 2010.***

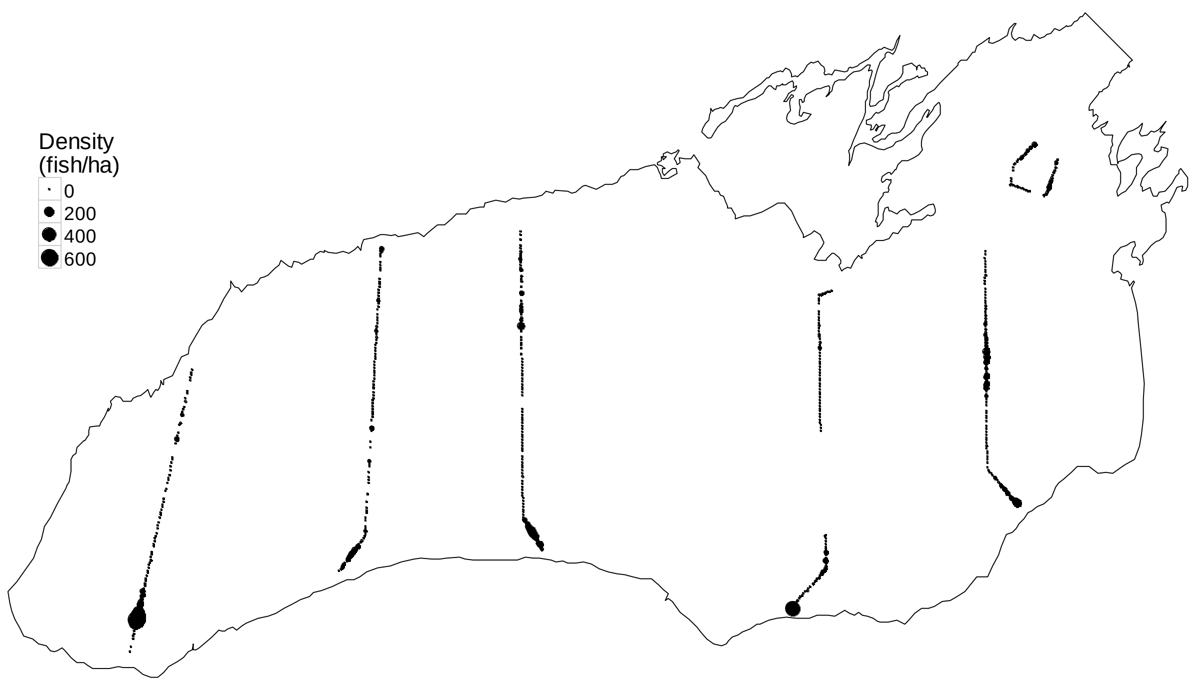
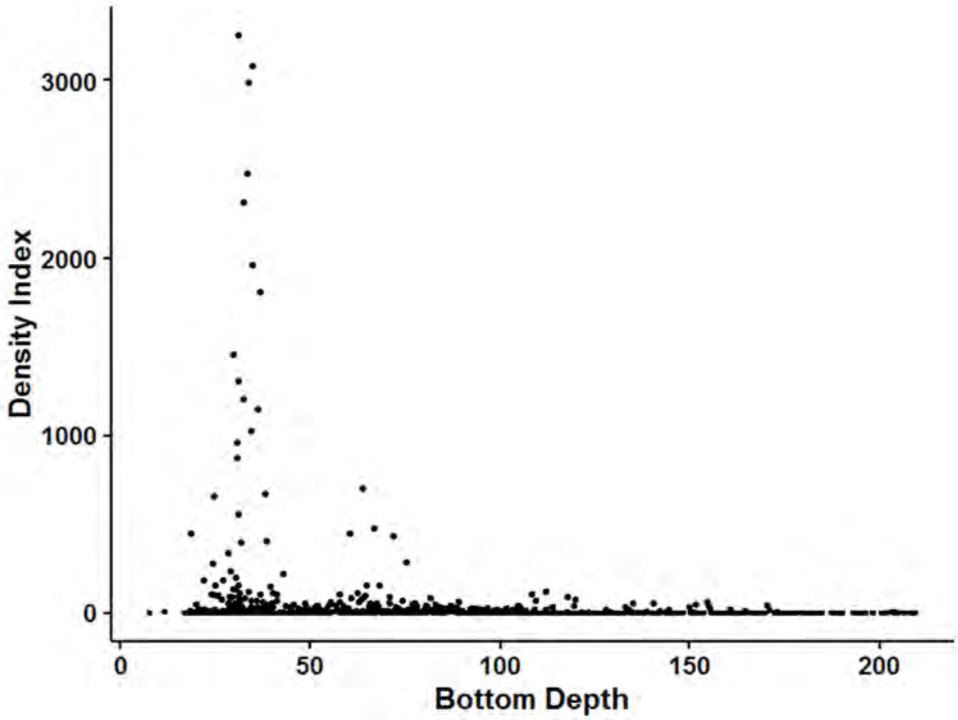



***Figure 13. Relative distribution (fish/ha) of and Rainbow Smelt observed during the hydroacoustic survey in July 2016.***



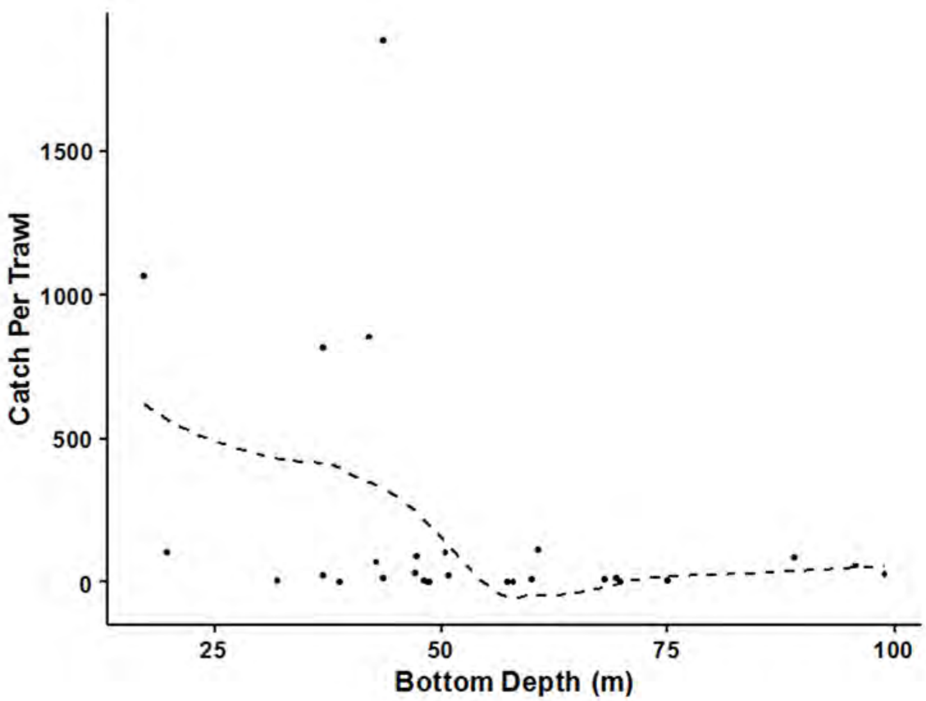




***Figure 14. Relative distribution of Rainbow Smelt to bottom depth determined by acoustics (fish/ha) and midwater trawls (catch per trawl) where towing occurred.***

## 2016 Status of the Lake Ontario Lower Trophic Levels

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**Significant Findings for Year 2016:**

1) Offshore spring total phosphorus (TP) in 2016 was 6.2 µg/L, higher than 2014 and 2015 (4.0 and 4.2 µg/L); there was no significant decline 2001 - 2016. Offshore soluble reactive phosphorus (SRP) was very low in 2016; Apr/May – Oct mean values were ≤1 µg/L. SRP has been stable in nearshore and offshore habitats since 1998 (range, 0.4 – 3.3 µg/L). Apr/May – Oct mean TP concentrations were low at both nearshore and offshore locations (range 5.2 – 9.9 µg/L). TP and SRP concentrations were significantly higher in nearshore compared to offshore habitats (7.6 µg/L vs 6.0 µg/L, TP; 1.4 µg/L vs 0.8 µg/L, SRP).
2) Chlorophyll-*a* and Secchi depth values are indicative of oligotrophic conditions in nearshore and offshore habitats. Offshore summer chlorophyll-*a* declined significantly 2000 - 2016. Nearshore chlorophyll-*a* increased 1995 - 2004 but then declined 2005 - 2016. Epilimnetic chlorophyll-*a* averaged between 1.4 and 2.5 µg/L across sites, and offshore and nearshore Apr/May – Oct concentrations were the same (1.9 µg/L). Summer Secchi depth increased significantly in the offshore 2000 - 2016 and showed no trend in the nearshore, 1995 – 2016. Apr/May – Oct Secchi depth ranged from 5.0 m to 13.0 m at individual sites and was significantly higher in the offshore (10.0 m) than nearshore (6.5 m).
3) In 2016, Apr/May – Oct epilimnetic zooplankton density and biomass were not different between the offshore and the nearshore, but calanoid copepod and *Limnocalanus* biomass were higher in the offshore (4.7 mg/m$^3$ vs 2.6 mg/m$^3$ and 0.7 mg/m$^3$ vs 0.1 mg/m$^3$), and bosminid biomass was higher in the nearshore (1.1 mg/m$^3$ vs 0.3 mg/m$^3$). Zooplankton size was significantly higher in the offshore than the nearshore (0.66 mm vs 0.49 mm).
4) Peak (July) epilimnetic biomass of *Cercopagis* was 1.0 mg/m$^3$ in the nearshore and 1.4 mg/m$^3$ in the offshore. Peak (October) epilimnetic biomass of *Bythotrephes* was 1.8 mg/m$^3$ in the nearshore and 0.6 mg/m$^3$ in the offshore. *Bythotrephes* biomass has increased significantly in the nearshore, 1995 – 2016. *Bythotrephes* was more abundant in 2016 than in the previous two years and the zooplankton community responded accordingly with a decrease in bosminds and cyclopoids.
5) Summer nearshore zooplankton density and biomass declined significantly 1995 – 2004 and then remained stable 2005 – 2016. The decline was due to reductions in bosminids and cyclopoids.
6) Summer epilimnetic offshore zooplankton density and biomass increased significantly 2005 – 2016. In 2016, offshore summer epilimnetic zooplankton biomass was 22 mg/m$^3$--less than half that observed in 2015--but still slightly higher than the mean from 2005 – 2015 (21 mg/m$^3$).
7) Most offshore zooplankton biomass was found in the metalimnion in July and September, and in the hypolimnion in October. *Limnocalanus* dominated the metalimnion in July while other calanoids and daphnids comprised most of the biomass in September. *Limnocalanus* and other calanoids dominated the October hypolimnion. Whole water column samples taken show a stable zooplankton biomass but changing community composition since 2010. Cyclopoids increased 2013 – 2015 and declined in 2016, while the calanoid pattern was the opposite. Daphnids declined 2014 – 2015 but rebounded in 2016.

## Introduction

This report presents data on the status of lower trophic levels of the Lake Ontario ecosystem (zooplankton, phytoplankton, nutrients) in 2016 collected by the US Biological Monitoring Program (BMP). Trophic level indicators for 2016 are compared with data collected by this program since 1995 and with similar long-term data from other sources. Production at lower trophic levels determines the lake's ability to support the prey fish upon which both wild and stocked salmonids depend. The maintenance of current Alewife production in the offshore of the Great Lakes is uncertain due to declines in lower trophic level parameters and the general correlation found between lower trophic level production and prey fish abundance (Bunnell et al. 2014). A decline in offshore lower trophic level productivity is considered a main cause for the collapse of the Alewife population and decline in Chinook Salmon fishery in Lake Huron after 2003 by some authors (e.g. Barbiero et al. 2011, Bunnell et al. 2012), although others point at the importance of predation and winter severity as the causative mechanisms (Dunlop and Riley 2013, He et al. 2015, Riley and Dunlop 2016, Bence et al. 2016). Alewife have not returned to Lake Huron as of 2016. Speculation that a similar crash could occur in Lake Michigan led to a decision to decrease Chinook stocking rates in that lake by some states. Despite declines in offshore productivity, high nutrient levels close to shore are contributing to excessive growth of attached algae (e.g., *Cladophora*) in some shoreline and beach areas (Makarewicz and Howell 2012). This simultaneous desertification of the offshore and eutrophication of the nearshore (Dove 2009, Koops et al. 2015) was considered one of the major research and management issues in Lake Ontario by a 2012 bi-national workshop discussing the lake's research needs (Stewart et al. 2016).

From 1995-2016 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), soluble reactive phosphorus (SRP), chlorophyll *a* (chl-*a*), Secchi depth (SD), and crustacean zooplankton (density, biomass, species composition, and size structure). Samples were collected from late April through early 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, and these nutrients fuel biological activity during the entire year. Therefore, spring TP is an important indicator. The summer stratified period characterizes the peak production period for phytoplankton and many zooplankton species; therefore, summer chl-*a* and summer 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 2016, included the New York State Department of Environmental Conservation (NYSDEC) Lake Ontario Unit and Region 6, 7 and 8 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.

We recently summarized time trends in the BMP data and combined them with data from the Lake Ontario Lower food web Assessments (LOLA) from 2003 and 2008 (Munawar et al. 2015), the Cooperative Science and Monitoring Initiative (CSMI) from 2013, and other data series (Rudstam et al. 2017). Total phosphorus and chlorophyll-*a* declined, and Secchi depth increased in the long-term data (since 1981), but showed no trend since the mid-1990s (Holeck et al. 2015). However, Dove and Chapra (2015) reported continued decline in spring TP based on data from Environment & Climate Change Canada's Surveillance program. Therefore, we are especially interested in any evidence of further decreases in lower trophic level indicators in the 2016 BMP data compared to the 1995 – 2015 data collected by the same program and whether any such further declines occurred in both the nearshore and offshore areas of the lake. This is particularly important since two failed Alewife year classes in Lake Ontario (2013 and 2014, see Walsh et al. 2016) may indicate the beginning of similar declines as were observed in Lakes Huron and Michigan.

In contrast to the stable nutrient concentrations observed 1995 - 2015, epilimnetic zooplankton declined abruptly in 2005 in our dataset. This decline was primarily due to declines in cyclopoid copepods and the small cladoceran *Bosmina longirostris*. Rudstam et al. (2015) attributed this decline to increased presence of the predatory cladoceran *Bythotrephes longimanus*. This invasive predatory zooplankton species increased in the lake around 2005, likely a result of decreased Alewife abundance (see also Barbiero et al. 2014). Whole water column zooplankton biomass was less affected (Barbiero et al. 2014, Rudstam et al. 2015, 2017) due to increases in large calanoid copepods associated with deep chlorophyll layers. Phytoplankton below the thermocline can be abundant and productive (Twiss et al. 2012, Watkins et al. 2015), and have received little attention in past studies (but see Bramburger and Reavie 2016). Concentration of zooplankton in deeper waters may be the new normal for Lake Ontario and lead to changes in fish distributions. After a peak in 2010, *Bythotrephes* declined to an almost undetectable level in 2014; abundance remained low in 2015 and we are particularly interested in whether the zooplankton community composition and biomass is now returning to the pre-2005 levels. We are also interested in any changes in vertical distributions as the presence of *Bythotrephes* induces vertical migrations in several zooplankton species (Pangle and Peacor 2006).

## Report Objectives

Using data from 1995 to 2016, we address the following questions:

(1) What is the status of Lake Ontario's lower trophic levels in 2016, and what differences exist between nearshore and offshore sites this year?
(2) How does the year 2016 compare to the same indicators in 1995-2015 (using BMP data and other long-term data)?
(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 could be indicative of changes in Alewife or invertebrate predation, or lake productivity?
(5) Is the vertical distribution of different zooplankton groups changing, possibly a result of more phytoplankton production in deeper water?

## Methods

### Sampling

We measured total phosphorus (TP), soluble reactive phosphorus (SRP), chlorophyll-*a* (chl-*a*), Secchi depth (SD), 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 2016 (12 potential sampling weeks). Inclement weather precluded sampling during one week at Galloo Island (GIL) and Chaumont Bay (CBL), and during two weeks at Sandy Pond (SPL). Offshore samples were collected during late April-early May, July, and September by the R/V Seth Green, and in April, July, September, and October by the R/V Kaho. In addition, eight stations were sampled at night in July during the hydroacoustic survey conducted by the R/V Seth Green and R/V Lake Observer (NYSDEC and OMNRF). Nearshore sites had depths ranging from 9.5 m to 15.2 m (31 to 50 ft), and offshore sites ranged from 21 m to 214 m (69 to 702 ft). Nearshore sampling totaled 80 samples taken from seven sites. Offshore sampling totaled 26 daytime samples taken from seven sites and eight nighttime samples from eight 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 (APHA 1998; SM 4500-P). 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 acetone extraction followed by fluorometry (EPA 2013). A 100 mL aliquot of filtered water was frozen for later analysis of SRP (APHA 1998 SM 4500-P). TP and SRP samples were analyzed at the Upstate Freshwater Institute (UFI). Chl-*a* was analyzed at CBFS using a calibrated Turner 10-AU benchtop fluorometer and the EPA standard operating procedure SOP LG 405 (Revision 9, March 2013).

<u>Quality Control and Variability</u>

To measure analytical precision at nearshore sites we processed replicate samples for TP and SRP. In July, six aliquots of water were taken from the same sample at each nearshore site. We also collected replicate samples at nearshore sites to determine within-site variability of TP, SRP, and chl-*a*. Triplicate samples were collected once in August. From each of the three samples, one aliquot was taken for TP, one for SRP, and one for chl-*a* analysis. At offshore locations, duplicate samples for TP, SRP, and chl-*a* were collected throughout the year. Mean values from those duplicates were used in the analyses.

<u>Zooplankton</u>

Zooplankton samples were collected with a standard 0.5 m diameter, 153-µm mesh, nylon net equipped with a calibrated flowmeter. At nearshore sites, tow depths ranged from 8.7 to 11 m. At offshore sites, epilimnetic tow depths ranged from 7 to 55 m (from the thermocline when stratification was present). At offshore sites less than 100 m bottom depth (four daytime sites and three nighttime sites) a total water column sample (from 2 m from the bottom to the surface) was collected in addition to the epilimnetic sample when stratification was present. At daytime sites greater than 100 m bottom depth, one metalimnetic tow (16-50 m to the surface) and one hypolimnetic tow (93-100 m to the surface) were obtained in addition to the standard epilimnetic sample. At nighttime sites greater than 100 m bottom depth, two tows were taken—an epilimnetic tow (7-18 m to the surface), and a hypolimnetic tow (97-100 m to the surface). Zooplankton were anesthetized with antacid tablets and then preserved in the field with 95% ethyl alcohol to obtain a final concentration of 70%. At nearshore sites, single samples were collected on a biweekly basis from May to October from 1 – 2 m above the bottom to the surface, depending on weather conditions.

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 1.02 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 (or all animals from samples where fewer than 100 were present) from one or more 1 mL 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 small copepodites) using Pennak (1978) and 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.

<u>Data Analyses</u>

We compared April/May to October mean TP, SRP, chl-*a*, SD, zooplankton density, size, and biomass, and zooplankton group biomass between the two habitats by first obtaining monthly means for each site and then fitting a general linear model with month and habitat as categorical predictor variables. Data for zooplankton density, size, biomass, and group biomass were log-transformed prior to analysis. Offshore data collected in late April was analyzed with May nearshore data because of the proximity of nearshore to offshore sampling dates for those months. Data from June and August were omitted from this analysis because the offshore was not sampled during those months. We divided zooplankton into the following six groups: daphnids (*Daphnia mendotae*, *D. pulicaria*, *D. retrocurva, D. longiremis, D. schodleri*); bosminids (*Bosmina longirostris*, *Eubosmina coregoni*); calanoid copepods (*Leptodiaptomus minutus*, *Skistodiaptomus oregonensis*, *Leptodiaptomus sicilis*, *Leptodiaptomus ashlandi*, *Epischura lacustris*, *Eurytemora affinis*); cyclopoid copepods (*Acanthocyclops vernalis*, *Diacyclops thomasi*, *Mesocyclops edax*, *Tropocyclops prasinus*); other cladocera (*Alona sp., Ceriodaphnia quadrangula*, *Chydorus sphaericus*, *Diaphanosoma sp*., *Alona sp*., *Polyphemus pediculus, Leptodora kindtii*, *Camptocercus sp*., *Scapholeberis sp., Ilyocryptus sp.*); and nauplii. Four individual species were analyzed separately from the groups. Those species are: *Bythotrephes longimanus*; *Cercopagis pengoi*, *Holopedium gibberum,* and *Limnocalanus macrurus.* Differences were considered significant at $p<0.05$.

Change point analyses (Taylor Enterprises, Inc. 2003) were performed separately on nearshore and offshore data using the entire data series (1995–2016 for nearshore and 2000–2016 for offshore) to test for breaks in the data. SRP data were available for 1998 – 2016 in both habitats. Analyses were performed on spring TP, Apr/May – Oct SRP, summer chl-*a*, summer epilimnetic zooplankton density and biomass, and 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 1000 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 v12.0.1, SAS Institute Inc. 2015) were performed on two time stanzas (1995–2016 and 2005–2016) for the offshore and three time stanzas (1995 – 2016, 1995 – 2004, and 2005 - 2016) for the nearshore using spring TP, summer chl-*a*, summer epilimnetic zooplankton density and biomass, and zooplankton group biomass. Night time zooplankton data are not included in time trend analyses. Zooplankton migrate up in the water column at night causing an increase in density and biomass in the epilimnion; therefore results from daytime and nighttime are not comparable.

## Results

<u>Quality Control and Variability</u>

To estimate analytical precision (i.e. within sample variability), we analyzed 42 TP samples and 42 SRP samples (7 sites x 6 samples per site). Coefficients of variation (CV=SD/mean) ranged from 6 to 13% (mean of 9%) for TP and from 6 to 53% (mean of 23%) for SRP. Values from replicated sampling occasions were averaged for all analyses. Variation for SRP is larger because the concentrations are lower. These values were similar to previous years.

The analysis of August nearshore TP, SRP, and chl-*a* triplicate samples showed that the CV for TP ranged from 7 to 24% (mean of 14%), the CV for SRP ranged from 12 to 21% (mean of 16%), and the CV for chl-*a* ranged from 5 to 75% (mean of 30%). Within site variability for TP and SRP were similar to analytical precision, and ranges represent typical variation observed in previous years. Values were averaged for later analyses. Within site variability for chl-*a* was high for CBL (50%) and SOL (75%), but the concentrations were low (CBL, 1.2 – 3.5 μg/L; SOL 1.1 – 3.9 μg/L) and do not represent unusual variation for August samples. Values were averaged for later analyses.

2016 Water Quality

May through October mean chl-*a*, TP, SRP, and SD were similar across nearshore sites in 2016 (Table 1). TP was highest at Niagara East Lake (NEL; 9.9 µg/L TP) and lowest at Sodus Lake (SOL; 5.9 µg/L TP). SOL also had the lowest SRP (0.8 µg/L). SD was lowest at the site east of the Niagara River (NEL; 4.6 m) and highest at SOL (8.4 m). Chl-*a* was lowest at Oak Orchard Lake and Sodus Lake (OOL and SOL, 1.6 µg/L) and highest at Chaumont Lake and Niagara West Lake (CBL and NWL; 2.4 µg/L) (Table 1). With the exception of SD, measurements of the same parameters at offshore locations also showed low variability. Chl-*a* ranged from 1.4 µg/L (Mid Lake) – 2.5 µg/L (Oak Orchard-N), TP ranged from 5.2 µg/L (Smoky Point-O) – 6.9 µg/L (Oak Orchard-N and Tibbetts Point), SRP ranged from 0.7 µg/L (Mid Lake) – 1.0 µg/L (Main Duck), and SD ranged from 7.9 m (Oak Orchard-N) – 13.2 m (Smoky Point-O) (Table 1). Apr/May – October SRP concentrations were very low (<1.6 µg/L) in both habitats (Figure 5a). TP concentrations at nearshore (7.8 µg/L) and offshore (6.0 µg/L) sites were below the 10 µg/L target established by the Great Lakes Water Quality Agreement (International Joint Commission 1988) for offshore waters (Figure 4a). Apr/May – Oct mean TP and SRP concentrations were significantly higher at nearshore sites while SD was significantly higher offshore (Table 2).

Seasonal trends were also observed for most variables. Nearshore SD was stable (6 – 7 m) Apr/May to October, while offshore SD was high (13 m) in Apr/May and declined to 8 m by September (Figure 2a). Nearshore chl-*a* concentrations were also stable (1.5 – 2.1 µg/L) from Apr/May to October. Offshore chl-*a* values were similar to nearshore except in October when offshore values spiked to just over 3.0 µg/L (Figure 3a). The TP pattern mirrored that of SD and chl-*a* in the nearshore with monthly concentrations ranging 7.2 – 8.5 µg/L. In the offshore, TP was highest in July (8.0 µg/L) and similar (6.0 – 6.3 µg/L) in other months (Figure 4a). SRP concentrations were highest Apr/May - July in the nearshore (1.5 µg/L) and in September in the offshore (1.1 µg/L; Figure 5a).

Water Quality Trends Since 1995

Comparisons with data collected since 1995 show that 2016 had average SD in the nearshore and above average SD in the offshore (Figure 2b). Summer chl-*a* concentrations increased in the nearshore after a record low in 2015 (Figure 3b). Offshore chl-*a* was lower than in the nearshore and below the 1995 – 2015 mean. Summer chl-*a* decreased significantly 2000 – 2016 in the offshore, and there was a negative change point in 2009. In the nearshore, summer chl-*a* increased 1995 – 2004 and decreased 2005 – 2016; there was a positive change point in 2003 and a negative change point in 2009 (Table 3). Spring TP and Apr/May – Oct SRP increased in both nearshore and offshore habitats (Figure 4b, 5b). Offshore TP was higher than the previous 10-year mean and nearshore TP was slightly below the mean for the same time period. TP and SRP were stable in nearshore (1995 – 2016) and offshore (2000 – 2016) habitats.

2016 Zooplankton

In 2016, mean Apr/May-Oct zooplankton density and biomass did not differ significantly between nearshore and offshore sites (Table 2, Figure 6). However, average zooplankton size was significantly higher offshore and was due to a greater abundance of large calanoids there. Offshore density and biomass were highest during July (Figure 6), and this coincided with peak biomass of daphnids and other cladocerans (Figure 7). Nearshore density was highest in late June and biomass was highest in early August (Figure 6); the August biomass was associated with peaks in daphnids, other cladocerans, and bosminids (Figure 7).

As with total epilimnetic zooplankton biomass, most individual group biomasses were not significantly different between nearshore and offshore habitats (Table 2, Figure 7). However, bosminids were significantly higher in the nearshore (1.1 $mg/m^3$) than in the offshore (0.3 $mg/m^3$), and calanoid copepods and *Limnocalanus* were higher in the offshore (4.7 and 0.7 $mg/m^3$) than in the nearshore (2.6 and 0.1 $mg/m^3$) (Table 2). These differences were reflected in significantly higher mean zooplankton size in the offshore (Table 2).

Calanoid copepods (excluding *Limnocalanus*) represented the greatest proportion of Apr/May – Oct epilimnetic biomass in the nearshore (26%) and offshore (36%).

In 2016, *Cercopagis* and *Bythotrephes* were detected in samples from both habitats (Figures 7, Table 2). *Cercopagis* was first detected in mid-May in the nearshore and in early July in the offshore. *Cercopagis* peaked during mid-July in the nearshore and early July in the offshore (Figure 7). *Bythotrephes* was present in mid-May in the nearshore, mid-July in the offshore and peaked in mid-October in both habitats (Figure 7). Combined biomass of *Cercopagis* and *Bythotrephes* represented 11% of the zooplankton community at nearshore sites and 5% at offshore sites, with most of that biomass contributed by *Bythotrephes.*

Comparison of epi-, meta-, and hypolimnetic daytime zooplankton tows showed that most zooplankton were present in the metalimnion at 2 of the 3 deep sites (Oak Orchard-O and Mid Lake) during the July stratified period (Figure 8). At Smoky Point-O zooplankton biomass was more evenly distributed between the metalimnion and hypolimnion. Toward the end of the stratified period (September), the same pattern was evident; most zooplankton were in the metalimnion at Smoky Point-O and Oak Orchard-O, but at the Mid Lake site the biomass was distributed more evenly between the meta- and hypolimnion. During the unstratified period (October) most zooplankton biomass was found in the hypolimnion. Epilimnetic biomass represented only 8 – 12% of total water column biomass during the July stratified period and only 1 - 13% during September (Figure 8). In July and September, an average of 93% of the zooplankton biomass at deep offshore sites resided in the meta- and hypolimnion.

The species composition of zooplankton in the epi-, meta-, and hypolimnetic tows also changed seasonally. In the epilimnion, daphnids and *Holopedium* represented the greatest biomass in July. In September and October, calanoids other than *Limnocalanus* dominated the epilimnion. The metalimnion had highest biomass of *Limnocalanus* in July, daphnids in September, and cyclopoids in October. Calanoids and *Limnocalanus* dominated zooplankton biomass in the hypolimnion during July and October while daphnid biomass was greatest in September (Figure 9).

<u>Zooplankton Trends Since 1995</u>

Nearshore summer total zooplankton density and biomass declined significantly 1995 – 2016 (Figures 10 and 11, Table 3). These declines were driven by significant declines from 1995 – 2004 after which density and biomass stabilized (Table 3, regression results). Change point analysis showed that a negative break occurred in nearshore total zooplankton density and biomass in 1998 and in zooplankton density in 2005 (Figures 10 and 11, Table 3). In the offshore, there was no decline in summer epilimnetic zooplankton density or biomass from 2000 – 2016, but both density and biomass increased significantly from 2005 – 2016 (Figures 10 and 11; Table 3). Change point analysis showed a negative break in density and biomass in 2005 followed by a positive break in density in 2013 (Table 3).

Several trends were noted in nearshore summer zooplankton group biomass (Figure 12, Table 3). From 1995 – 2016, significant declines occurred in bosminid, cyclopoid, and daphnid biomass. At the same time, *Bythotrephes* and *Holopedium* biomass increased significantly (Table 3). Bosminids decreased from 1995 – 2004 and then increased, 2005 – 2016. Cyclopoid copepods declined 1995 – 2004 but then remained stable thereafter. *Holopedium* biomass increased 1995 – 2004 and 2005 – 2016. In the offshore, calanoid and *Holopedium* biomass increased, 2000 – 2016. Bosminids, cyclopoids and daphnids increased, 2005 – 2016 and *Cercopagis* and *Bythotrephes* biomass declined (Figure 13, Table 3). *Cercopagis* and *Bythotrephes* biomasses were low compared to overall zooplankton biomass. Therefore, we plotted them separately to better depict patterns in their biomass (Figure 14). The nearshore showed negative change points in *Bythotrephes* biomass (2002 and 2012) and a positive change point in 2006 (Table 3) while *Cercopagis* biomass showed no breaks. In the offshore, *Bythotrephes* showed a positive change point in 2006 while *Cercopagis* showed no breaks. Change points in the nearshore were also evident with cyclopoid copepods (negative, 1998, 1999; positive, 2013), bosminids (negative, 2005; positive, 2011), calanoids (negative, 1996) and *Holopedium* (positive, 2003 and 2013) (Table 3). In the offshore, change points occurred in bosminids (negative, 2004; positive, 2013) and cyclopoids (negative, 2005; positive, 2015) (Table 3).

Summer whole water column zooplankton biomass has been stable, 2010 – 2016 (Figure 15). However, zooplankton community group composition changed during this time. Cyclopoids increased 2013 – 2015 and declined in 2016, while the calanoid pattern was the opposite. Daphnids declined 2014 – 2015 but rebounded in 2016 (Figure 15).

**Discussion**

Secchi depth, chl-*a,* and TP are indicators of lake trophic status (Carlson 1977). In 2016, average Apr-Oct values for all sites ranged from 5.0 to 13.0 m SD, 1.4 to 2.5 μg/L chl-*a*, 5.2 to 9.9 μg/L TP, and 0.7 to 1.6 μg/L SRP. These values are within the range for oligotrophic (low productivity) systems (0.3-3.0 μg/L chl-*a*, 1-10 μg/L TP; Wetzel 2001).

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 low spring TP concentrations. Spring TP declined from values between 20 and 25 μg/L in the 1970s to values 3-7 μg/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 (Dove and Chapra 2015) and EPA's lower trophic level assessments in the intensive field years of 2003, 2008, and 2013 (Holeck et al. 2008; Holeck et al. 2015; Rudstam et al. 2017). Spring TP has been mostly below or only slightly above the goal of 10 μg/L at both offshore and nearshore sites since the BMP started in 1995 (Figure 4b).

Although it is clear that spring TP has declined since the 1970s in both habitats, the BMP data does not show any further decline since 1995 suggesting that nutrient loading into Lake Ontario in both the offshore and nearshore has remained relatively stable over the last two decades. However, in a recent analysis of the Canadian Surveillance data, Dove and Chapra (2015) found continued decline in spring TP in Lake Ontario through 2013. Rudstam et al. (2017) compared trends in spring TP data using averages for all data available to them (EPA-GLNPO, OMNRF, CSMI, DFO-Canada, Environment Canada, BMP) and did not find a decline up to 2013. However, they note that the EC Surveillance data did show a marginally significant decline from 1995 to 2013 when considered alone ($p<0.08$). Since the values for 2014 and 2015 are even lower in EC data (Dove, unpubl data), it is likely that the declining trend is significant for the time period 1995 – 2015 in that data series. We note that both the 2014 and 2015 TP levels were low in the BMP data but increased in 2016.

Summer chl-*a* increased 1995 - 2004 in the nearshore but then decreased significantly in the nearshore and offshore after 2005 with negative change points in 2009 in both habitats. The nearshore trend remained despite an increase in nearshore chl-*a* in 2016 to 2.0 μg/L, a level not observed since 2008 in that habitat Declines in offshore summer chl-*a* were also observed by Environment Canada and EPA-GLNPO programs since 2005 (Dove and Chapra 2015, Rudstam et al. 2017). Summer Secchi depth has not changed significantly since 1995 in the nearshore but has increased significantly in the offshore. Thus, two of the three common trophic level indicators (SD and chl-*a*) show a significant trend towards increased oligotrophication in offshore Lake Ontario.

In contrast to the trend towards continued oligotrophication in the offshore, summer epilimnetic offshore zooplankton biomass increased 2005 - 2016, with cyclopoid copepods and bosminids (2013 – 2015) or daphnids and *Holopedium* (2016) accounting for most of that increase. Epilimnetic density and biomass had declined in the offshore in 2005 (Figure 13) and in the nearshore in 1998 (Figure 12), declines we attributed to increased *Bythotrephes* abundance in the offshore and also *Cercopagis* in the nearshore (Warner et al. 2006, Barbiero et al. 2014, Rudstam et al. 2015). These trends are consistent with observed effects of these predatory zooplankton elsewhere (Lehman and Caceres 1993, Yan et al. 2001, Pangle et al. 2007). *Bythotrephes* abundance rebounded in 2016 after two years of very low abundance (2014 and 2015). As anticipated, we observed a zooplankton community with a smaller proportion of bosminids and cyclopoids, similar to the community present pre-2005 in the offshore. This is strong support for the importance of *Bythotrephes* predation on zooplankton in Lake Ontario.

Generally, *Bythotrephes* abundance is negatively correlated with Alewife abundance due to predation (Johannsson and O'Gorman 1991, Barbiero et al. 2014). In Lake Ontario, *Bythotrephes* biomass was low 2012 – 2015 compared with 2005 – 2011, but rebounded in 2016. (Figure 14). This mirrors changes in adult Alewife abundance to some extent, but there are also inconsistencies. Adult Alewife abundance was relatively stable 2005 – 2016 with the exception of 2010 and 2016 when abundance was very low (Weidel et al. 2017). *Bythotrephes* biomass was at a record high level in 2010. In 2016, biomass increased after a 3-year low to an above average level in the nearshore but still below average in the offshore. We would have expected even higher *Bythotrephes* abundance in 2016 based on the low Alewife abundance. In addition, a year of relatively high Alewife abundance (2008; Walsh et al. 2016) had the second highest biomass of *Bythotrephes* (Figure 14). These inconsistencies suggest additional factors are impacting trends in *Bythotrephes*. Note that Alewife abundance is estimated in spring while *Bythotrephes* peak biomass estimates are from fall (September – October). Therefore, changes that occur over the course of the summer may also contribute to the lack of consistency between Alewife abundance and *Bythotrephes* biomass.

The deep chlorophyll layer and associated zooplankton are not part of the long-term data set collected by the BMP. However, we have given this more attention since 2010 and are now collecting whole water column (100 m or bottom minus 2 m to the surface) zooplankton tows, as does the EPA-GLNPO program. EPA data show little decline in the offshore zooplankton biomass from 1998 to 2016 (Rudstam and Watkins, unpubl data), and whole water column data from the BMP (2010 – 2016) support this observation (Figure 15). However, calanoids (other than *Limnocalanus*) and daphnids declined in whole water column tows, 2010 – 2015, and this decline was evident in the epilimnion as well. Calanoids and daphnids both rebounded in whole water column tows in 2016 while cyclopoids declined. The lower daphnid biomass and higher cyclopoid biomass observed in 2014 – 2015 in July is due in part to an altered seasonal pattern. Cyclopoids usually peak in spring and daphnids in summer. In 2014 - 2015, cyclopoid biomass peaked in summer and daphnid biomass peaked in fall. In 2016, both groups returned to the typical seasonal pattern. The reason for the increase in calanoid biomass is unclear. Calanoid biomass peaked in the fall in all years (2010 – 2016) and it may be that their summer biomass is lower and more variable.

The BMP data from 2016 showed interesting and partly contradictory patterns in the lower trophic levels. Chl-*a* and Secchi depth suggest lower offshore productivity in 2016, while phosphorus remained stable. Offshore zooplankton density and biomass returned to an average level after an atypical high in 2015. This coincided with a return by *Bythotrephes* after three consecutive low years, and the zooplankton community responded with decreased biomass of bosminids and cyclopoids and a return to biomass values similar to the average in the 2000s. Although caution about decreased offshore productivity is warranted, our data suggest changes primarily in zooplankton community composition and less in overall abundance. This is not what we would expect from a decrease in phytoplankton production. In addition, there has not been a decline in August whole water column biomass of zooplankton from 1997 to 2016, which includes a large proportion of deep water forms, such as large calanoids, consistent with patterns through the 2000s (Rudstam and Watkins, Great Lakes Program Office preliminary data).

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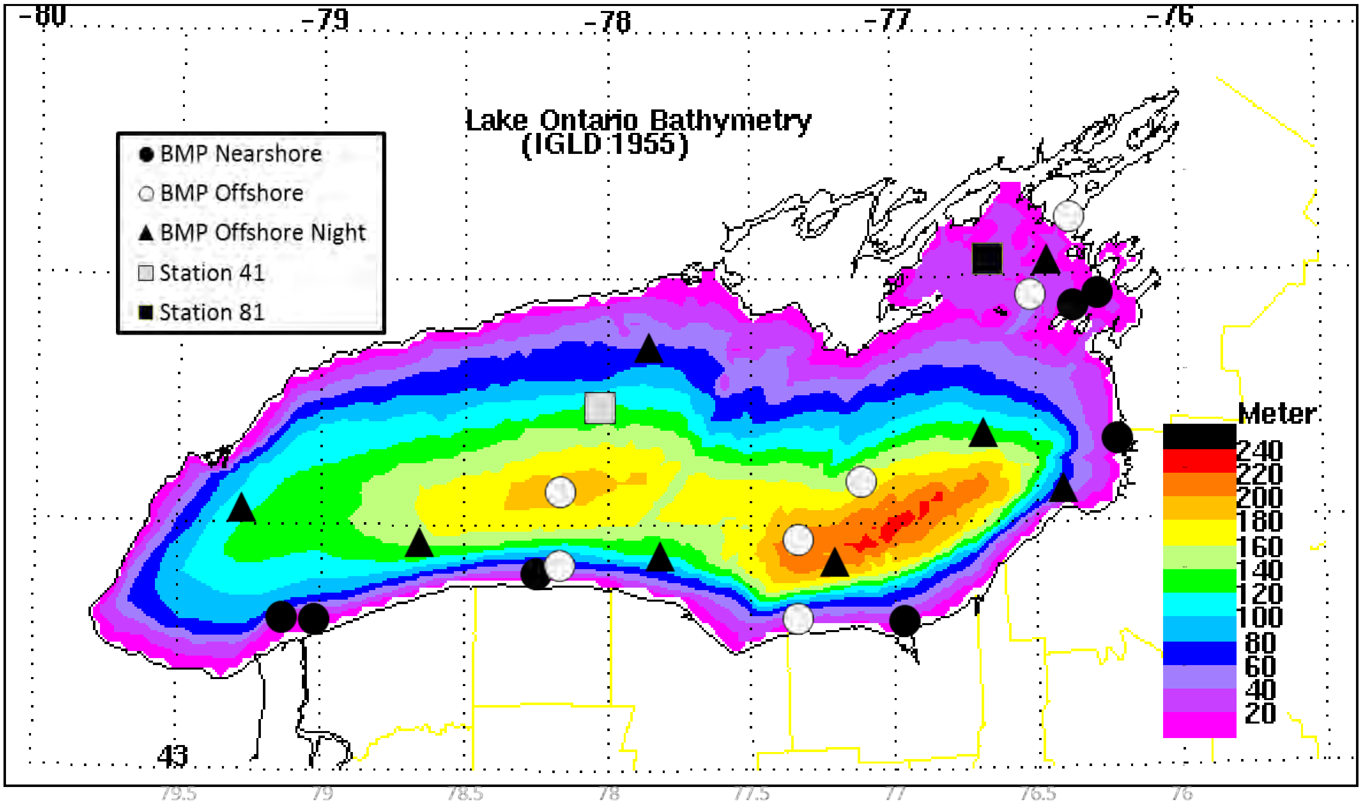



***Figure 1. Map of Biomonitoring Program sites, 2016. Station 41 and station 81 are locations sampled by the Department of Fisheries and Oceans Canada's Bioindex Program (1981 – 1995) and are included here as reference for long-term data included in subsequent figures.***

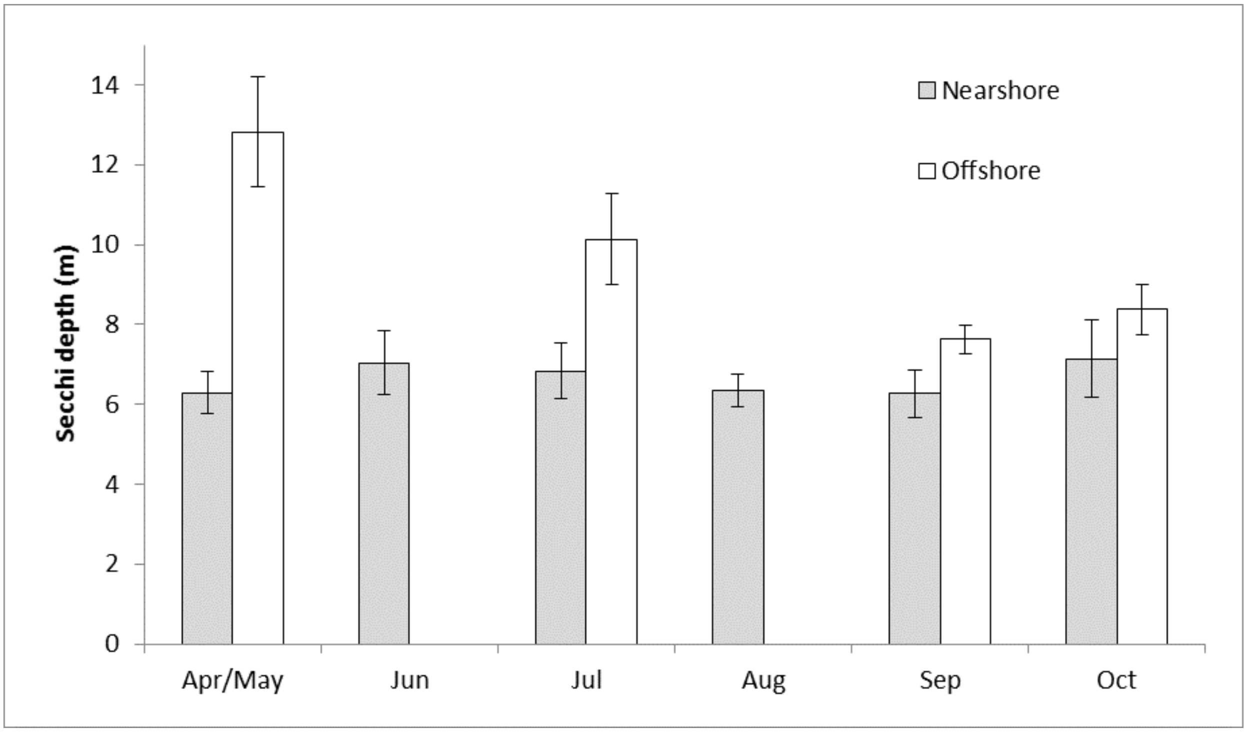



*Figure 2a. Mean monthly Secchi depth (meters) for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2016. Error bars are ± 1SE.*

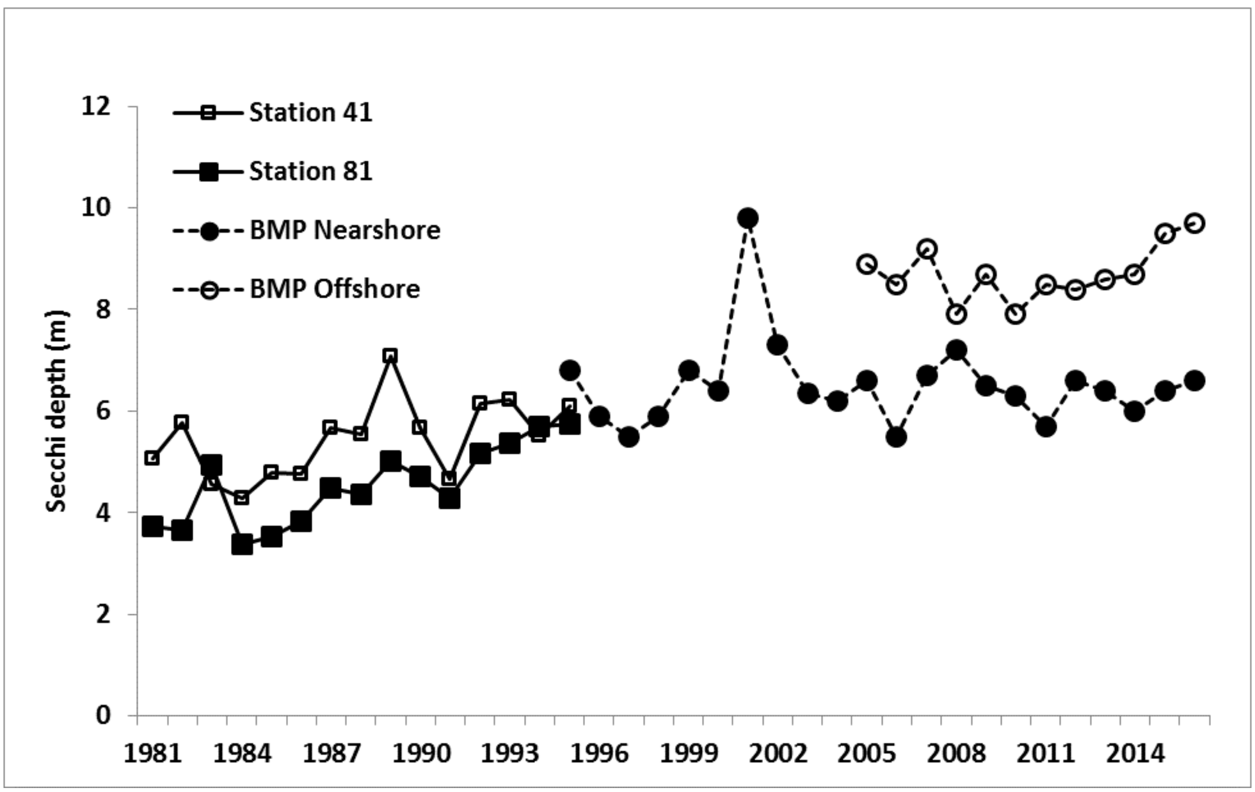



*Figure 2b. Long-term mean Apr/May – Oct Secchi depth (meters) in Lake Ontario, 1981 – 2016. Station 41 and Station 81 are from the Department of Fisheries and Oceans Canada's Bioindex Program. Data from 1995 – 2016 are from the US Biomonitoring Program (BMP).*

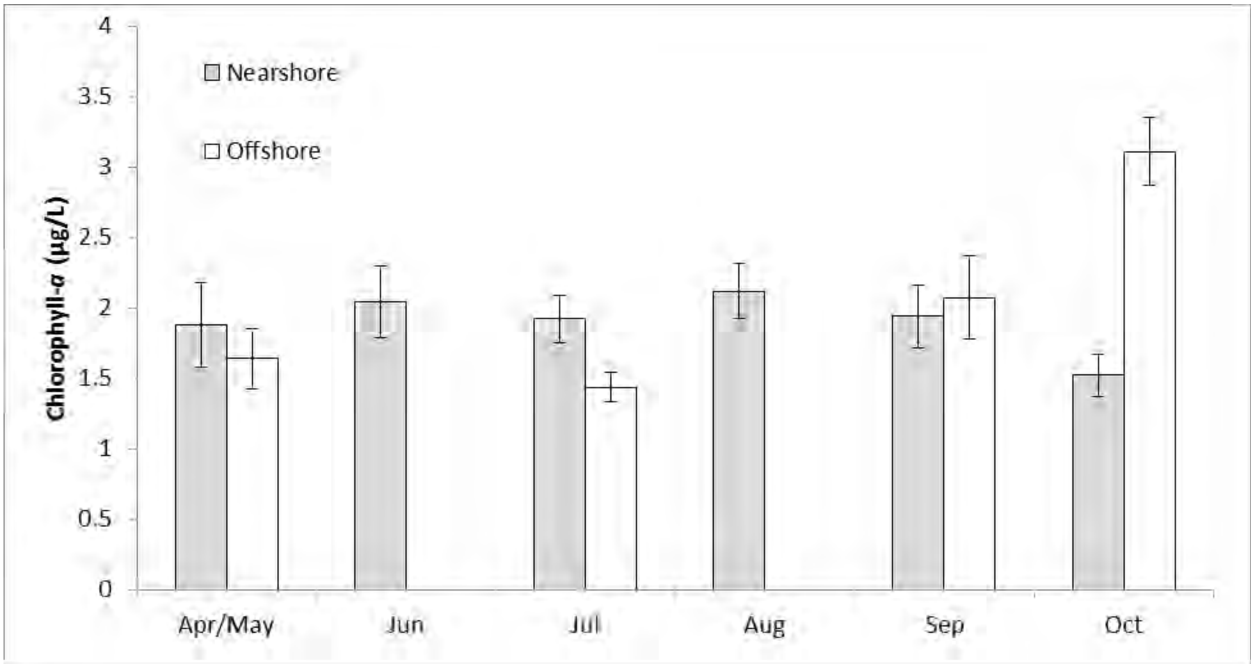



*Figure 3a. Mean monthly epilimnetic chlorophyll-a concentrations for nearshore and offshore habitats in Lake Ontario, Apr/ May - October, 2016. Error bars are ± 1SE.*

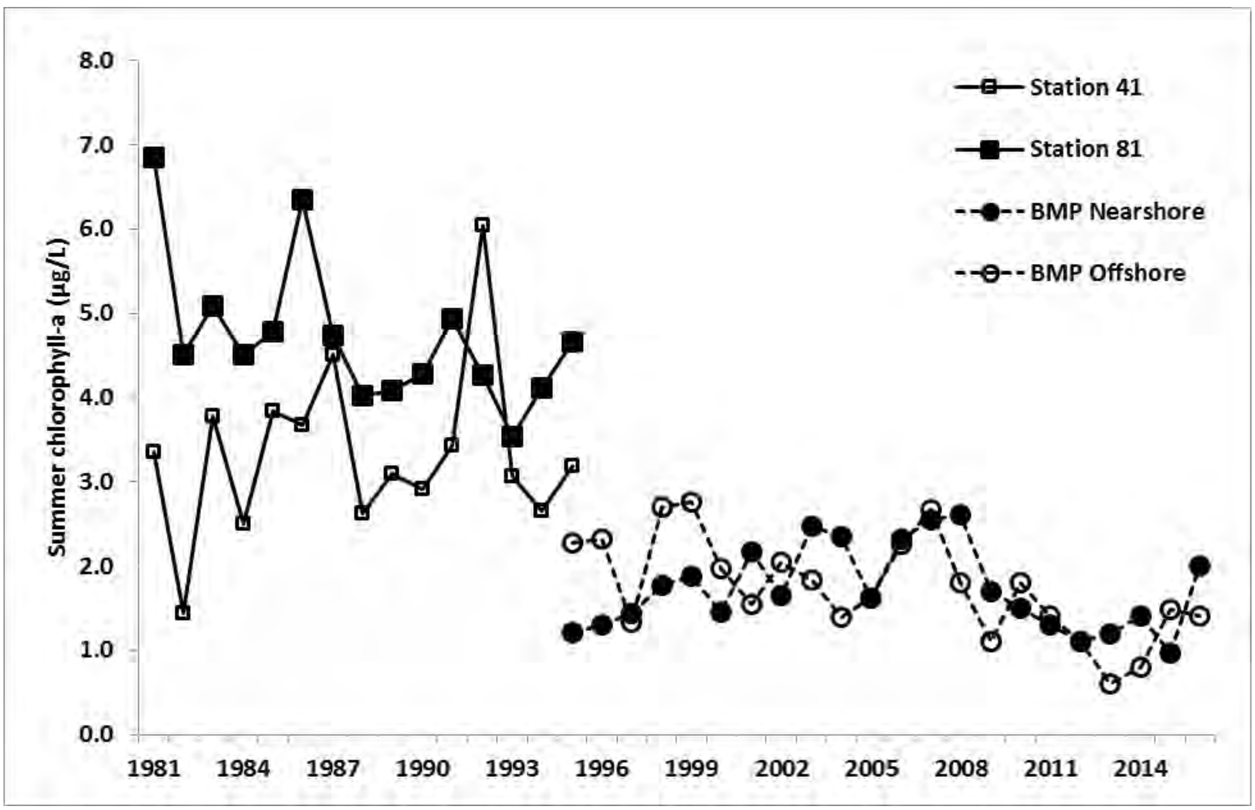



*Figure 3b. Long-term summer (Jul – Aug) epilimnetic chlorophyll-a concentrations in Lake Ontario, 1981 - 2016. Station 41 and Station 81 are from the Department of Fisheries and Oceans Canada's Bioindex Program. Data from 1995 – 2016 are from the US Biomonitoring Program.*

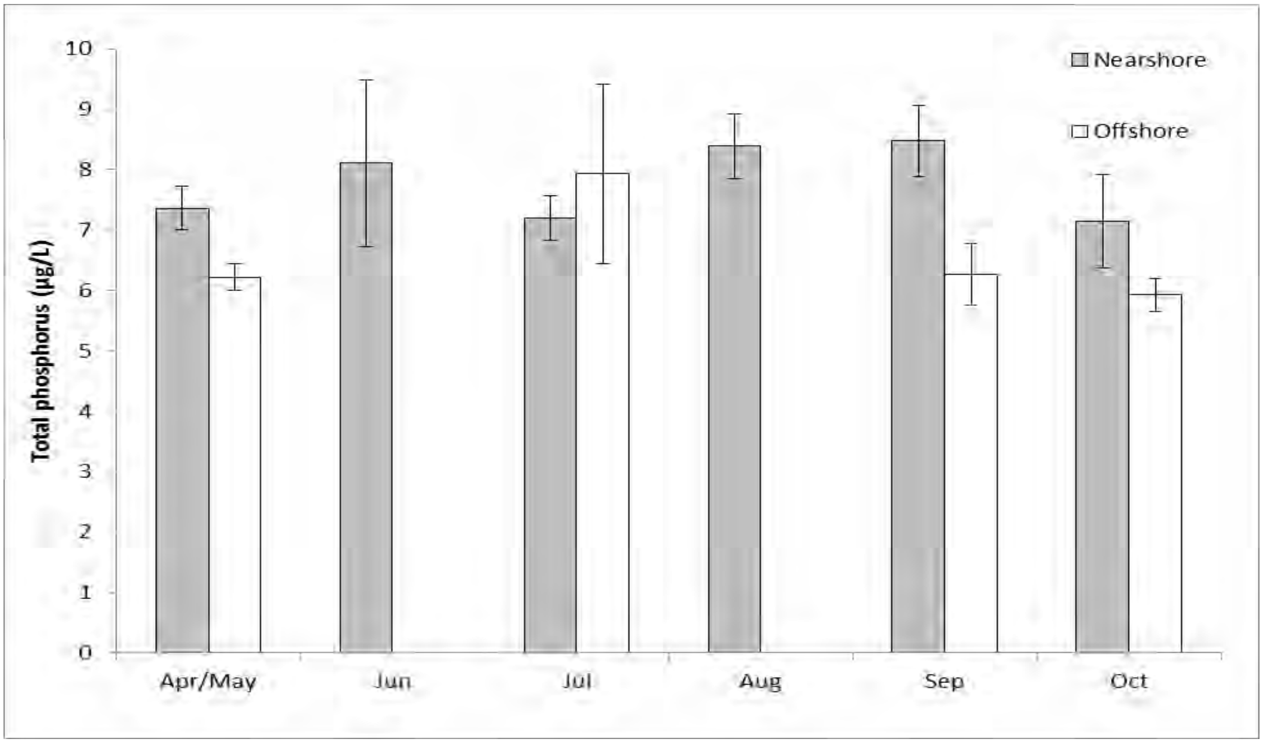



*Figure 4a. Mean monthly total phosphorus concentrations for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2016. Error bars are ± 1SE.*

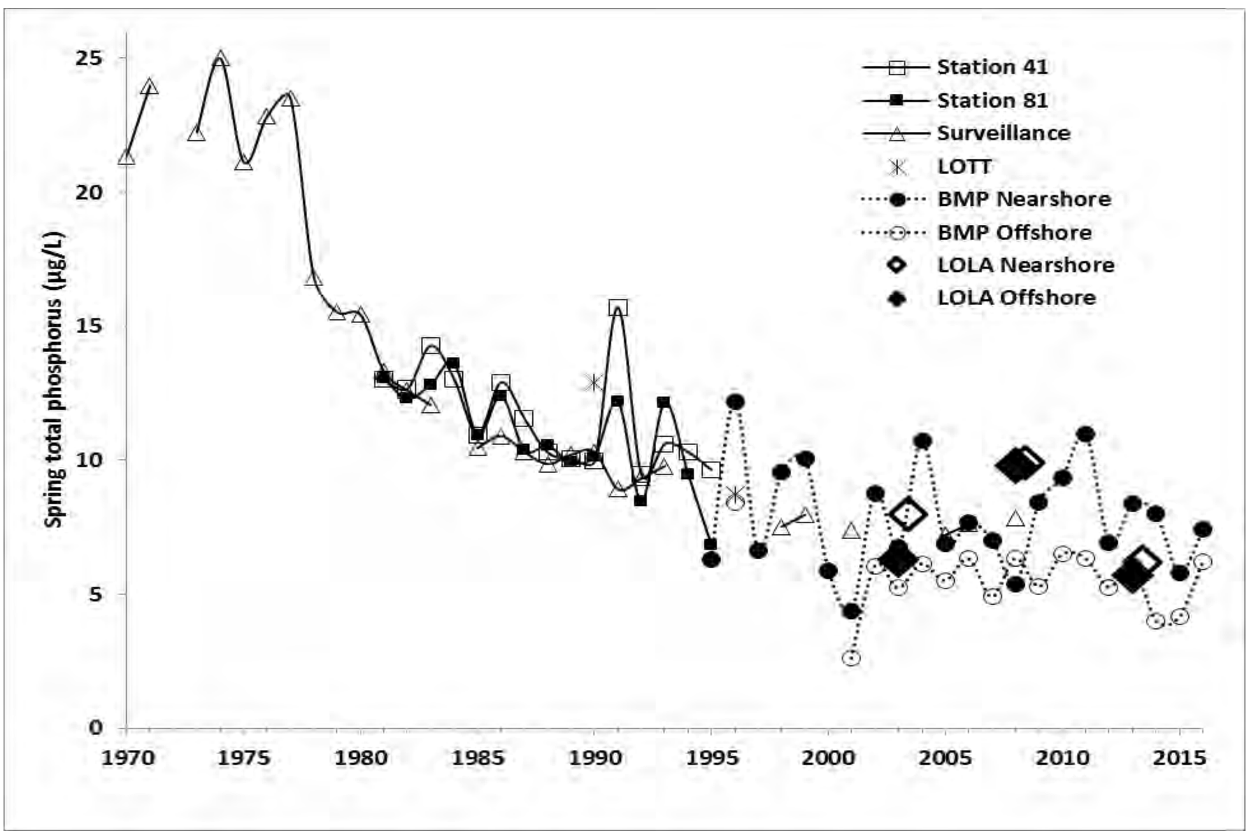



*Figure 4b. Long-term spring (Apr – May) epilimnetic total phosphorus concentrations in Lake Ontario, 1981 - 2016. Data from 1981 – 1995 are from the Department of Fisheries and Oceans Canada's Bioindex Program. Data from 1995 – 2016 are from the US Biomonitoring Program.*

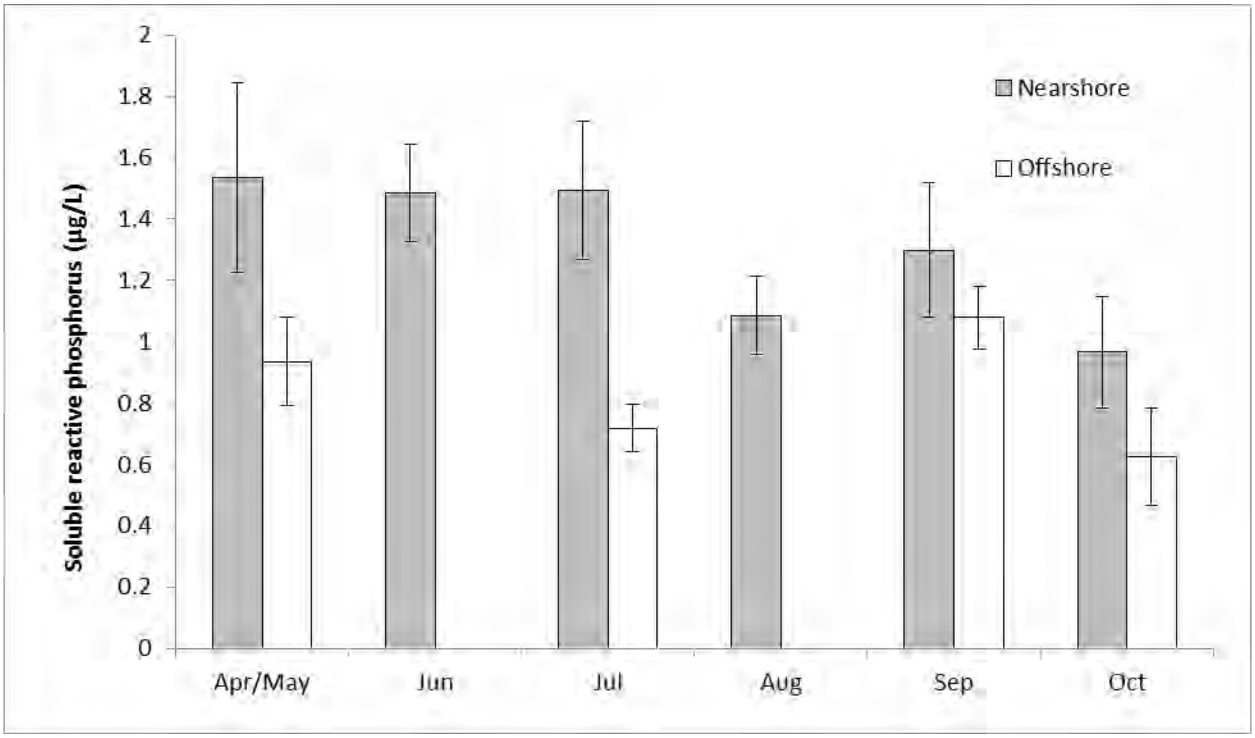



***Figure 5a. Mean monthly soluble reactive phosphorus concentrations for nearshore and offshore habitats in Lake Ontario, Apr/May - October, 2016. Error bars are ± 1SE.***

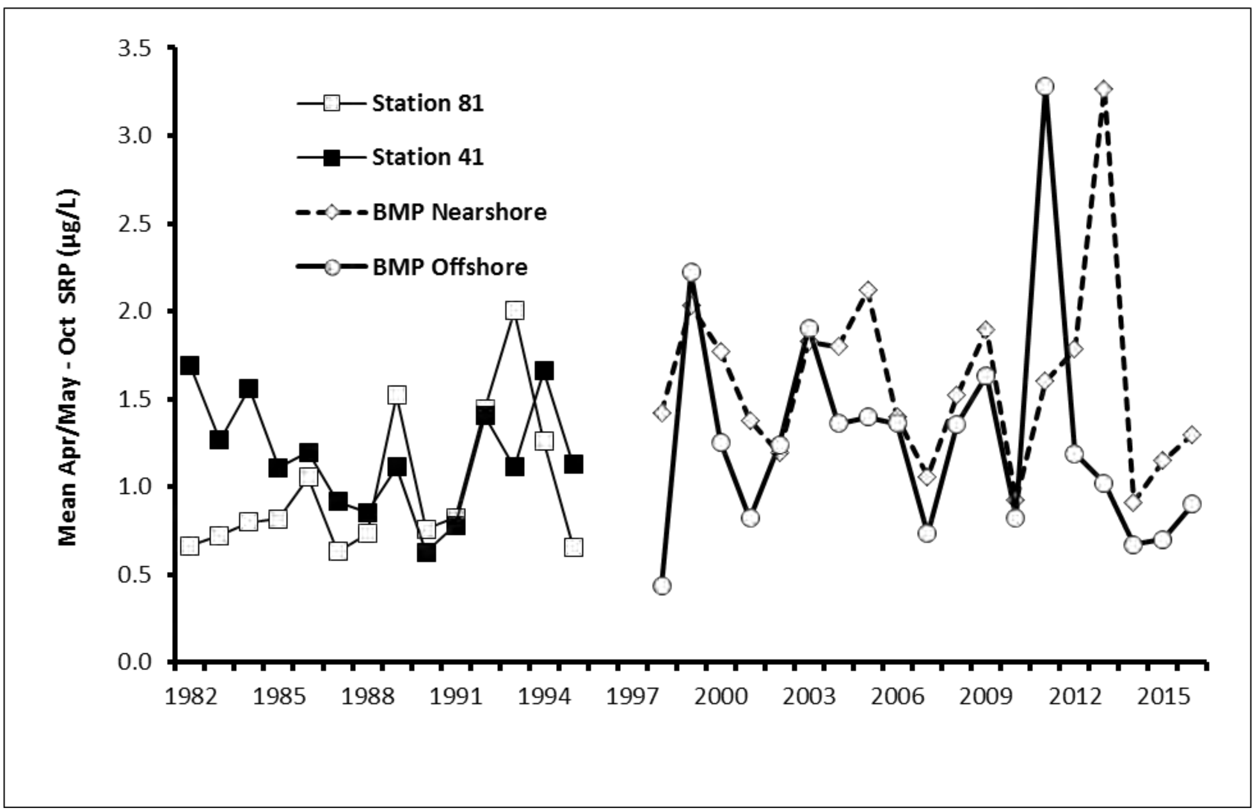



***Figure 5b. Long-term mean Apr/May – Oct soluble reactive phosphorus concentrations in Lake Ontario, 1982 – 2016. Station 41 and Station 81 are from the Department of Fisheries and Oceans Canada's Bioindex Program. Data from 1998 – 2016 are from the US Biomonitoring Program.***

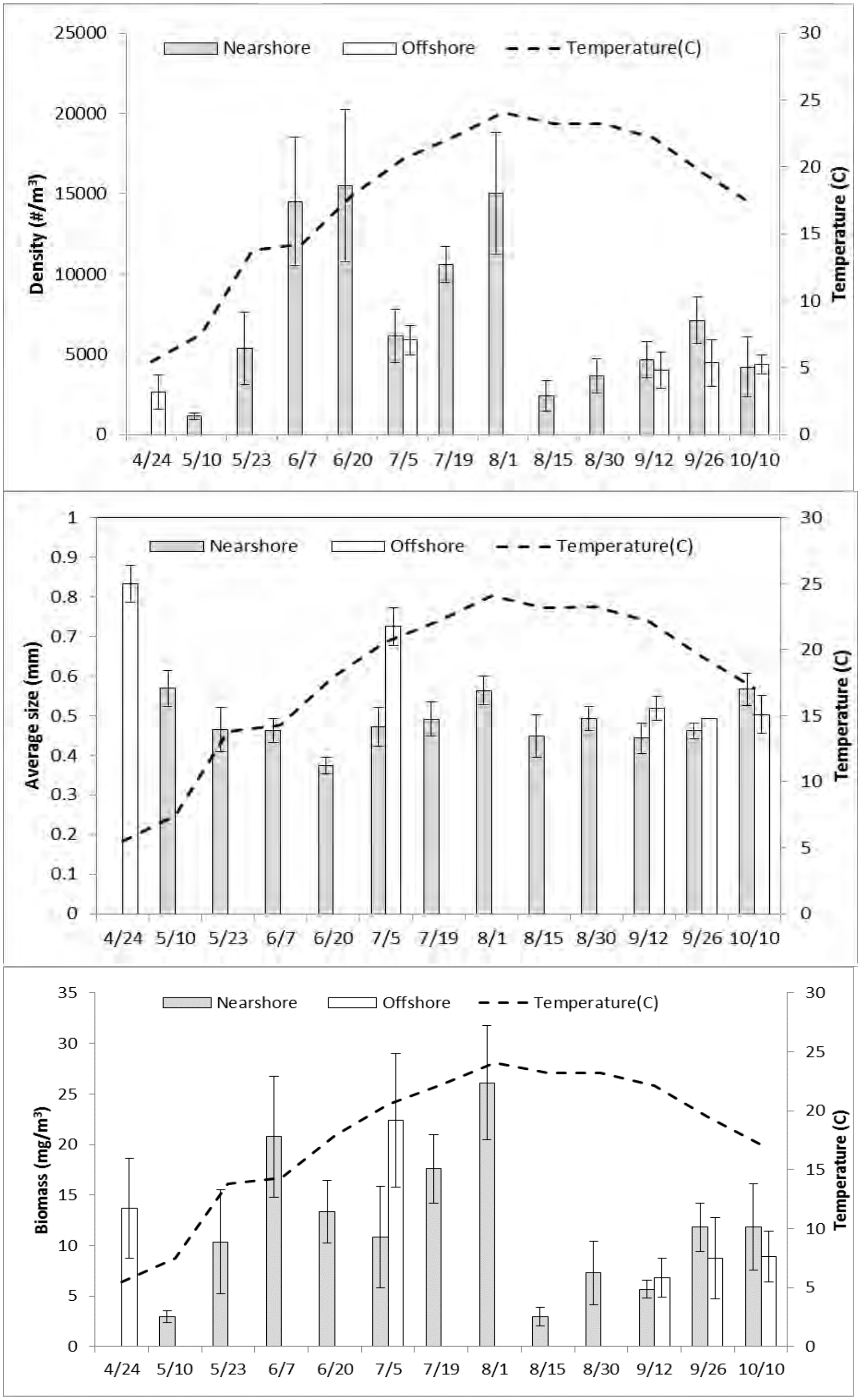



*Figure 6. Biweekly mean (± 1 SE) daytime epilimnetic zooplankton density, size, and dry biomass for April through October 2016 at nearshore and offshore sites on Lake Ontario. On the x-axis, biweeks are designated by the date beginning each biweek. When no error bar is present, only one sample was taken that biweek. Sea surface temperatures (secondary x-axis) are from NOAA CoastWatch web site (https://coastwatch.glerl.noaa.gov/ftp/glsea/avgtemps/2016/glsea-temps2016_1024.dat)*

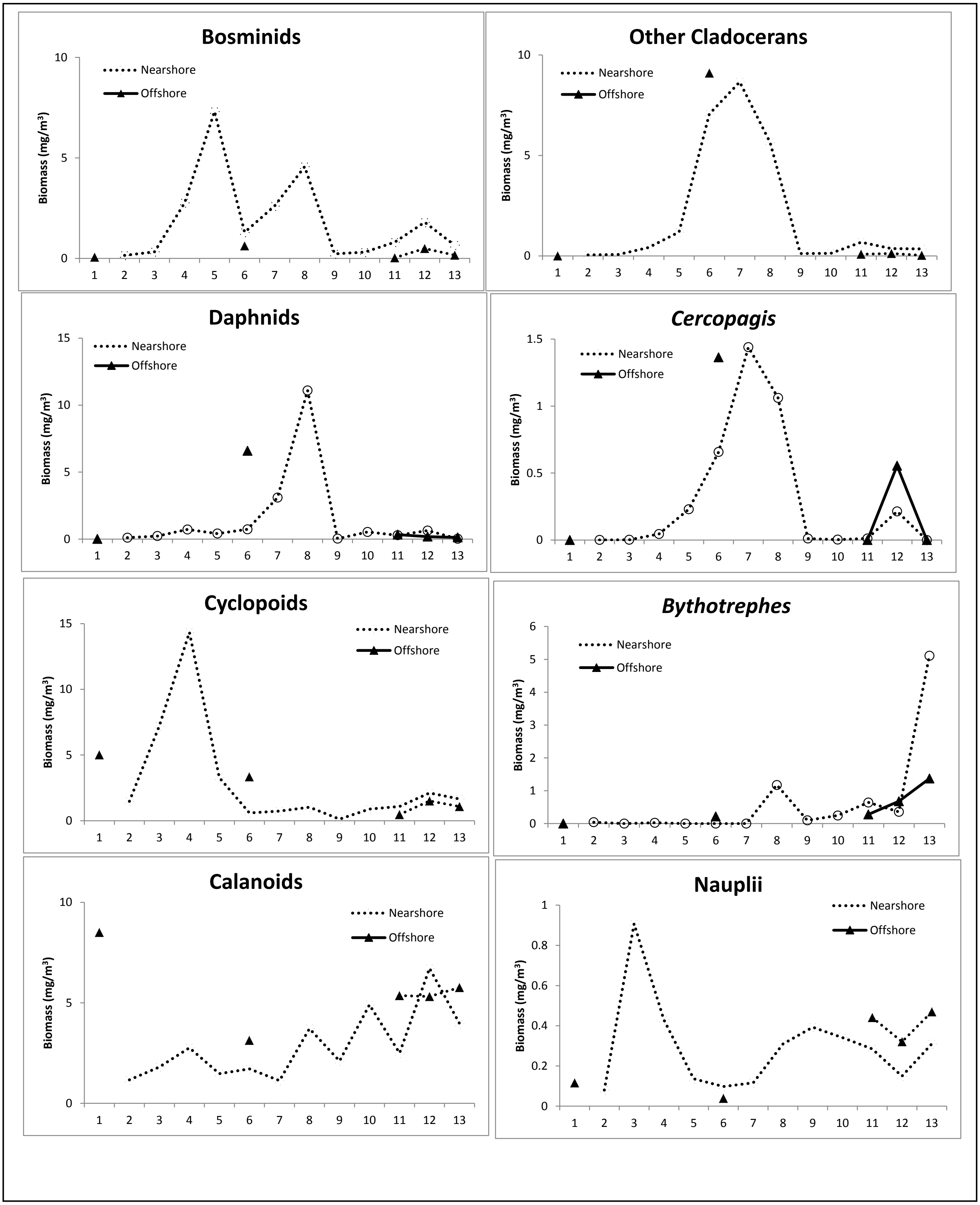



*Figure 7. Daytime epilimnetic dry biomass of zooplankton community groups for nearshore and offshore areas of Lake Ontario, April - October 2016. Note different y-axis scales. On the x-axis, biweeks are designated by the date beginning each biweek.*

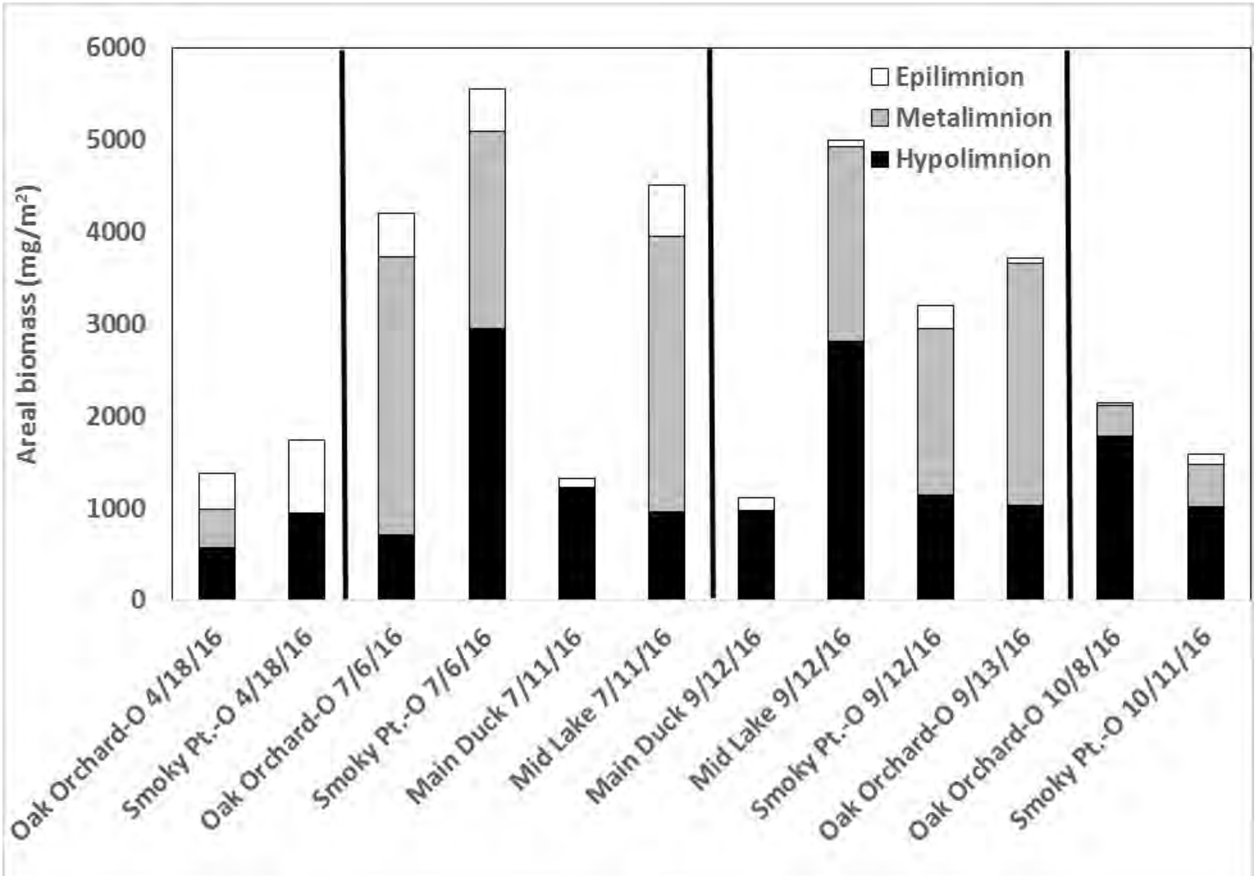



***Figure 8. Daytime epilimnetic, metalimnetic, and hypolimnetic zooplankton dry biomass (areal) in Lake Ontario's offshore, 2016. Epilimnetic values determined directly from the epilimnetic tow. Metalimnetic values determined by subtracting epilimnetic tow values from the metalimnetic tow. Hypolimnetic values determined by subtracting metalimnetic tow values from the hypolimnetic tow. Stations without metalimnetic values are either shallower stations where only two tows were performed (Main Duck 7/11 and 9/12) or stations where the metalimnetic value was negative (Smoky Pt-O 4/18) due to variation in catch of zooplankton between epilimnetic and metalimnetic tows.***

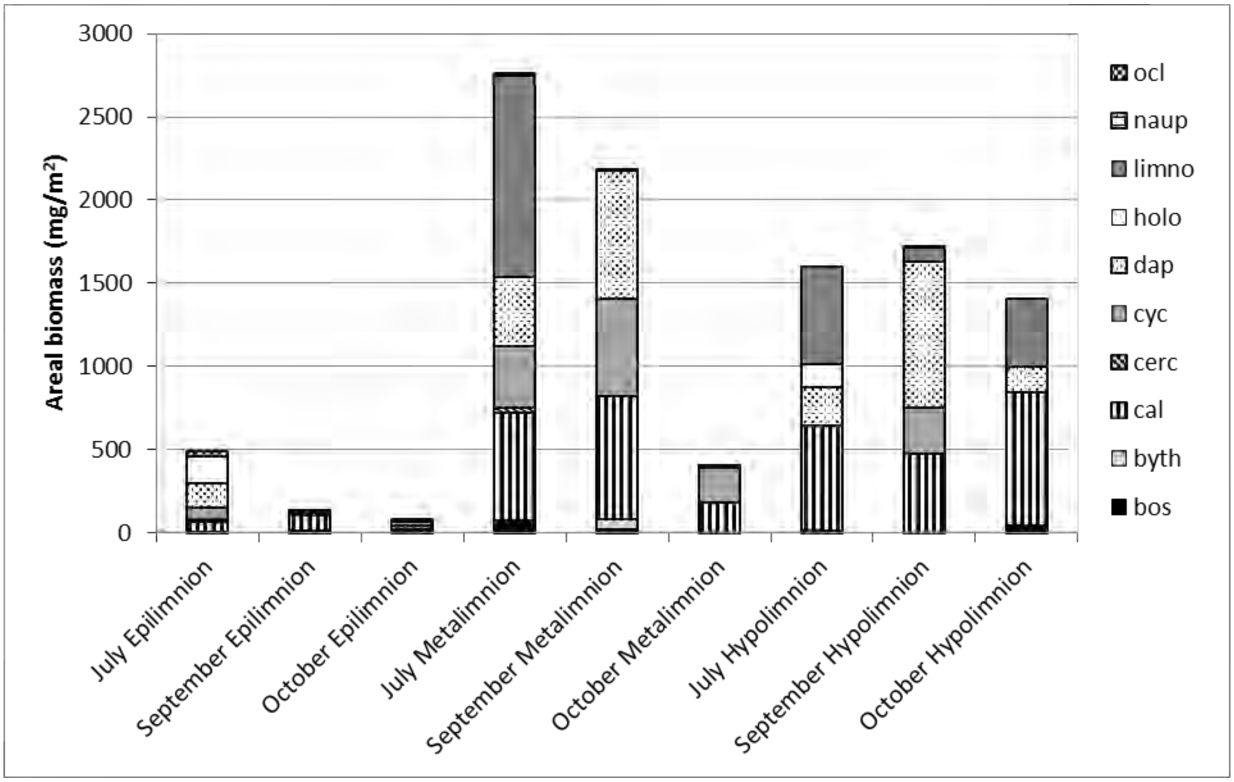



***Figure 9. Comparison of mean zooplankton biomass (dry) in epilimnetic, metalimnetic, and hypolimnetic samples taken from deep (>100m) sites in Lake Ontario's offshore, July, September, and October 2016. The epilimnetic strata includes zooplankton from the thermocline (8 – 26 m) up to the surface, the metalimnetic strata includes zooplankton from 16 – 50 m up to the thermocline, and the hypolimnetic strata contains zooplankton from 93 - 100 m up to the metalimnion. Abbreviations are BOS=bosminids, BYTH=Bythotrephes, CAL=calanoid copepods excluding Limnocalanus, CERC=Cercopagis, CYC=cyclopoid copepods, DAP=Daphnids, HOLO=Holopedium gibberum, LIMNO=Limnocalanus macrurus, NAUP=nauplii, OCL=other cladocerans. A value of zero was assigned when values were negative due to variation in catch of zooplankton between epilimnetic and metalimnetic tows or between metalimnetic and hypolimnetic tows.***

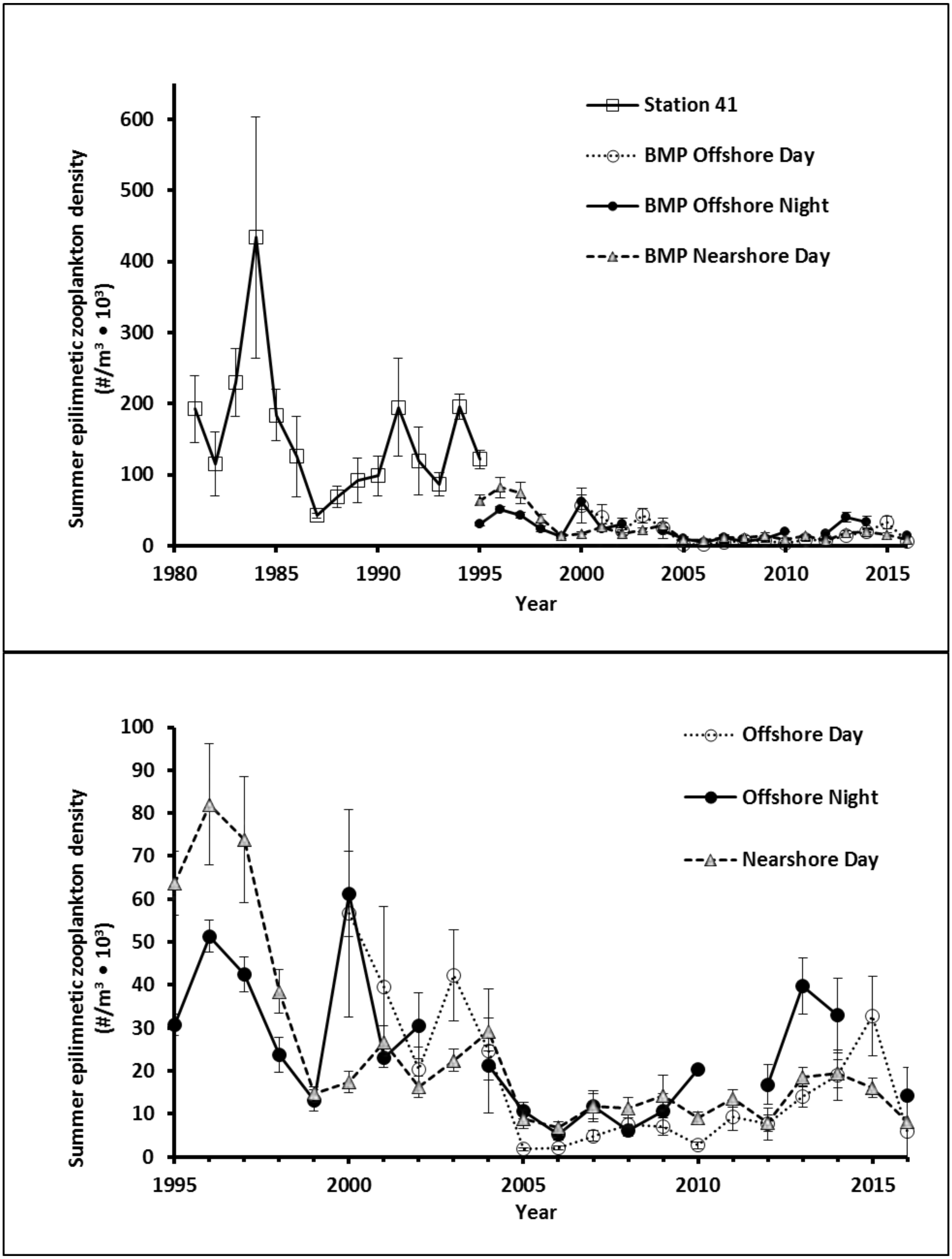



*Figure 10. Mean summer (Jul-Aug) epilimnetic zooplankton density in nearshore and offshore habitats in Lake Ontario, 1981 – 2016 (top panel) and from 1995 – 2016 (bottom panel). Station 41 data are from the Department of Fisheries and Oceans Canada's Bioindex Program. Error bars are ± 1 SE.*

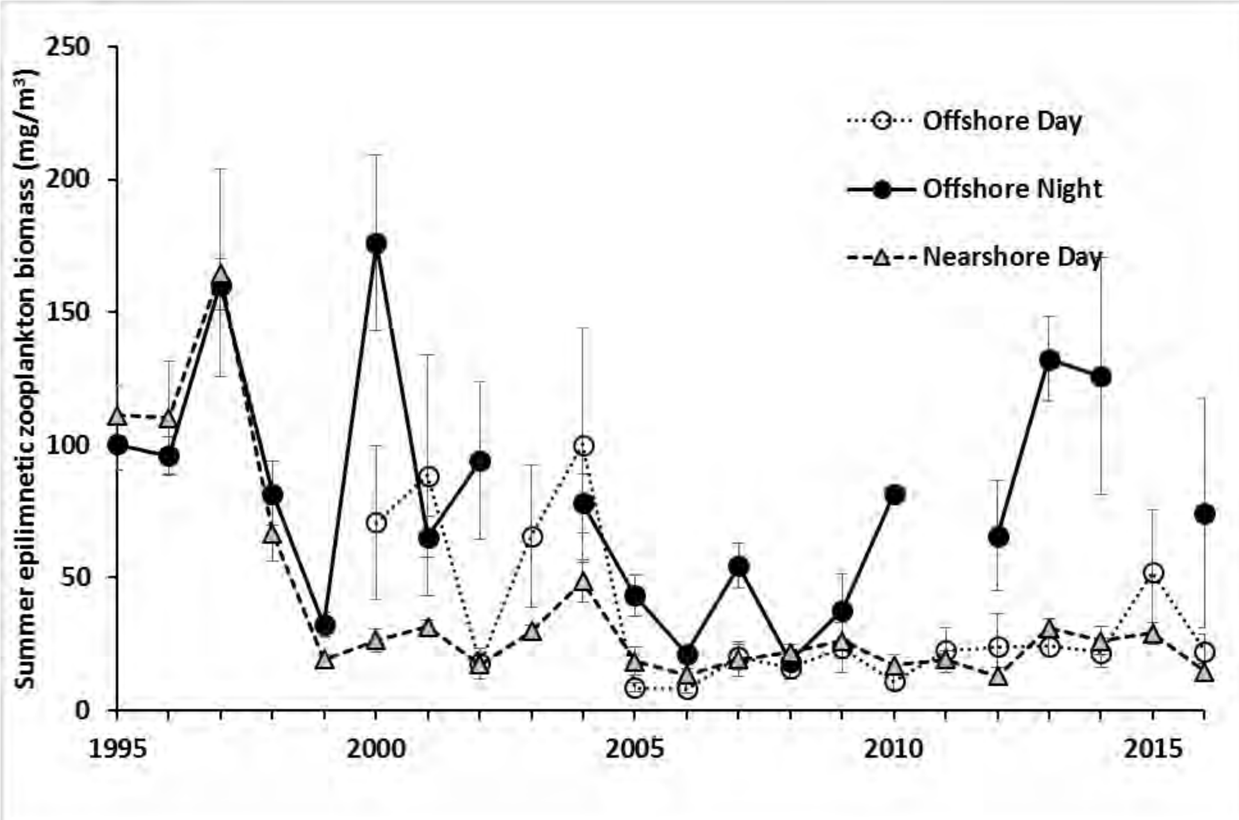



*Figure 11. Mean summer (Jul – Aug) epilimnetic zooplankton biomass in nearshore and offshore habitats in Lake Ontario, 1995 - 2016. Error bars are ± 1 SE.*

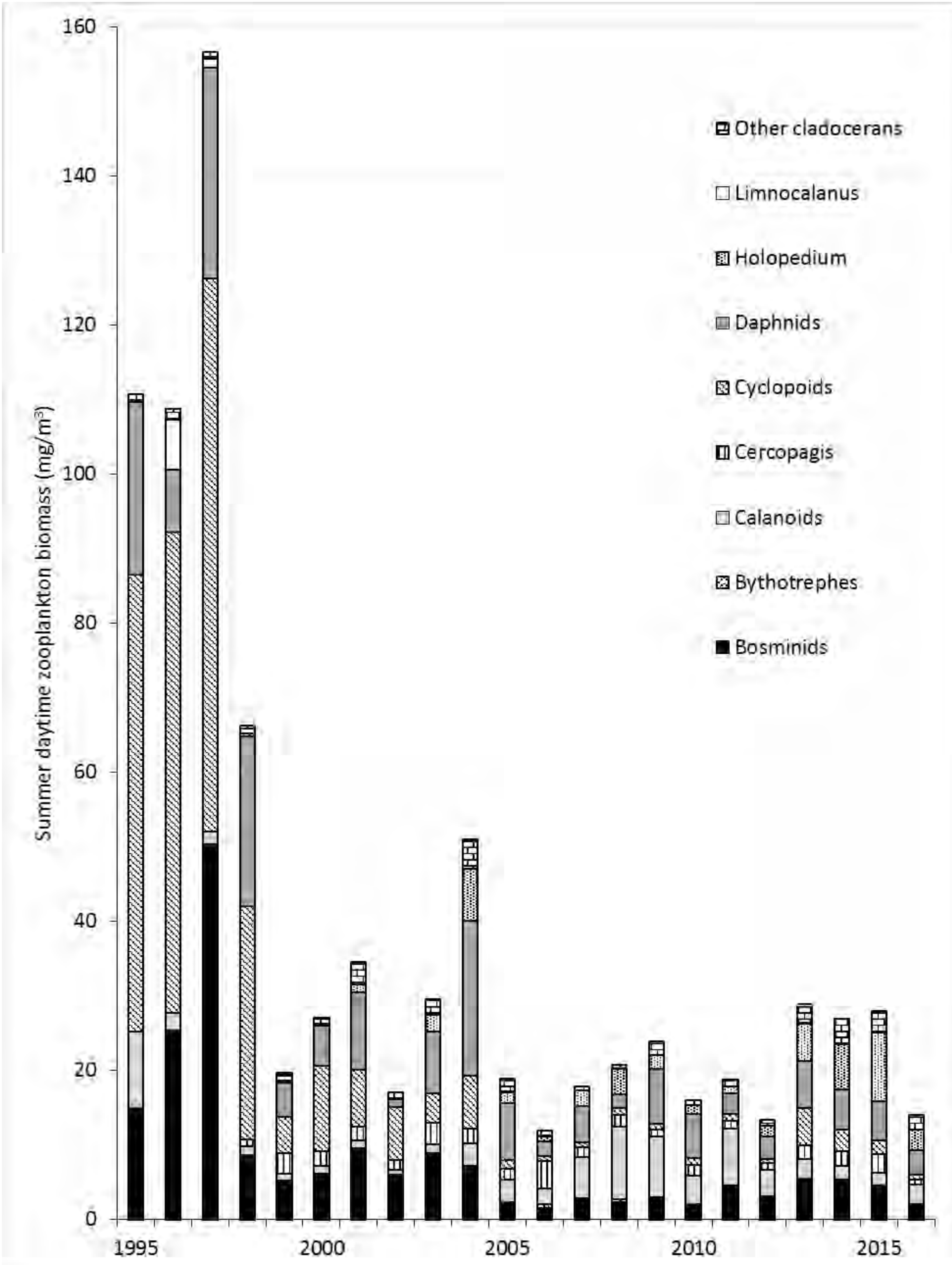



***Figure 12. Mean summer (Jul – Aug) daytime nearshore zooplankton group biomass in Lake Ontario, 1995 – 2016.***

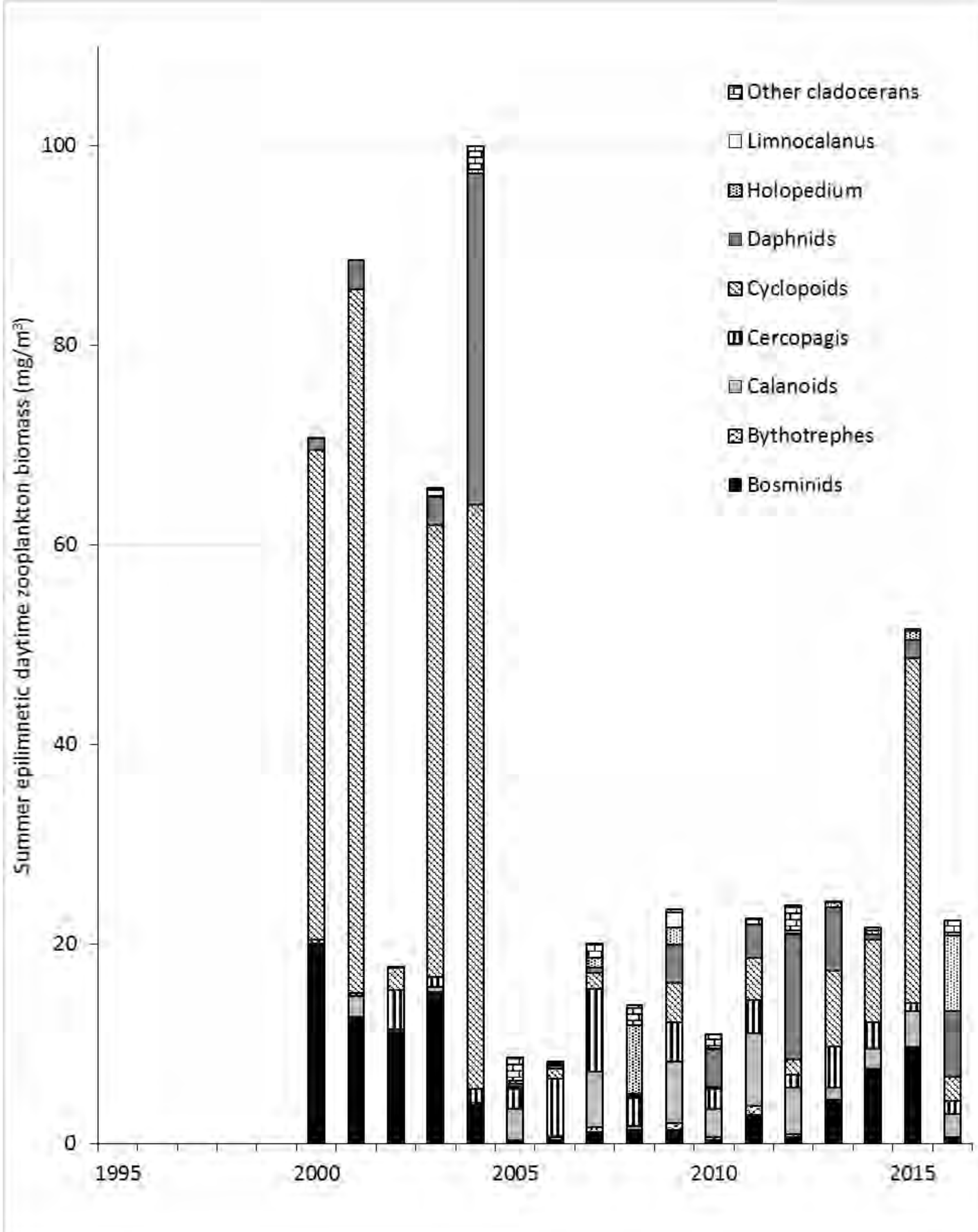
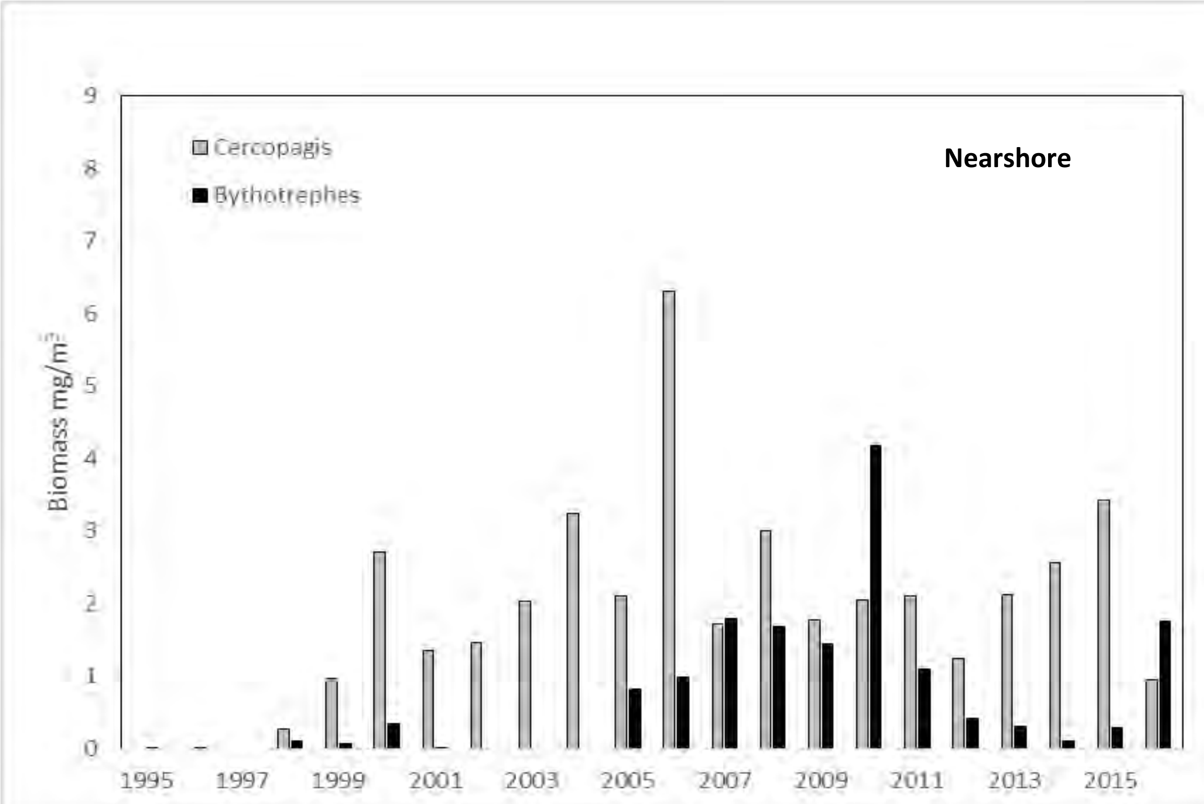



***Figure 13. Mean summer (Jul – Aug) daytime epilimnetic offshore zooplankton group biomass in Lake Ontario, 2000 – 2016.***



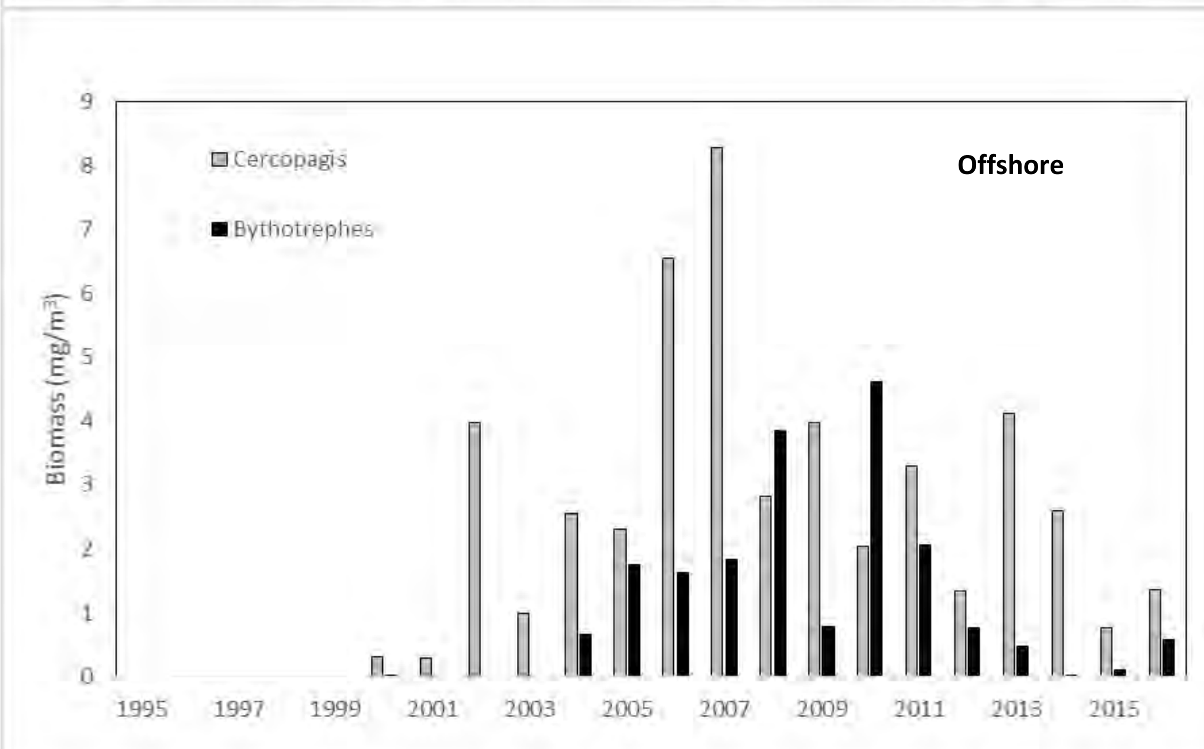




*Figure 14. Daytime epilimnetic nearshore and offshore fall (September and October)* **Bythotrephes** *and summer (July)* **Cercopagis** *biomass in Lake Ontario, 1995 – 2016.*

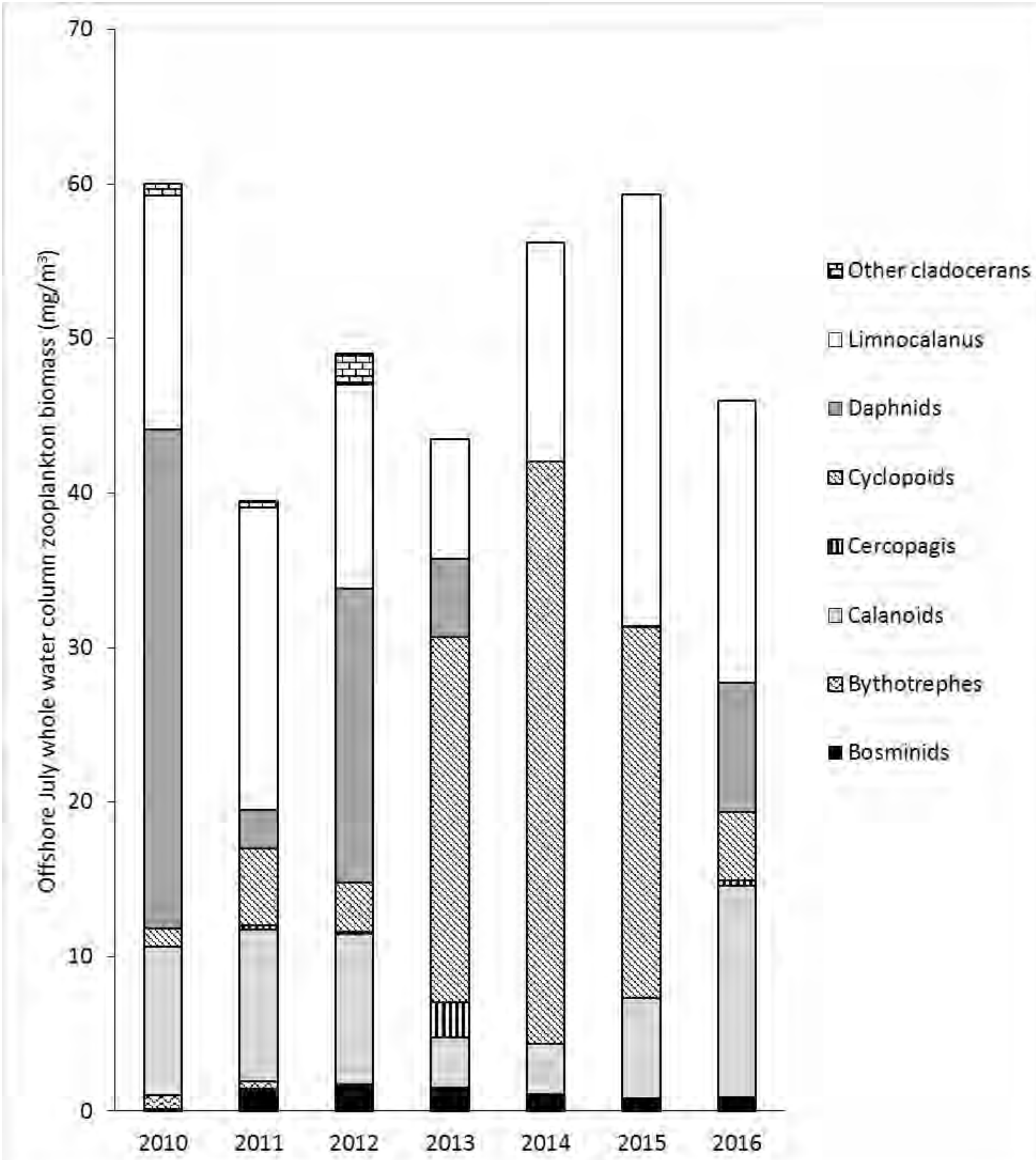



***Figure 15.** Mean July whole water column offshore zooplankton group biomass in Lake Ontario, 2010 – 2016.*

***Table 1. Mean chl a, TP, SRP and Secchi depth (± 1 SE) for nearshore and offshore sites, April – October 2016.***

| Sites | Chlorophyll-*a* (µg/L) | Total phosphorus (µg/L) | Soluble reactive phosphorus (µg/L) | Secchi depth (m) |
|---|---|---|---|---|
| | Mean ± 1 SE | | | |
| ***Nearshore*** | | | | |
| Chaumont Lake (CBL) | 2.4± 0.2 (n=11) | 7.4± 0.6 (n=11) | 1.6± 0.3 (n=11) | 5.8± 0.4 (n=11) |
| Galloo Island (GIL) | 2.0± 0.3 (n=11) | 7.2± 0.6 (n=11) | 1.2± 0.1 (n=10) | 7.3± 0.6 (n=11) |
| Oak Orchard (OOL) | 1.6± 0.1 (n=11) | 8.1± 0.9 (n=11) | 1.4± 0.1 (n=12) | 6.0± 0.9 (n=11) |
| Sodus Lake (SOL) | 1.6± 0.2 (n=11) | 5.9± 0.3 (n=12) | 0.8± 0.2 (n=12) | 7.8± 0.7 (n=12) |
| Sandy Pond Lake (SPL) | 1.7± 0.2 (n=10) | 8.4± 0.6 (n=10) | 1.2± 0.1 (n=7) | 7.1± 0.9 (n=6) |
| Niagara East Lake (NEL) | 2.1± 0.1 (n=11) | 9.9± 0.8 (n=11) | 1.6± 0.3 (n=11) | 5.0± 0.3 (n=12) |
| Niagara West Lake (NWL) | 2.4± 0.4 (n=10) | 8.1± 0.6 (n=11) | 1.6± 0.2 (n=11) | 5.9± 0.7 (n=12) |
| ***Offshore*** | | | | |
| Kaho | | | | |
| Oak Orchard-N | 2.5± 0.5 (n=4) | 6.9± 0.6 (n=4) | 0.9± 0.2 (n=4) | 7.5± 1.5 (n=4) |
| Oak Orchard-O | 2.0± 0.6 (n=4) | 5.3± 0.7 (n=4) | 0.9± 0.2 (n=4) | 13.0± 2.3 (n=4) |
| Smoky Point-N | 2.0± 0.3 (n=4) | 6.1± 0.6 (n=4) | 0.8± 0.3 (n=4) | 7.5± 1.3 (n=4) |
| Smoky Point-O | 2.2± 0.5 (n=4) | 5.2± 0.3 (n=4) | 0.7± 0.2 (n=4) | 9.9± 2.0 (n=3) |
| Seth Green | | | | |
| Main Duck | 1.6± 0.1 (n=3) | 5.9± 0.4 (n=3) | 1.0± 0.2 (n=3) | 9.2± 2.0 (n=3) |
| Mid Lake | 1.4± 0.2 (n=3) | 5.7± 0.3 (n=3) | 0.7± 0.2 (n=3) | 8.2± 1.4 (n=3) |
| Tibbetts Point | 1.6± 0.4 (n=3) | 6.9± 0.6 (n=3) | 0.8± 0.1 (n=3) | 9.3± 2.4 (n=3) |

***Table 2. Comparison of nearshore and offshore sites Apr/May-October, 2016 by fitting a general linear model with month and habitat as the effects on log-transformed (zooplankton density, biomass, and group biomasses) or untransformed (TP, SRP, chl-a, SD, and zooplankton size) Apr/May – Oct mean values. Reported p-values are for the significance of habitat, not month. Values shown are arithmetic means summarized by site and then across months 4/5, 7, 9, and 10. Months 6 and 8 were removed from the analysis because the offshore was not sampled during those months. 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) | 7.6 | 6.0 | **<0.0001** |
| | Soluble reactive phosphorus (µg/L) | 1.4 | 0.8 | **0.0015** |
| | Chlorophyll *a* (µg/L) | 1.9 | 1.9 | 0.8177 |
| | Secchi depth (m) | 6.5 | 10.0 | **<0.0001** |
| Total zooplankton: | | | | |
| | Density (#/$m^3$) | 5631 | 4231 | 0.43 |
| | Size (mm) | 0.49 | 0.66 | **<0.0001** |
| | Biomass (mg dw/$m^3$) | 10.1 | 13.5 | 0.12 |
| Group biomass (mg dw/$m^3$): | | | | |
| | Bosminids | 1.1 | 0.3 | **0.0003** |
| | Daphnids | 0.7 | 1.9 | 0.34 |
| | Calanoid copepods (excluding *Limnocalanus*) | 2.6 | 4.7 | **0.0051** |
| | Cyclopoid copepods | 2.0 | 2.4 | 0.50 |
| | Other cladocerans (excluding *Holopedium*) | 1.1 | 0.4 | 0.25 |
| | *Cercopagis pengoi* | 0.3 | 0.4 | 0.15 |
| | *Bythotrephes longimanus* | 0.8 | 0.3 | 0.40 |
| | *Holopedium gibberum*. | 1.2 | 2.1 | 0.18 |
| | *Limnocalanus macrurus* | 0.1 | 0.7 | **0.05** |

***Table 3. Results of regression analyses performed on data from two time stanzas in Lake Ontario's offshore (2000 – 2016 and 2005 – 2016) and for three time stanzas in Lake Ontario's nearshore (1995 - 2016, 1995 – 2004, and 2005 – 2016). Paucity of data precluded analysis of the offshore 1995 – 2004 time period. SRP data were available from 1998 – 2016 in both habitats. All regression data were log-transformed prior to analysis. Trends are indicated by (+) or (-). Significant p-values are indicated in bold. Marginally significant p-values ($0.05<p<0.1$) are reported but not bolded. ns=not significant. Change is the slope of the log-linear regression and represents instantaneous rates per year. Change point analyses were performed on 2000 -2016 in the offshore and 1995 – 2016 in the nearshore. No breaks – no significant break points at $p<0.10$ level. **change point performed on ranks due to outliers. SRP data not available for 1995 – 1997. Secchi depth data not available 1995 – 1996. Offshore Secchi depth data 1997 – 2016 from USGS.***

| | Regression | | | | Change Point Analysis |
|---|---|---|---|---|---|
| **Offshore** | 2000 – 2016 | Change | 2005 – 2016 | Change | 2000 - 2016 |
| April/May – Oct SRP (µg/L) | ns | | ns | | no breaks |
| Spring TP (µg/L) | ns (2001-2016) | | ns | | no breaks |
| Summer Secchi Depth (m) | **(+) p=0.008** | **0.02** | **(+) p=0.0024** | **0.06** | no breaks |
| Summer chlorophyll *a* (µg/L) | **(-) p=0.022** | **0.04** | **(-) p=0.047** | **0.07** | (-) 2009 |
| Summer epilimnetic zooplankton density (#/L) | ns | | **(+) p=0.005** | **0.18** | (-) 2005, (+) 2013 |
| Summer epilimnetic zooplankton biomass (µg/L) | ns | | **(+) p=0.004** | **0.11** | (-) 2005 |
| **Summer epilimnetic zooplankton group biomass** | | | | | |
| Bosminids | ns | | **(+) p=0.040** | **0.20** | (-) 2004, (+) 2013 |
| *Bythotrephes longimanus* | ns | | (-) p=0.085 | | (+) 2006 |
| Calanoid copepods | **(+) p=0.022** | **0.15** | ns | | no breaks |
| *Cercopagis pengoi* | ns | | **(-) p=0.040** | **0.11** | no breaks |
| Cyclopoid copepods | ns | | **(+) p=0.015** | **0.31** | (-) 2005, (+) 2015 |
| Daphnids | ns | | **(+) p=0.030** | **0.25** | no breaks |
| Other Cladocerans | ns | | ns | | no breaks |
| *Limnocalanus* | ns | | ns | | no breaks |
| *Holopedium* | **(+ ) p= 0.009** | **0.35** | ns | | no breaks |

| | Regression | | | | | | Change Point Analysis |
|---|---|---|---|---|---|---|---|
| **Nearshore** | 1995 - 2016 | Change | 1995 - 2004 | Change | 2005 – 2016 | Change | 1995 -2016 |
| April/May – Oct SRP (µg/L) | ns | | ns | | ns | | no breaks |
| Spring TP (µg/L) | ns | | ns | | ns | | no breaks |
| Summer Secchi Depth (m) | ns | | ns | | ns | | no breaks |
| Summer chlorophyll *a* (µg/L) | ns | | **(+) p=0.003** | **0.07** | (-) p=0.054 | | (+) 2003, (-) 2009 |
| Summer epilimnetic zooplankton density (#/L) | **(-) p=0.0002** | **0.08** | **(-) p=0.026** | **0.14** | ns | | (-) 1998, (-)2005 |
| Summer epilimnetic zooplankton biomass (µg/L) | **(-) p=0.0006** | **0.07** | **(-) p=0.031** | **0.17** | ns | | (-) 1998 |
| **Summer epilimnetic zooplankton group biomass** | | | | | | | |
| Bosminids | **(-) p= 0.001** | **0.09** | (-) p=0.061 | | (+) p=0.075 | | **(-) 2005, (+) 2011 |
| *Bythotrephes longimanus* | **(+) p=0.026** | **0.04** | ns | | ns | | **(-) 2002, (+) 2006, (-) 2012 |
| Calanoid copepods | ns | | ns | | ns | | (-) 1996 |
| *Cercopagis pengoi* | ns | | ns | | ns | | no breaks |
| Cyclopoid copepods | **(-) p<0.001** | **0.20** | **(-) p=0.001** | **0.33** | ns | | (-) 1998, (-) 1999, (+) 2013 |
| Daphnids | **(-) p=0.02** | **0.06** | ns | | ns | | no breaks |
| Other Cladocerans | ns | | ns | | **(+) p=0.042** | **0.11** | no breaks |
| *Limnocalanus* | ns | | ns | | ns | | no breaks |
| *Holopedium* | **(+) p<0.001** | **0.26** | **(+) p=0.002** | **0.67** | **(+) p=0.036** | **0.14** | (+) 2003, (+) 2013 |

# Northern Pike Research, 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 2016) continues to indicate low population levels. Smith et al. (2007) demonstrated an overall dampening in the strength of Thousand Islands northern pike year classes beginning in the 1990s and seining indices show a corresponding low abundance for young of the year (YOY). Models of YOY northern pike production developed as part of the International Joint Commission (IJC) St. Lawrence River Water Levels Study indicated a negative relationship of water level regulation on northern pike reproduction (Farrell et al. 2006). Water level regulation and spawning habitat changes appear to have promoted deep-water pike spawning (over ~5 meters or 15') 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. Nearshore pike spawning has been negatively affected by water level regulation by limiting spawner access to wetlands. A related effect is the expansion of hybrid cattail (*Typha* x *glauca*) into shallow riparian wet meadow habitats that northern pike prefer for spawning (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). Water levels at 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 early indications of success with managed marshes demonstrating significant production of emigrating fingerlings (Farrell et al. 2003), it is hypothesized that low abundance of spawning adults and female skewed sex ratios have resulted in low levels of YOY production at managed marshes.

Northern pike YOY have been monitored in eleven seining survey sites also used to index muskellunge and in larger bays and in tributaries. Overall YOY production has declined significantly from historic levels. Continued monitoring is necessary to track pike reproductive success and evaluate responses to management activities (managed marshes and habitat enhancements) and as a baseline to assess future effects of proposed IJC water level management Plan 2014. Other needs fulfilled by the project include a better understanding of early life history processes for northern pike in drowned river mouth tributary systems and coastal bays. 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 Marsh, Cranberry Creek extension (tributary), Little Cranberry Creek, and Chippewa (Creek) Tributary. The managed marsh was Carpenters Branch of French Creek (Figure 1). A trapnet was also set at French Bay, Clayton NY to monitor northern pike.

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 inches). 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 each site.

Water levels were held ~0.6 m or about 2 feet above main river level at Carpenters Branch and Delaney Marsh. Delaney Marsh was not included in the spring spawning survey because of its remote island location, but was surveyed for emigrating YOY pike. The water level management strategy for marshes is intended to prevent the dramatic fall drawdown (Farrell et al. 2010) experienced under IJC water level regulation Plan 1958DD. Higher water levels provide improved spring water level conditions for spawning pike.

During a related study funded by the US Fish and Wildlife Service, northern pike have been monitored and managed at habitat enhancement areas in the DEC French Creek Wildlife Management Area and provide a useful comparison to the spawning marsh monitoring reported annually here. Excavated marsh spawning pools were created by Ducks Unlimited, and the US Fish and Wildlife Service Partners for Fish and Wildlife Program restored channels connecting French Creek to remnant wet meadow habitats by. Spawning pool and connecting channel sites were created in an attempt to increase YOY pike production through improved habitat and access to spawners.

In spring 2016, 44,465 advanced northern pike fry (~25mm or 1 inch total length) were given oxytetracycline (OTC) marks and released in the Carpenters Branch spawning marsh, in excavated spawning pools and channels, and reference sites to better understand their survival to emigration.

In early summer, YOY pike emigrating from marshes were captured in spillway traps set and emptied daily at Carpenter's Branch and Delaney Marsh. Also, fine-mesh mini-hoopnets were set and emptied daily at exits of habitat enhancement project sites. All fish captured were identified and enumerated. Northern pike were measured for total length (mm), and a pelvic fin for all fish greater than 80 mm (2.3 in.) was removed to evaluate the presence of marsh-origin fish during subsequent summer seining surveys and future spring adult trapnetting surveys.

A sample of pike from these sites were sacrificed and otoliths were extracted, sectioned and examined for the presence of the OTC mark under a UV microscope to determine stocked vs. wild origin.

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') long seine (90 hauls) and during August with a large-mesh, 18.3 m (60') long seine (90 hauls) (for methods details see Murry and Farrell 2007). In addition, 98 bays were sampled (298 hauls) in an exploratory series with the fine-mesh seine. This exploratory series is also used to compare to the long-term index seining results. Seining also occurs at Delaney Bay in an attempt to detect marsh-origin northern pike.

## Results and Discussion

Spawning run trapnet survey

A total of 60 northern pike were captured at five index tributary sites from March 28 to April 15, 2016, comprising an effort of 83 net nights(catch per unit of effort (CPUE) of 0.72 fish/night;Table 1). The catch of spawning northern pike at index sites remains low since a significant peak in 2008 (CPUE=3.36; Figure 2). Catches at Chippewa tributary (0 pike, 14 net-nights) and Cranberry Creek (2 pike, 15 net-nights; CPUE=0.13) were considerably lower compared to all other tributary sites. In 2015, catches were considerably higher at Cranberry Creek (26 pike in 14 net-nights; CPUE=1.86) compared to all other tributary sites. Catch at Carpenters Branch, a managed marsh, consisted of 23 northern pike in 2016 while in 2015 no pike we captured.

Current and past trapnet catches continue to indicate a significant dominance of female pike in the spawning run at the managed marsh sites. For 637 pike of known sex captured at Carpenters Branch in twelve seasons since 2003, 447 were female or 2.35 females to each male. Similarly at Delaney Marsh from 2007 to 2011, 71 of 95 pike were female (2.96 female to male ratio).

Emigration of northern pike at managed marshes and excavated spawning pools

In 2016, emigration traps were deployed at Delaney Marsh from June 17 to June 27 and at Carpenters Branch from June 15 to July 1 to evaluate success of released fry. Despite the supplementation with stocked fry, no pike were recorded at Delaney Marsh in 10 days of monitoring. Catches at Carpenters Branch remained low with 6 YOY northern pike captured over 15 days of monitoring. The catch per unit effort at Carpenters Branch increased from 0 in 2015 to 0.38 in 2016. Low production of northern pike from Carpenters and Delaney spawning marshes has continued for eight consecutive years (Figure 3) despite supplementation efforts.

The 2016 catch and OTC evaluation data show spawning habitat excavation sites outperformed managed marshes in YOY catch and the presence of stocked origin fish. A total of 466 emigration trap net nights of effort was expended at sites that resulted in a moderate total catch of 154 YOY northern pike (CPUE=0.33 fish/d; Table 2). At reference wetland sites, 22 YOY pike were captured in 154 net-nights (CPUE=0.14 fish/d) 9/29 or 31% of fish examined were stocked (Table 2). Excavated pools had the most YOY pike with 79 captured in 199 net-nights (CPUE=0.40 fish/d) and 36 of 66 fish sacrificed had OTC marks (55%). Channel excavations had the highest catch rate of 47 pike in 87 net-nights (CPUE=0.54 fish/d) and 42% (15 of 36 fish) had OTC marks indicating stocked origin. Only 1 of 6 fish (1.7%) sacrificed at the Carpenters Branch spawning marsh had an OTC mark.

Summer seining surveys

The YOY seining survey at eleven index sites targeting muskellunge produced 7 northern pike YOY from the 30' seine series in 90 hauls (standardized CPUE = 0.08 fish/haul; Table 3) and 1 in the 60' seine series in 90 hauls (standardized CPUE = 0.01 fish/haul). Ninety-eight additional upper St. Lawrence River bays were sampled by seining and 44 YOY pike were captured (N=298 hauls; CPUE = 0.15). Seine hauls at Delaney Bay (N=8) resulted in the capture of 1 YOY pike (Table 3).

## Conclusions and Recommendations

Water level conditions were poor in 2016 and the drought likely contributed to the generally poor performance of both wild and stocked northern pike in study locations. The stocked fry, however, did contribute significantly to the overall catch (45%) and could have performed better with improved environmental conditions. Interestingly, spawning habitat enhancements via excavation of spawning pools and channels performed better than spawning marshes and hold promise as a management technique.

The extensive exploratory seining at numerous sites yielded a low catch per effort, similar to observations at long-term index locations. Continued low abundance of adult and YOY northern pike on spawning/nursery grounds is likely due to a combination of poor habitat and spawning conditions, low adult stock size and skewed sex ratios.

It is recommended that DEC, the US Fish and Wildlife Service (FWS) and Ducks Unlimited (DU) continue to enhance critical spawning and nursery habitat in the region. The long-term monitoring developed in this study will additionally serve as an important indicator to assess effects ofIJC Plan 2014, if adopted, and to help guide the IJC adaptive management process.

## Acknowledgements

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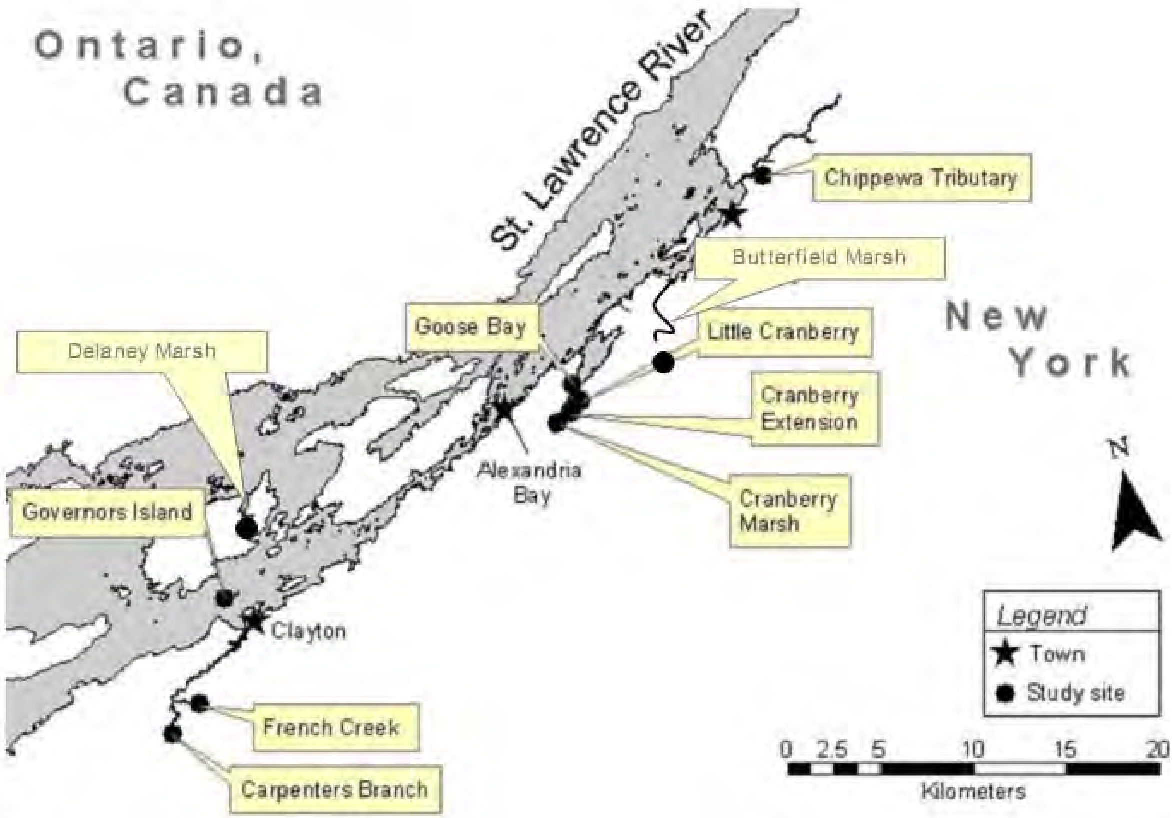


**Figure 1.** Study sites in the Thousand Islands Region of the upper St. Lawrence River in Clayton and Alexandria Bay, New York, including spawning marshes at Carpenters Branch (French Creek Wildlife Management Area) and Delaney Marsh (Grindstone Island) and sampling index locations at French Creek, Little Cranberry Creek, Cranberry Extension, and Chippewa (Creek) Tributary. Governors Island is the location of the Thousand Islands Biological Station. Additional seining locations (not shown) are index YOY muskellunge monitoring sites and other regional embayments.

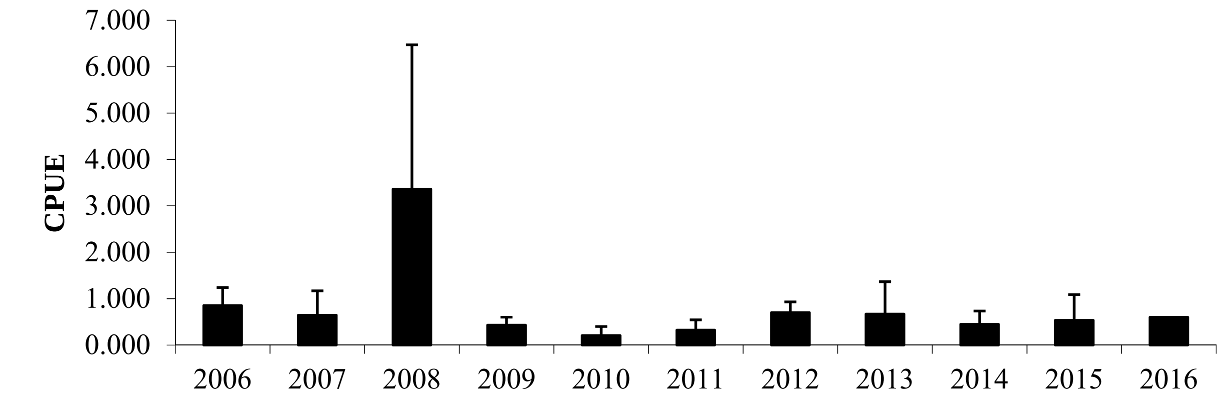


**Figure 2.** Average catch per net-night of northern pike in five spring spawning index trapnetting locations from 2006 to 2016 with 90% confidence limits.

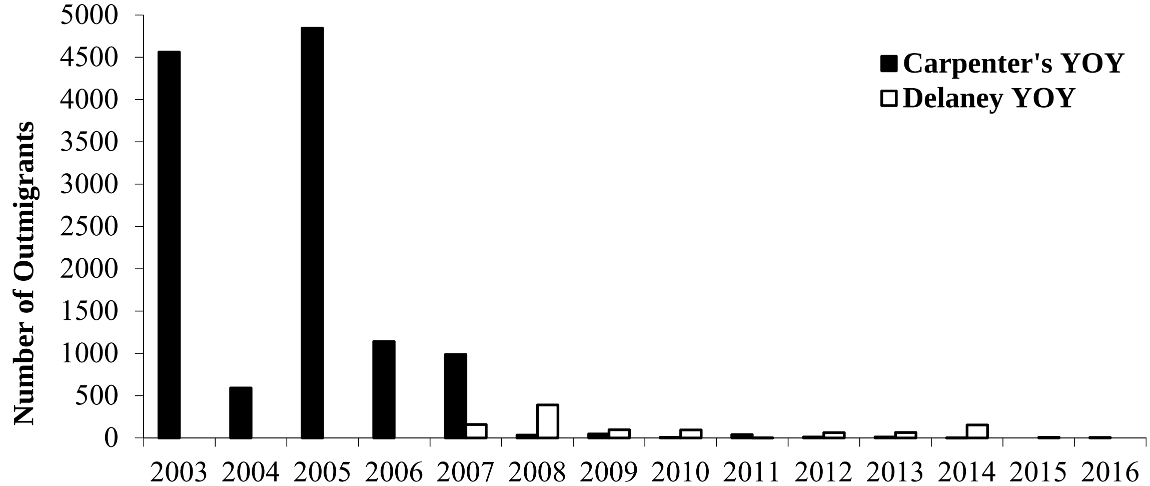


**Figure 3.** Number of out-migrant northern pike YOY from managed spawning marshes at Carpenters Branch (2003 to 2016) and Delaney Marsh (2007 to 2016).

**Table 1.** 2016 upper St. Lawrence River northern pike spawning survey effort and results by site from March 28 to April 15. Effort is defined as the total number of net-nights fished. M/F ratio is the ratio of male to female northern pike.

| **2016 NP Spawning** | | | | | | |
|---|---|---|---|---|---|---|
| **Site** | **Gear** | **Effort** | **Net nights** | **NP** | **CPUE** | **M/F ratio** |
| Bevin's (French Creek) | Hoop | 14 | 3/28-4/1, 4/6-14 | 16 | 1.143 | 0.400 |
| Carpenters (French Creek) | Hoop | 14 | 3/28-4/1, 4/6-14 | 23 | 1.643 | 0.545 |
| Chippewa | Hoop | 14 | 3/28-4/1, 4/5-8, 4/10-14 | 0 | 0.000 | N/A |
| Cranberry | Oneida | 15 | 3/28-4/1, 4/5-14 | 2 | 0.133 | 0.000 |
| Cranberry Ext. | Hoop | 13 | 3/28-4/1, 4/6-8, 4/10-14 | 10 | 0.769 | 0.667 |
| Little Cranberry | Hoop | 13 | 3/28-4/1, 4/6-8, 4/10-14 | 9 | 0.692 | 0.286 |
| **Total** | | **83** | | **60** | **0.723** | **0.456** |

**Table 2.** Catch of YOY northern pike in emigration traps (set at spillways associated with managed spawning marshes at Carpenters Branch and Delaney Marsh), and traps set at outlets of spawning pools and channel excavation sites at French Creek. Clayton NY. Sites were stocked with OTC marked advanced fry at three site types (reference, excavated spawning pools and excavated channels) and fish sacrificed were examined for presence of marks to determine stocked origin.

| 2016 NP Emigration | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Location** | **Set Date** | **End Date** | **Net-Nights** | **# Stocked** | **NP Catch** | **Marked/ observed** | **CPUE** |
| | | | **REFERENCE SITE COMPLEXES** | | | | |
| FC 1-REF | 6/13/2016 | 7/1/2016 | 18 | 810 | 3 | 0/1 | 0.17 |
| FC 2-REF | 6/13/2016 | 7/1/2016 | 34 | 3720 | 3 | 1/2 | 0.09 |
| FC 3-REF | 6/13/2016 | 6/30/2016 | 17 | 1830 | 1 | 0/1 | 0.06 |
| FC 4-REF | 6/14/2016 | 6/30/2016 | 16 | 1110 | 1 | 1/1 | 0.06 |
| FC 5-REF | 6/13/2016 | 6/30/2016 | 17 | 1710 | 0 | 0/0 | 0.00 |
| FC 6-REF | 6/13/2016 | 7/1/2016 | 18 | 780 | 4 | 1/4 | 0.22 |
| FC 7-REF | 6/13/2016 | 7/1/2016 | 18 | 690 | 0 | 0/0 | 0.00 |
| FC 8-REF | 6/13/2016 | 6/29/2016 | 16 | 4200 | 10 | 6/10 | 0.63 |
| TOTAL | | | 154 | 14,400 | 22 | 9/29 (31%) | 0.14 |
| | | | **EXCAVATED SPAWNING POOL COMPLEXES** | | | | |
| FC 1-SP | 6/13/2016 | 7/1/2016 | 69 | 1950 | 11 | 3/9 | 0.16 |
| FC 2-SP | 6/13/2016 | 7/1/2016 | 18 | 480 | 3 | 2/3 | 0.17 |
| FC 3-SP | 6/13/2016 | 6/30/2016 | 50 | 1650 | 8 | 4/7 | 0.16 |
| FC 4-SP | 6/14/2016 | 6/30/2016 | 32 | 2460 | 47 | 22/38 | 1.47 |
| FC 5-SP | 6/14/2016 | 6/30/2016 | 30 | 3840 | 10 | 5/9 | 0.33 |
| TOTAL | | | 199 | 10,380 | 79 | 36/66 (55%) | 0.40 |
| | | | **CHANNEL EXCAVATION COMPLEXES** | | | | |
| FC 1-EXC | 6/13/2016 | 6/29/2016 | 16 | 3540 | 8 | 3/8 | 0.38 |
| FC 2-EXC | 6/13/2016 | 7/1/2016 | 18 | 630 | 32 | 9/22 | 0.11 |
| FC 3-EXC | 6/13/2016 | 6/30/2016 | 17 | 660 | 7 | 3/6 | 1.00 |
| TOTAL | | | 87 | 4,830 | 47 | 15/36 (42%) | 0.54 |
| | | | **SPAWNING MARSHES** | | | | |
| Carpenters Branch | 6/15/2016 | 7/1/2016 | 16 | 6800 | 6 | 1/6 | 0.38 |
| Delaney Marsh | 6/17/2016 | 6/27/2016 | 10 | 8055 | 0 | 0 | 0.00 |
| TOTAL | | | 26 | 14,855 | 6 | 1/6 (17%) | 0.23 |
| **OVERALL SITES** | | | 466 | 44,465 | 154 | 61/137 (45%) | 0.33 |

**Table 3.** Seining catch summary for 2016 using a 1/8" fine-mesh 30' bag seine in index sites, exploratory sites, and the 1/4" large-mesh bag seine targeting esocids.

| **2016 30' Index Seining** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Site | Hauls | MKY | NP | GP | MKY CPUE | NP CPUE | GP CPUE |
| Affluence Bay | 6 | 0 | 0 | 2 | 0.00 | 0.00 | 0.33 |
| Boscobel Bay | 6 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Cobb Shoal | 12 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Deer Island | 6 | 2 | 0 | 1 | 0.33 | 0.00 | 0.17 |
| Frink's Bay | 10 | 0 | 0 | 1 | 0.00 | 0.00 | 0.10 |
| Garlock Bay | 10 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Lindley Bay | 6 | 1 | 0 | 0 | 0.17 | 0.00 | 0.00 |
| Millens Bay | 12 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Peos Bay | 6 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Rose Bay | 10 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Salisbury Bay | 6 | 0 | 7 | 2 | 0.00 | 1.17 | 0.33 |
| **Total** | **90** | **3** | **7** | **6** | **0.03** | **0.08** | **0.07** |

**Table 3.** Continued

| **2016 60' Index Seining** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Site | Hauls | MKY | NP | GP | MKY CPUE | NP CPUE | GP CPUE |
| Affluence Bay | 6 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Boscobel Bay | 6 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Cobb Shoal | 12 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Deer Island | 6 | 0 | 0 | 1 | 0.00 | 0.00 | 0.17 |
| Frink's Bay | 10 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Garlock Bay | 10 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Lindley Bay | 6 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Millens Bay | 12 | 2 | 0 | 0 | 0.17 | 0.00 | 0.00 |
| Peos Bay | 6 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Rose Bay | 10 | 2 | 0 | 0 | 0.20 | 0.00 | 0.00 |
| Salisbury Bay | 6 | 1 | 1 | 0 | 0.17 | 0.17 | 0.00 |
| **Total** | **90** | **5** | **1** | **1** | **0.06** | **0.01** | **0.01** |

**Table 3.** Continued

| **2016 30' Exploratory Seining** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Site | Hauls | MKY | NP | GP | MKY CPUE | NP CPUE | GP CPUE |
| Seven Isles - Wellesley | 1 | 0 | 1 | 0 | 0.00 | 1.00 | 0.00 |
| A1- Grindstone N | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| A2- Grindstone N | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| A3- Grindstone N | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |

**Table 3.** Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Atlantis Island | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Aunt Jane's Bay | 6 | 0 | 1 | 0 | 0.00 | 0.17 | 0.00 |
| Benedict Island 1 | 1 | 0 | 3 | 0 | 0.00 | 3.00 | 0.00 |
| #9 Island | 2 | 0 | 1 | 0 | 0.00 | 0.50 | 0.00 |
| Pt. Marguerite Marsh | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Barnhart Beach | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Bartlett Pt | 4 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Benedict Island 2 | 3 | 0 | 7 | 0 | 0.00 | 2.33 | 0.00 |
| Birch Island | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Bison Point - Lake Ontario | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Blind Bay | 16 | 0 | 5 | 0 | 0.00 | 0.31 | 0.00 |
| Bradley Pt | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Brandy Brook | 2 | 1 | 0 | 0 | 0.50 | 0.00 | 0.00 |
| Brown Bay | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Brown House | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Brush Island | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Buck Bay | 6 | 2 | 1 | 0 | 0.33 | 0.17 | 0.00 |
| Carrier Bay | 6 | 1 | 1 | 0 | 0.17 | 0.17 | 0.00 |
| Cedar Point | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Cedar South | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Chippewa Pt | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Chippewa - Blind Bay | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Chippewa - Goose Bay | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Point Comfort | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Crow Island - Oak Pt | 4 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Crow's Nest - Oak Pt | 2 | 2 | 0 | 0 | 1.00 | 0.00 | 0.00 |
| Crow's Nest East - Oak Pt | 1 | 1 | 0 | 0 | 1.00 | 0.00 | 0.00 |
| Oak Point West - Chub Is. | 2 | 1 | 0 | 0 | 0.50 | 0.00 | 0.00 |
| Cuba Is. | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Delaney Marsh | 8 | 0 | 1 | 0 | 0.00 | 0.13 | 0.00 |
| Densmore Bay | 5 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Dodge Bay | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Doheny Pt. | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| E Grass Pt to Cobb Pt | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| East Chippewa 1 | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| East Chippewa 2 | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| East Chippewa 3 | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| East Chippewa 4 | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Eel Bay | 7 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Escanaba Bay | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Exploratory P | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Flynn Bay | 16 | 0 | 5 | 0 | 0.00 | 0.31 | 0.00 |
| Fox Island | 5 | 1 | 1 | 0 | 0.20 | 0.20 | 0.00 |

**Table 3.** Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| French West | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Galop East | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Galop West | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Goose Bay | 7 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Grants Island | 3 | 0 | 0 | 4 | 0.00 | 0.00 | 1.33 |
| Grass Bay | 5 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Grass Point | 11 | 3 | 1 | 1 | 0.27 | 0.09 | 0.09 |
| Iroquois - LSL | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Jacques Cartier | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Jolly Island | 3 | 0 | 2 | 0 | 0.00 | 0.67 | 0.00 |
| Grenadier N - L. Ontario | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Keewaydin | 2 | 0 | 2 | 0 | 0.00 | 1.00 | 0.00 |
| Keystone Pt | 5 | 1 | 0 | 0 | 0.20 | 0.00 | 0.00 |
| Grenadier Is. - L. Ontario | 4 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Lake of the Isles | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Long Point | 3 | 0 | 3 | 0 | 0.00 | 1.00 | 0.00 |
| Long Sault Island | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Mead Island | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Morristown Bridge | 3 | 0 | 2 | 0 | 0.00 | 0.67 | 0.00 |
| Mud Bay - L. Ontario | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Nichols | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Nichols Mill Island | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Oak Island North | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Ogden Isle | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Ogdensburg | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Oswegatchie at SLR | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Owatonna Island | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Point Marguerite Marsh | 2 | 0 | 1 | 0 | 0.00 | 0.50 | 0.00 |
| Point Vivian | 9 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Poplar Tree Bay | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Rabbit North | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Red Barn | 4 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| International Rift | 2 | 0 | 2 | 1 | 0.00 | 1.00 | 0.50 |
| Roods Cove | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Saint Margarettes Island | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Sand Bay | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Sand Island | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Sawmill Bay | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| South Bay - Wellesley | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| South of Shambo | 2 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Strait by Cedar Island | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Swan Bay | 8 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Thurso Bay | 4 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |

**Table 3.** Continued

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Town Line Bay | 4 | 0 | 1 | 2 | 0.00 | 0.25 | 0.50 |
| Waddington Beach East | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Waddington Beach West | 2 | 0 | 2 | 0 | 0.00 | 1.00 | 0.00 |
| West Chippewa | 3 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Whitehouse Bay | 11 | 0 | 0 | 2 | 0.00 | 0.00 | 0.18 |
| Whitehouse Bay - Waddington | 1 | 0 | 0 | 0 | 0.00 | 0.00 | 0.00 |
| Wilson Hill | 1 | 0 | 1 | 0 | 0.00 | 1.00 | 0.00 |
| Oak Point Bay | 2 | 1 | 0 | 0 | 0.50 | 0.00 | 0.00 |
| **Total** | **298** | **14** | **44** | **10** | **0.05** | **0.15** | **0.03** |

**Research, 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 (EWG) 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 muskellunge per hour fished). The EWG is composed of resource managers from the US and Canada and 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 risks subsequent to an invasive viral hemorrhagic septicemia (VHS) 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. From 2005 through 2008, however, widespread mortality of adult muskellunge was observed and attributed to VHS 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 understand the population's response to perturbations such as disease-induced mortality and changes to habitat or fish community structure. For example, the nonnative species, round goby, (*Neogobius melanostomus*) has invaded littoral nursery habitats of muskellunge (Farrell et al. 2010). Miano (2015) demonstrated in experimental treatments of northern pike and muskellunge habitats that round goby have the potential to be significant egg predators of esocids, a broadcast spawning species. Round goby are also known as reservoirs and vectors for VHSV (Groocock et al. 2007). Further, the St. Lawrence River esocid seining index has detected changes in the nearshore fish assemblage associated with the dominance of round goby that potentially affects esocid prey availability.

Because of these stressors, maintenance of productive spawning and 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 continue 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 et al. 1996, Cooper 2000, Farrell 2001), 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 YOY response to invasions by non-native prey fish

(Kapuscinski and Farrell 2014). The information obtained in these studies is being 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

Trapnet surveys have been used to monitor spring spawning adult muskellunge populations at a set of index bays for 16 years (1997-2000, 2003, and annually since 2006). In 2016, eighteen nets, including 3' and 4' hoop nets and 6' Oneida trap nets, were fished near shore in eleven muskellunge spawning bays between May 10 and June 22. An additional eleven sites (Buck Bay, French Bay, Grass Point, Whitehouse Bay, Delaney Bay, Thurso Bay, Long Point, Mead Island, Grass Bay, A3 and Carrier Bay) were surveyed using roving net placement in an attempt to increase catch of spawning muskellunge.

Data collected from captured muskellunge included total length (TL), sex, spawning condition, and weight when possible. All adult muskellunge were tagged with Passive Integrated Transponder (PIT) tags. Catch data are reported as an index to monitor trends in relative 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 fish movements, particularly as it pertains to spawning site fidelity. In addition to collecting muskellunge-specific data, all other fishes are identified and enumerated to characterize fish assemblages present at muskellunge spawning sites and this information will be summarized elsewhere.

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 occurred, with two surveys per year at each of eleven sites between Cape Vincent and Alexandria Bay, NY. Survey procedures are further detailed in Farrell and Werner (1999). Habitat data collected include geographic coordinates, depth, temperature, vegetation type, and coverage. Juvenile esocid data collected comprises abundance, distribution, and total length (mm). Seining survey data are used to monitor trends in abundance and growth between periods, and to monitor fish assemblage/habitat relationships at muskellunge nursery locations. Diet information for YOY muskellunge was obtained from selected juveniles >80 mm or 3.2 in TL by gastric lavage (Farrell 1998, Kapuscinski et al. 2012).

A fin tissue sample was retained in 95% non-denatured ETOH for genetic analysis of all muskellunge sampled (both YOY and adults). Samples from multiple years (including those from angler cooperators) were sent to the lab of Dr. Louis Bernatchez at Université Laval for genomic analyses using whole genome sequencing focusing on single nucleotide repeats (SNP) as markers. These samples will build on our current understanding of population and genetic structure of muskellunge in the upper St. Lawrence River, its tributaires (Kapuscinski et al. 2013) and downriver Québec populations.

Angler diary program

We continue to maintain an angler diary program with participants ranging in angling frequency from casual to dedicated muskellunge anglers to several professional guides. Cooperators are selected based on the quality of information volunteered in previous diary projects and responses to requests for program assistance. Anglers are asked to record data on daily effort (rod hours), catch and harvest rates, total lengths, and approximate location of angled muskellunge.

Muskellunge catch and release program

A partnership with a local environmental advocacy group, Save the River, continued through 2016 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 (54 inch) 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.

## Results and Discussion

Spring trapnetting survey

A total of 3 spawning adult and 1 sub-adult muskellunge were captured (catch rate = 0.005 fish/net night) in 2016 (Table 1 and 2; Figure 1). The mean number of muskellunge caught in the spring trapnetting survey before the VHS outbreak was 0.063 muskellunge per net-night (SD = 0.032), but a mean of 0.018 (SD = 0.012) muskellunge per net-night have been captured in subsequent years. The 2016 catch rate of 0.005 muskellunge per net- night was notably less than that of 2015 (0.019) (Figure 1).

Summer seining surveys

The annual standardized YOY muskellunge seining index was completed in 2016 and showed diminished CPUEs from 2015. Eleven bays were sampled during July with a 30' (1/8") fine-mesh seine. A total of 3 YOY muskellunge were captured in 90 hauls (CPUE = 0.03 fish/haul) (Figure 2; Table 3). In August, a 60' (1/4") large-mesh seine was employed in the same 11 bays. As a result, 5 YOY muskellunge were captured in 90 seine hauls (CPUE = 0.06) (Figure 3; Table 3). In addition to annual index seining, 30' exploratory seining was conducted from July 25 to August 16 in known nursery sites from Cape Vincent to the Moses Saunders power dam. This survey lead to a catch of 14 muskellunge (CPUE 0.05) across 98 exploratory sites (Table 4). The greatest CPUE for age-0 muskellunge was at Crow's Nest and Crow's Nest East (exploratory sites) with 1.00 fish per haul, and at Deer Island (index site) with 0.33 fish per haul.

Angler diary program

In 2016, anglers from the angler diary program fished 665 hours of effort for 9 muskellunge captured (0.014 fish / hour; Figure 3). The catch rate was a decrease from 2015 where 28 muskellunge were captured in 770 hours of effort (0.036 fish / hour), and less than 2014 where 17 muskellunge were captured in 587 hours of effort (0.029 fish / hour). Catch rates remain well below the management goal of 0.1 fish per hour.

Muskellunge catch and release program

In 2016, four anglers participated in the Muskellunge Catch and Release program with TIBS and Save the River. Anglers submitted only four muskellunge release award affidavits, for fish ranging from 44 inches to 57 inches (average 53 inches). Anglers participating in this program estimated their angling effort ranging from 3 to 120 hours, with an average of 56.5 angler hours to catch a 44 inch or greater muskellunge. The increase in the muskellunge size limit and reductions in muskellunge has reduced participation in the release award program.

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**Table 1.** Locations, number of trapnets, trapnet effort (net nights), muskellunge catch, and CPUE for index and roving bays in the St. Lawrence River, 2016.

| Bay | # Nets | Effort | MKY | CPUE |
|---|---|---|---|---|
| **Index** | | | | |
| Blind | 2 | 80 | 0 | 0.00 |
| Cobb Shoal | 1 | 40 | 0 | 0.00 |
| Densmore | 2 | 62 | 0 | 0.00 |
| Flynn | 4 | 100 | 3 | 0.03 |
| Frink's | 1 | 41 | 0 | 0.00 |
| Garlock | 1 | 41 | 0 | 0.00 |
| Lindley | 1 | 33 | 1 | 0.03 |
| Millen's | 2 | 75 | 0 | 0.00 |
| Peos | 1 | 41 | 0 | 0.00 |
| Rose | 2 | 78 | 0 | 0.00 |
| Swan | 1 | 33 | 0 | 0.00 |
| Sub-Total | 18 | 624 | 4 | 0.006 |
| **Roving** | | | | |
| A3 | 1 | 9 | 0 | 0.00 |
| Buck | 1 | 33 | 0 | 0.00 |
| Carrier | 1 | 9 | 0 | 0.00 |
| Delaney | 1 | 20 | 0 | 0.00 |
| French | 1 | 18 | 0 | 0.00 |
| Grass Bay | 1 | 16 | 0 | 0.00 |
| Grass Point | 1 | 38 | 0 | 0.00 |
| Long Point | 2 | 44 | 0 | 0.00 |
| Mead Island | 1 | 19 | 0 | 0.00 |
| Thurso | 1 | 24 | 0 | 0.00 |
| Whitehouse | 1 | 21 | 0 | 0.00 |
| Sub-Total | 12 | 251 | 0 | 0.00 |
| Total | 30 | 875 | 4 | 0.005 |

**Table 2.** Summary of location of catch, total length (TL-mm), sex, reproductive stage, tag number and recapture history of spawning adult muskellunge caught and released from trapnets in St. Lawrence River bays, 2016. The tag entry number is for PIT type tags. * Muskellunge captured by students during an ESF Limnology practicum.

| Date | Bay | Sex | Stage | TL (mm) | Recap tag # | Tag # |
|---|---|---|---|---|---|---|
| 5/12/2016 | Lindley | Male | Immature | 564 | - | 900118001105680 |
| 5/13/2016 | Flynn | Male | Ripe | 1214 | - | 900118001105170 |
| 5/15/2016 | Flynn | Female | Hard | 1005 | - | 900118001104154 |
| 5/16/2016 | Flynn | Male | Ripe | 900 | - | 900118001356344 |
| *10/1/2016 | French | Female | NA | 1390 | - | 900118001347399 |

**Table 3.** Seining catch summary for 2016 sampling using a 1/8" fine-mesh 30' bag seine (top) and a 1/4" large-mesh 60' bag seine (bottom).

| **Index Seining (30')** | | | | | |
|---|---|---|---|---|---|
| Bay | Hauls | MKY | NP | CPUE MKY | CPUE NP |
| Affluence | 6 | 0 | 0 | 0.00 | 0.00 |
| Boscobel | 6 | 0 | 0 | 0.00 | 0.00 |
| Deer Island | 6 | 2 | 0 | 0.33 | 0.00 |
| Millen's | 12 | 0 | 0 | 0.00 | 0.00 |
| Rose | 10 | 0 | 0 | 0.00 | 0.00 |
| Cobb Shoal | 12 | 0 | 0 | 0.00 | 0.00 |
| Frinks | 10 | 0 | 0 | 0.00 | 0.00 |
| Garlock | 10 | 0 | 0 | 0.00 | 0.00 |
| Lindley | 6 | 1 | 0 | 0.17 | 0.00 |
| Peos | 6 | 0 | 0 | 0.00 | 0.00 |
| Salisbury | 6 | 0 | 7 | 0.00 | 1.17 |
| **Total** | **90** | **3** | **7** | **0.03** | **0.08** |

| **Index Seining (60')** | | | | | |
|---|---|---|---|---|---|
| Bay | Hauls | MKY | NP | CPUE MKY | CPUE NP |
| Affluence | 6 | 0 | 0 | 0.00 | 0.00 |
| Boscobel | 6 | 0 | 0 | 0.00 | 0.00 |
| Deer Island | 6 | 0 | 0 | 0.00 | 0.00 |
| Rose | 10 | 2 | 0 | 0.20 | 0.00 |
| Millen's | 12 | 2 | 0 | 0.17 | 0.00 |
| Cobb Shoal | 12 | 0 | 0 | 0.00 | 0.00 |
| Frinks | 10 | 0 | 0 | 0.00 | 0.00 |
| Garlock | 10 | 0 | 0 | 0.00 | 0.00 |
| Lindley | 6 | 0 | 0 | 0.00 | 0.00 |
| Peos | 6 | 0 | 0 | 0.00 | 0.00 |
| Salisbury | 6 | 1 | 1 | 0.17 | 0.17 |
| **Total** | **90** | 5 | 1 | 0.06 | 0.01 |

**Table 4.** Summary of 30' exploratory seining by bay from July 25 to August 16. Effort is defined as the total number of hauls completed per site. Data for northern pike captures are also shown.

| **Exploratory Seining (30')** | | | | | |
|---|---|---|---|---|---|
| Site | Hauls | MKY | NP | MKY CPUE | NP CPUE |
| Seven Isles - Wellesley | 1 | 0 | 1 | 0.00 | 1.00 |
| A1- Grindstone N | 3 | 0 | 0 | 0.00 | 0.00 |
| A2- Grindstone N | 1 | 0 | 0 | 0.00 | 0.00 |
| A3- Grindstone N | 2 | 0 | 0 | 0.00 | 0.00 |
| Atlantis Island | 1 | 0 | 0 | 0.00 | 0.00 |
| Aunt Jane's Bay | 6 | 0 | 1 | 0.00 | 0.17 |
| Benedict Island 1 | 1 | 0 | 3 | 0.00 | 3.00 |
| #9 Island | 2 | 0 | 1 | 0.00 | 0.50 |
| Pt. Marguerite Marsh | 2 | 0 | 0 | 0.00 | 0.00 |
| Barnhart Beach | 2 | 0 | 0 | 0.00 | 0.00 |
| Bartlett Pt | 4 | 0 | 0 | 0.00 | 0.00 |
| Benedict Island 2 | 3 | 0 | 7 | 0.00 | 2.33 |
| Birch Island | 1 | 0 | 0 | 0.00 | 0.00 |
| Bison Point - Lake Ontario | 1 | 0 | 0 | 0.00 | 0.00 |
| Blind Bay | 16 | 0 | 5 | 0.00 | 0.31 |
| Bradley Pt | 2 | 0 | 0 | 0.00 | 0.00 |
| Brandy Brook | 2 | 1 | 0 | 0.50 | 0.00 |
| Brown Bay | 1 | 0 | 0 | 0.00 | 0.00 |
| Brown House | 1 | 0 | 0 | 0.00 | 0.00 |
| Brush Island | 1 | 0 | 0 | 0.00 | 0.00 |
| Buck Bay | 6 | 2 | 1 | 0.33 | 0.17 |
| Carrier Bay | 6 | 1 | 1 | 0.17 | 0.17 |
| Cedar Point | 1 | 0 | 0 | 0.00 | 0.00 |
| Cedar South | 1 | 0 | 0 | 0.00 | 0.00 |
| Chippewa Pt | 1 | 0 | 0 | 0.00 | 0.00 |
| Chippewa - Blind Bay | 1 | 0 | 0 | 0.00 | 0.00 |
| Chippewa - Goose Bay | 3 | 0 | 0 | 0.00 | 0.00 |
| Point Comfort | 2 | 0 | 0 | 0.00 | 0.00 |

**Table 4 (Continued).** Summary of 30' exploratory seining by bay from July 25 to August 16. Effort is defined as the total number of hauls completed per site. Data for northern pike captures are also shown.

| | | | | | |
|---|---|---|---|---|---|
| Crow Island - Oak Pt | 4 | 0 | 0 | 0.00 | 0.00 |
| Crow's Nest - Oak Pt | 2 | 2 | 0 | 1.00 | 0.00 |
| Crow's Nest East - Oak Pt | 1 | 1 | 0 | 1.00 | 0.00 |
| Oak Point West - Chub Is. | 2 | 1 | 0 | 0.50 | 0.00 |
| Cuba Is. | 2 | 0 | 0 | 0.00 | 0.00 |
| Delaney Marsh | 8 | 0 | 1 | 0.00 | 0.13 |
| Densmore Bay | 5 | 0 | 0 | 0.00 | 0.00 |
| Dodge Bay | 2 | 0 | 0 | 0.00 | 0.00 |
| Doheny Pt. | 2 | 0 | 0 | 0.00 | 0.00 |
| E Grass Pt to Cobb Pt | 2 | 0 | 0 | 0.00 | 0.00 |
| East Chippewa 1 | 3 | 0 | 0 | 0.00 | 0.00 |
| East Chippewa 2 | 1 | 0 | 0 | 0.00 | 0.00 |
| East Chippewa 3 | 2 | 0 | 0 | 0.00 | 0.00 |
| East Chippewa 4 | 1 | 0 | 0 | 0.00 | 0.00 |
| Eel Bay | 7 | 0 | 0 | 0.00 | 0.00 |
| Escanaba Bay | 2 | 0 | 0 | 0.00 | 0.00 |
| Exploratory P | 2 | 0 | 0 | 0.00 | 0.00 |
| Flynn Bay | 16 | 0 | 5 | 0.00 | 0.31 |
| Fox Island | 5 | 1 | 1 | 0.20 | 0.20 |
| French West | 1 | 0 | 0 | 0.00 | 0.00 |
| Galop East | 3 | 0 | 0 | 0.00 | 0.00 |
| Galop West | 3 | 0 | 0 | 0.00 | 0.00 |
| Goose Bay | 7 | 0 | 0 | 0.00 | 0.00 |
| Grants Island | 3 | 0 | 0 | 0.00 | 0.00 |
| Grass Bay | 5 | 0 | 0 | 0.00 | 0.00 |
| Grass Point | 11 | 3 | 1 | 0.27 | 0.09 |
| Iroquois - LSL | 3 | 0 | 0 | 0.00 | 0.00 |
| Jacques Cartier | 2 | 0 | 0 | 0.00 | 0.00 |
| Jolly Island | 3 | 0 | 2 | 0.00 | 0.67 |

**Table 4 (Continued).** Summary of 30' exploratory seining by bay from July 25 to August 16. Effort is defined as the total number of hauls completed per site. Data for northern pike captures are also shown.

| | | | | | |
|---|---|---|---|---|---|
| Grenadier N - L. Ontario | 2 | 0 | 0 | 0.00 | 0.00 |
| Keewaydin | 2 | 0 | 2 | 0.00 | 1.00 |
| Keystone Pt | 5 | 1 | 0 | 0.20 | 0.00 |
| Grenadier Is. - L. Ontario | 4 | 0 | 0 | 0.00 | 0.00 |
| Lake of the Isles | 3 | 0 | 0 | 0.00 | 0.00 |
| Long Point | 3 | 0 | 3 | 0.00 | 1.00 |
| Long Sault Island | 2 | 0 | 0 | 0.00 | 0.00 |
| Mead Island | 2 | 0 | 0 | 0.00 | 0.00 |
| Morristown Bridge | 3 | 0 | 2 | 0.00 | 0.67 |
| Mud Bay - L. Ontario | 2 | 0 | 0 | 0.00 | 0.00 |
| Nichols | 1 | 0 | 0 | 0.00 | 0.00 |
| Nichols Mill Island | 1 | 0 | 0 | 0.00 | 0.00 |
| Oak Island North | 1 | 0 | 0 | 0.00 | 0.00 |
| Ogden Isle | 3 | 0 | 0 | 0.00 | 0.00 |
| Ogdensburg | 3 | 0 | 0 | 0.00 | 0.00 |
| Oswegatchie at SLR | 3 | 0 | 0 | 0.00 | 0.00 |
| Owatonna Island | 1 | 0 | 0 | 0.00 | 0.00 |
| Point Marguerite Marsh | 2 | 0 | 1 | 0.00 | 0.50 |
| Point Vivian | 9 | 0 | 0 | 0.00 | 0.00 |
| Poplar Tree Bay | 2 | 0 | 0 | 0.00 | 0.00 |
| Rabbit North | 2 | 0 | 0 | 0.00 | 0.00 |
| Red Barn | 4 | 0 | 0 | 0.00 | 0.00 |
| International Rift | 2 | 0 | 2 | 0.00 | 1.00 |
| Roods Cove | 2 | 0 | 0 | 0.00 | 0.00 |
| Saint Margarettes Island | 1 | 0 | 0 | 0.00 | 0.00 |
| Sand Bay | 1 | 0 | 0 | 0.00 | 0.00 |
| Sand Island | 2 | 0 | 0 | 0.00 | 0.00 |
| Sawmill Bay | 2 | 0 | 0 | 0.00 | 0.00 |
| South Bay - Wellesley | 2 | 0 | 0 | 0.00 | 0.00 |

**Table 4 (Continued).** Summary of 30’ exploratory seining by bay from July 25 to August 16. Effort is defined as the total number of hauls completed per site. Data for northern pike captures are also shown.

| | | | | | |
|---|---|---|---|---|---|
| South of Shambo | 2 | 0 | 0 | 0.00 | 0.00 |
| Strait by Cedar Island | 1 | 0 | 0 | 0.00 | 0.00 |
| Swan Bay | 8 | 0 | 0 | 0.00 | 0.00 |
| Thurso Bay | 4 | 0 | 0 | 0.00 | 0.00 |
| Town Line Bay | 4 | 0 | 1 | 0.00 | 0.25 |
| Waddington Beach East | 3 | 0 | 0 | 0.00 | 0.00 |
| Waddington Beach West | 2 | 0 | 2 | 0.00 | 1.00 |
| West Chippewa | 3 | 0 | 0 | 0.00 | 0.00 |
| Whitehouse Bay | 11 | 0 | 0 | 0.00 | 0.00 |
| Whitehouse Bay - Waddington | 1 | 0 | 0 | 0.00 | 0.00 |
| Wilson Hill | 1 | 0 | 1 | 0.00 | 1.00 |
| Oak Point Bay | 2 | 1 | 0 | 0.50 | 0.00 |
| **Total** | **298** | **14** | **44** | **0.05** | **0.15** |

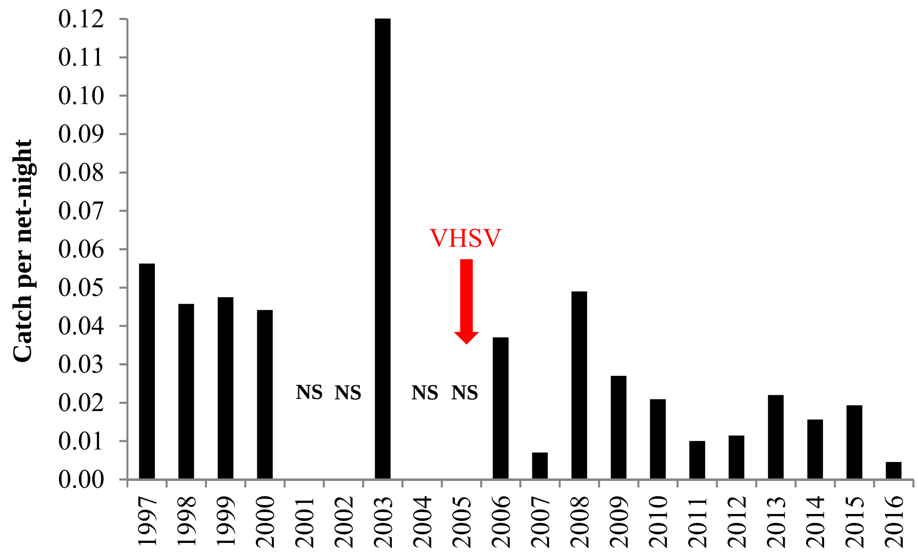


**Figure 1.** Total catch per net-night of muskellunge during spring trapnet sampling from 1997-2016. Samples were not collected in 2001-02 and 2004-05 (NS) because of a decision of the Esocid Working Group to monitor muskellunge every third year. Following VHSV outbreak it was decided to resume annual monitoring.

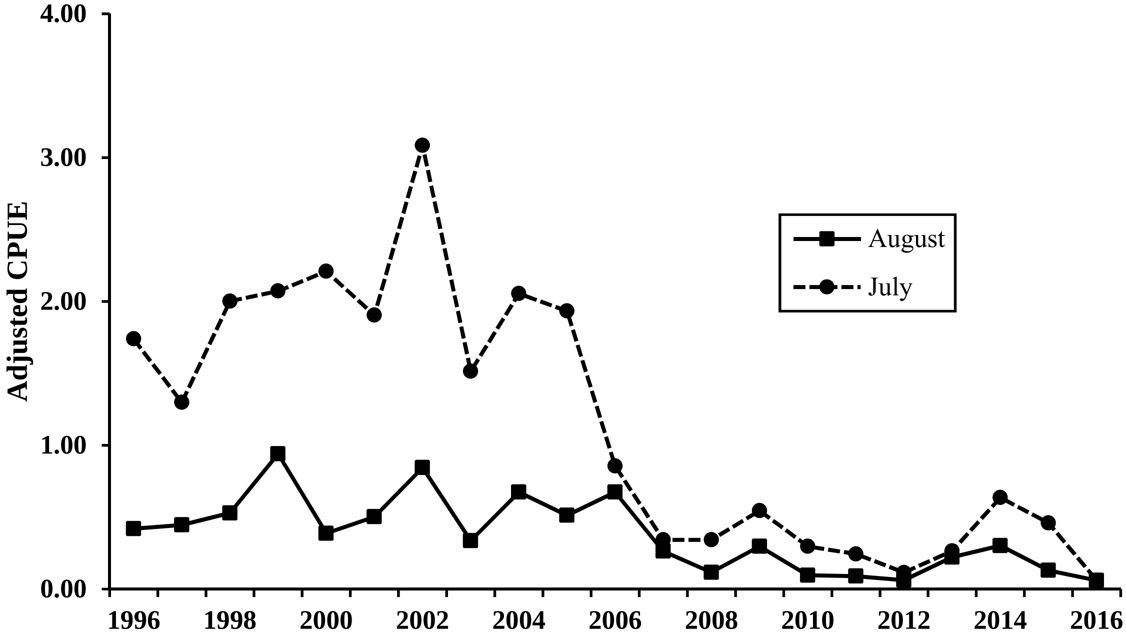


**Figure 2.** Catch per unit effort of YOY muskellunge captured in standardized seine hauls in eleven upper St. Lawrence River nursery sites from 1996 to 2016. A 9.14 m (30') fine-mesh seine was used during the month of July and an 18.3 m (60') large-mesh seine was used during the month of August. The fine-mesh seine CPUE was doubled to standardize the area swept among the two gears. Detection of VHSV occurred in 2005 and widespread mortality of muskellunge continued through 2008 in the upper River.

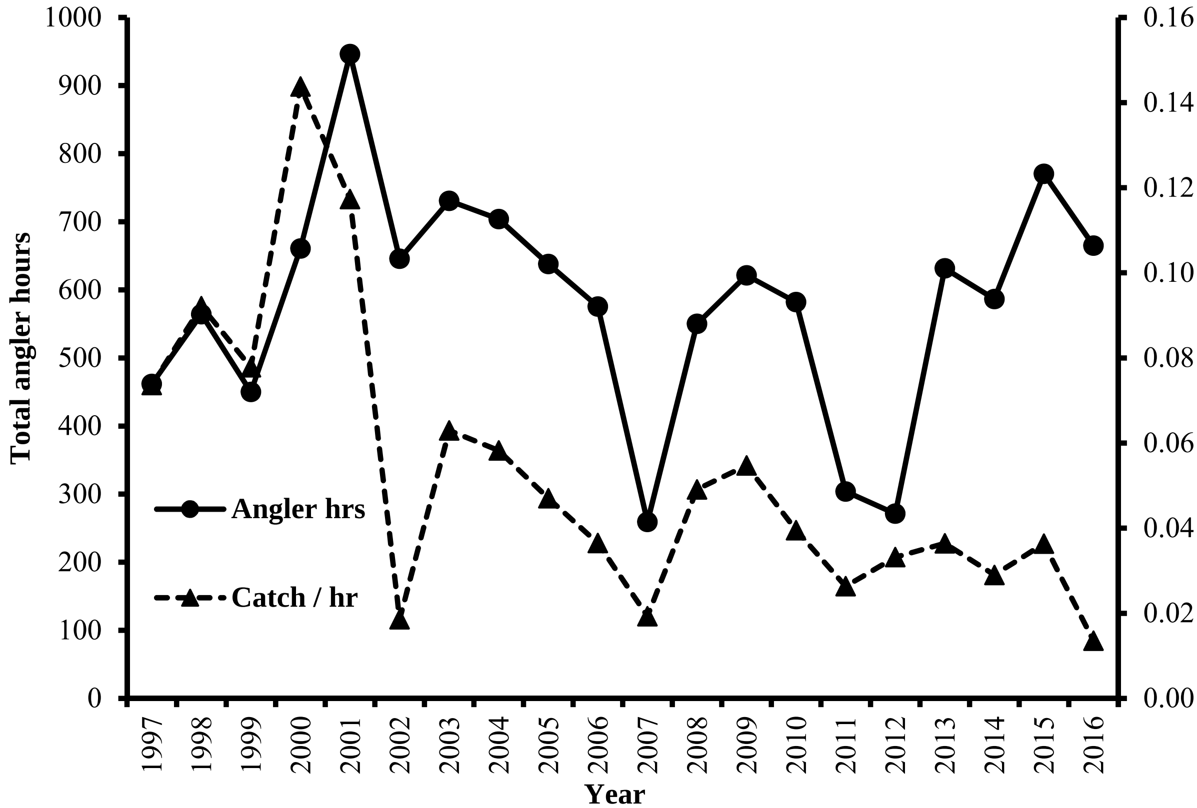


**Figure 3.** Thousand Islands Region Muskellunge Angler Diary Program data showing angler hours compared to average catch per angler hour. The management target goal is 0.1 fish per angler hour or 1 muskellunge per 10 hours fished. Note relationship between catch and effort over time, however, relatively high effort since 2012 has not produced large increases in catch of muskellunge.

# Lake Sturgeon Tagging Study and Egg Take 2016

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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 by the NYS Department of Environmental Conservation (DEC) in 1976. Lake Sturgeon were listed as a threatened species by NYSDEC in 1986, 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 tagging method that allows for long term fish identification has become important when considering brood stock genetics, understanding spawning site fidelity and gaining general biological knowledge.

This project is a continuation of a project funded 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 have been collected annually at various sites in the St. Lawrence River and Eastern Basin of Lake Ontario since 2010. Fish were evaluated for basic biological information and then scanned for Passive Integrated Transponder (PIT) tags to determine if they had been previously tagged. A PIT tag was 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.

Restoration of Lake Sturgeon has been ongoing in NYS since 1993 through propagation and stocking. Wild broodstock are collected downstream of the Moses Power Project (Massena, NY) adjacent to the South Channel annually. Gametes are collected, fertilized, and cultured at the Oneida Fish Culture Station (New York) and the Genoa National Fish Hatchery (Wisconsin). Progeny are stocked into the St. Lawrence River, various tributaries, and the Eastern Basin of Lake Ontario.

## Methods

<u>Geographic Area</u>

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 mouth of the St. Lawrence River at Cape Vincent, approximately 800 $mi^2$. Water less than 100 feet in depth was considered suitable for Lake Sturgeon sampling.

<u>Collection</u>

Lake Sturgeon (sturgeon) were collected from April-August in 2016. Collections included netting targeting sturgeon, and existing annual gill net surveys to assess warmwater fish populations which occasionally capture sturgeon.

Spawning sturgeon were sampled in Lake Ontario (Black River Bay), and in the St. Lawrence River immediately downstream of the Moses Power Dam (Dam). Existing, long term index gill netting programs include two on the St. Lawrence River (Thousand Islands and Lake St. Lawrence) and one in the Eastern Basin of Lake Ontario. Netting sites for 2016 are shown in Figure 1.

All fish were collected with monofilament gill nets fished from 16.8 – 25.6 hours in waters from 13-55 feet in depth. Gill net configurations used are described in Table 1.

Lake Sturgeon collected were measured to the nearest millimeter total length (TL), weighed, and examined/scanned for existing Floy® or PIT tags. Sex could only be verified in fish captured during the spawning period through extrusion of gametes. 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 or fish that were previously Floy® tagged. Tags were placed under the fourth dorsal scute, the standard location for the DEC, Ontario Ministry of Natural Resources and Forestry (OMNRF), and U.S. Geological Survey (USGS). All fish, with the exception of those held for egg and milt collections, 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 DEC has sampled St. Lawrence River sturgeon since the early 1990’s below the Dam. Collections initially focused on documenting presence of sturgeon and acquiring basic biological information. Beginning in 1996, sturgeon were collected for use as brood stock in restoration efforts. As restoration efforts intensified and genetic investigations have revealed distinct spawning stocks of sturgeon (Welsh et al. 2008), the need for reliable and permanent identification of individual fish became clear.

Use of PIT tags began in 2008 and has been the primary method of uniquely marking sturgeon to the present. In 2010 a FEMRF grant provided tags and related equipment for large scale tagging of sturgeon in the St. Lawrence River and Eastern Basin of Lake Ontario.

<u>Overall 2016 Results</u>

DEC personnel captured a total of 218 sturgeon throughout the sampling area in 2016. PIT tags were applied to 168 sturgeon (81% St. Lawrence River; 19% Lake Ontario), ranging in length from 37.7-68.7 inches TL and weighing from 9.9-87.0 pounds. Five juvenile sturgeon were collected ranging from 11-27.2 inches, two of which had verified Coded Wire Tags (CWT) proving hatchery origin. Length-weight relationships were constructed using data from all sturgeon collected (where lengths and weights were available) from 2010-2016 (Figure 2), and for adult fish separated by sex (Figure 3). Sturgeon body form can be quite variable as demonstrated by the relationships. A total of 49 recaptures were recorded in 2016. The majority of recaptured fish came from the general area of initial tagging. Three recaptures originated from outside the sampling area and are described below.

Males (N=66) accounted for 30.3% of the catch while females (N=15) constituted 6.9%. The remaining fish were either immature or of undetermined sex (N=137, 62.8%). Few juvenile sturgeon are represented in the catch, due to the large mesh size of gill nets used in targeted surveys. Index gill net surveys, which utilize nets with smaller mesh sizes, may not cover areas of preferred juvenile habitat.

<u>Black River</u>

Lake Sturgeon spawning in the Black River was first documented in 2005 (Klindt and Adams 2006). Sampling since 2005 has targeted spawning fish either in the Black River or Black River Bay, depending on environmental conditions, to acquire biological information and apply Floy® or PIT tags.

The Black River was sampled from April 18-May 3, 2016 for a total of 12 net nights (261.5 hrs). Discharge in the Black River fell below the maximum effective netting limit of 6000 cfs on 4/17 and remained in the acceptable range through the end of May (range 2450-5670 cfs, USGS gage 04260500, Watertown).

A total of 17 sturgeon were collected, 11 of which were recaptures. All recaptures were initially caught in either the Black River or Black River Bay.

On May 3, 2016 an influx of sturgeon (N=8) were intercepted entering the lower river. Four of these fish had been tagged in April 2016 in Black River Bay. While not verified, two of these fish were assessed as female based on body form. Based on the upstream migration of a large number of sturgeon, some of which had been collected earlier in the bay it would appear that a spawning event in the Black River likely occurred during the first week of May 2016.

Lake Ontario (Black River Bay & Eastern Basin)

A total of 39 lake sturgeon were captured in Black River Bay from April 13- May 10, 2016. Water temperature warmed through the period and ranged from 42-55 $^{o}$F. A total effort of 878.9 net-hrs was expended resulting in a catch per unit effort (CUE) of 0.04 fish/hr (Table 2). Sturgeon ranged in length from 37.8-68.7 inches. and weight from 15.4-87.0 pounds. Sex could not be determined for most fish. However, seven fish were determined to be ripe males and one fish, while not confirmed by internal examination, presented the body form of a gravid female and was recorded as such.
Black River Bay serves as a staging area for some fish that will later migrate to spawning sites upstream. It is unclear whether all sturgeon in the bay are staging for migration to spawning areas, or simply aggregating in common near shore areas in the spring.

Twelve fish were recaptures having been tagged from 2010-2015 in either Black River Bay or the Black River. This suggests a relatively small spawning population with high site fidelity using the Black River for spawning. Three fish were tagged significant distances from the bay having been originally tagged at Oneida Lake, the Genesee River, and Cayuga Lake Outlet (Table 4). In general all significant movements documented have been downstream.

The annual index gill net survey conducted by the DEC's Lake Ontario Unit in the Eastern Basin collected two juvenile sturgeon in 2016. Nets were fished at 28 sites with a total effort of 520.9 net-hrs (Table 2). Recent stockings of sturgeon have had CWT implants. Unfortunately these fish were not scanned for CWT, and their origin could not be determined.

St. Lawrence River Below Moses Power Dam

The confluence of the bypassed reach of the Dam or "South Channel" and the main stem of the St. Lawrence River has been used as a Lake Sturgeon brood stock source for the DEC since 1996 (LaPan et al. 1999). This area is considered a staging area for sturgeon spawning at the base of the Dam. Net sites used for this collection typically produce large numbers of fish, accounting for 80-90% of the annual sturgeon catch, including both potential spawners and resident fish.

A total of 157 sturgeon were collected from May 26-June 1, 2016 at four net sites with an effort of 359.0 net-hrs (Table 2). Water temperature in the South Channel ranged from 56-62°F during the sampling period. Catch rate in 2016 (CUE= 0.43 fish/hr) fell within the range of previous years (CUE range 2009-2015; 0.24-0.59 fish/hr). Ripe males (N=49) represented 31.2% of the catch whereas ripe females (N=11) represented 7.0%. One hard female with eggs in stage 3 of development was identified. Sex could not be determined for the remainder of the catch (N=96, 61.1%). Sturgeon collected in 2016 ranged in length from 37.8-64.6 inches and in weight from

9.9-70.5 pounds. Fish used for the 2016 egg take (females N=5, males N=16) were taken from this group.

There were 23 recaptures at this location in 2016 which were classified as either historic (N=1) or recent (N=22). Historic recaptures were fish originally Floy® tagged from 1995-1998 by researchers at SUNY ESF. Recent recaptures included fish tagged (Floy® or PIT) by DEC from 2006-2015. The recapture rate in 2016 was 14.6%. In general the recapture rate is showing an increasing trend (Figure 4).

All recaptured fish were originally tagged at previous egg take events at the South Channel. The single Historic recapture was originally tagged in October 1997 at a length of 23.7 inches. In 2016 this fish was 48.7 inches and sexed as a ripe male. Using age at length information previously described in Johnson et al (1998) this fish was likely age-3 at its 1997 tagging, making it approximately age-23 in 2016.

The annual egg take took place on June 7, 2016. Prior to the egg take fish were collected and evaluated for gamete maturation. Fish selected (F=5, M=16) were treated with Carp Pituitary Hormone to induce ovulation and spermiation (Klindt 2014). Approximately 180,000 fertilized eggs were distributed between culture facilities in New York and Wisconsin. Fertilization rates were high, however there was high mortality after hatch out in both facilities resulting in poor overall production. In October of 2016 approximately 4,650 coded wire tagged fingerlings were stocked into various waters of NYS (Table 5). Current rates of stocking are intended to continue through 2023. The purpose of stocking is to enhance the genetic diversity of new and rehabilitated populations for future spawning success.

The use of PIT tags below the Dam is particularly critical to effective management of broodstock genetics, as well as providing insight into sturgeon biology, including spawning periodicity, growth rates, and population mixing.

<u>St. Lawrence River Above Moses Power Dam</u>

In contrast to the Dam netting site, targeted sturgeon sampling upstream of the Dam has been limited. Occasional catches prior to 2016 have occurred in the Thousand Islands (N=6) and Lake St. Lawrence (N=13) index gill net surveys (DEC regional Warm Water Assessment database). Surveys had a combined effort of 1211.63 net-hrs (64 net-nights) in 2016 (Table 2). Three juvenile sturgeon ranging from 11.0-27.3 inches were collected in nets from Kring Pt. to Morristown. Two of these fish were scanned and found to have CWT tags. The smallest fish was not scanned.

**Summary**

The intent of this program was to collect biological data from, and PIT tag, sturgeon across a broad geographic area and create a long term database of individual fish that will be used to support ongoing species rehabilitation. Due to the unique life history of this species, collecting these data is a long term commitment which will continue.

From 2010-2016 a total of 1,245 unique sturgeon have been PIT tagged. Male fish and those classified as unknown are similar in percent occurrence (Table 3). Total female fish handled is approximately 5% of the sample, which is characteristic of spawning populations (Dr. Molly Webb, personal communication).

Recapture information to date indicates that most fish remain within a distinct population unit. Ten sturgeon collected through this project are known to have made long movements from initial capture sites. Eight fish traveled substantial distances downstream to a different spawning population, which included movement over, around, or through (entrained) a hydroelectric facility (Table 4).

With the preceding exceptions, spawning site fidelity appears to be high, with little documented movement between known spawning sites. Recapture rate was calculated for the broodstock collection at the South Channel (Figure 4). From 2009-2016 the recapture rate has averaged 10.4% with an increasing trend.

Several spawning congregations both in the St. Lawrence River and Lake Ontario have been identified, and, continually attract fish for reproduction. Past studies of age and growth (Jolliff and Eckert 1971, Johnson et al. 1998) would indicate that most sturgeon collected in this project range in age from 10-30 years.

**Recommendations**

1. Continue focused sampling effort on known spawning concentrations: Black River, SLR 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 sampling effort on areas of the St. Lawrence River with demonstrated concentrations of Lake Sturgeon such as Oak Point, Morristown, and Coles Creek.

4. Continue exploratory netting in areas of Lake Ontario around Point Peninsula, Grenadier Island, and Henderson Bay.

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Welsh, A., T. Hill, H. Quinlan, C. Robinson, and B. May. 2008. Genetic assessment of lake sturgeon population structure in the Laurentian Great Lakes. North American Journal of Fisheries Management 28: 572-591.

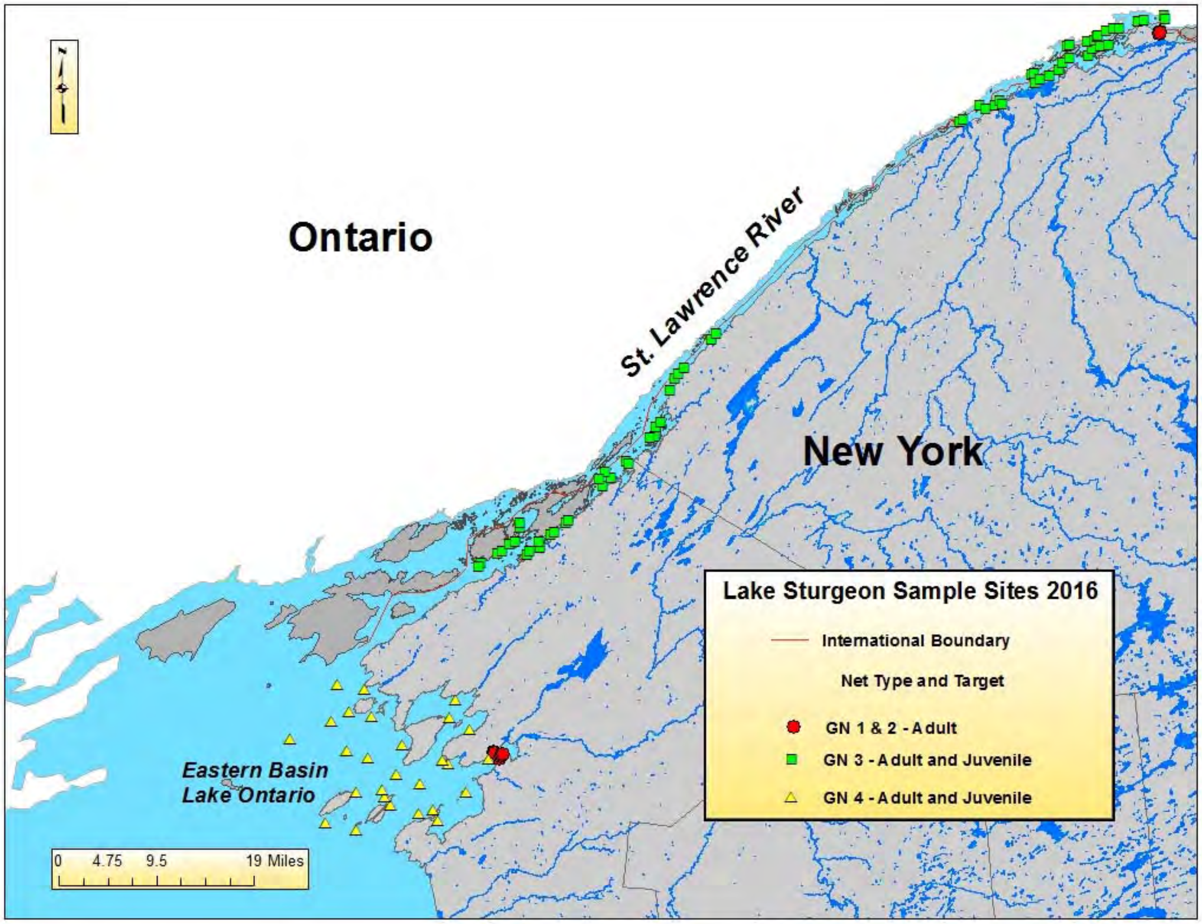


Figure 1. Lake Sturgeon sampling locations and targets for 2016. Adults were targeted with large mesh gill nets only (GN1 & 2). Existing index projects in the Thousand Islands, Lake St. Lawrence, and Lake Ontario potentially targeted both juveniles and adults, utilizing experimental gill nets (GN3 & 4).

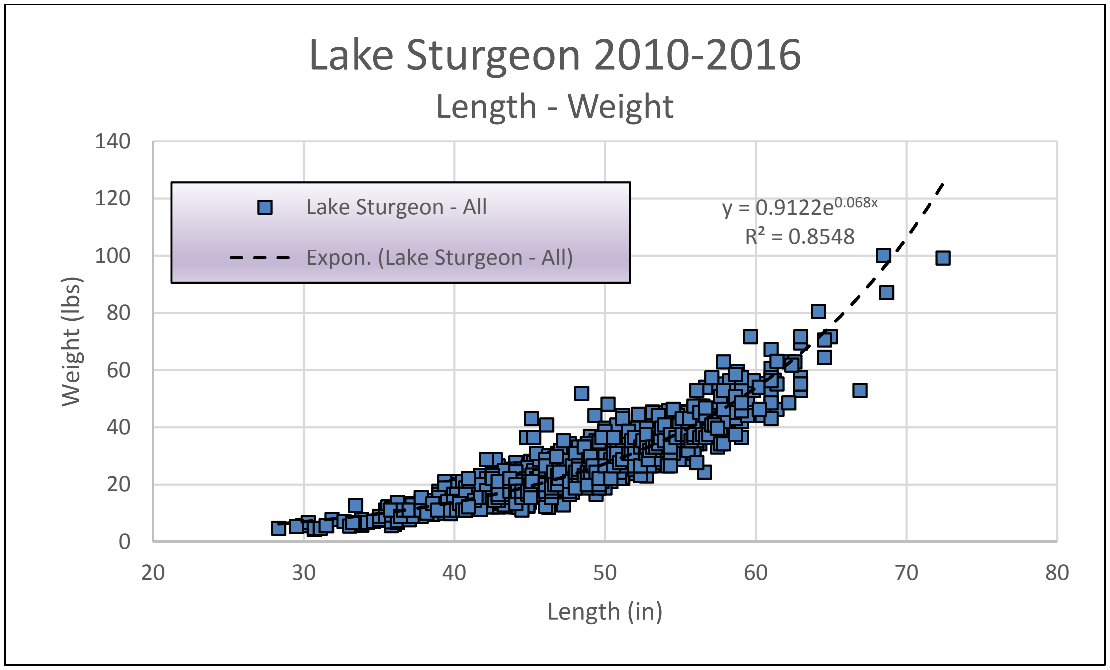


Figure 2. Length-weight relationship for Lake Sturgeon collected by DEC from 2010-2016. Fish from the St. Lawrence River, Lake Ontario, and the Black River were combined with no differentiation to sex.

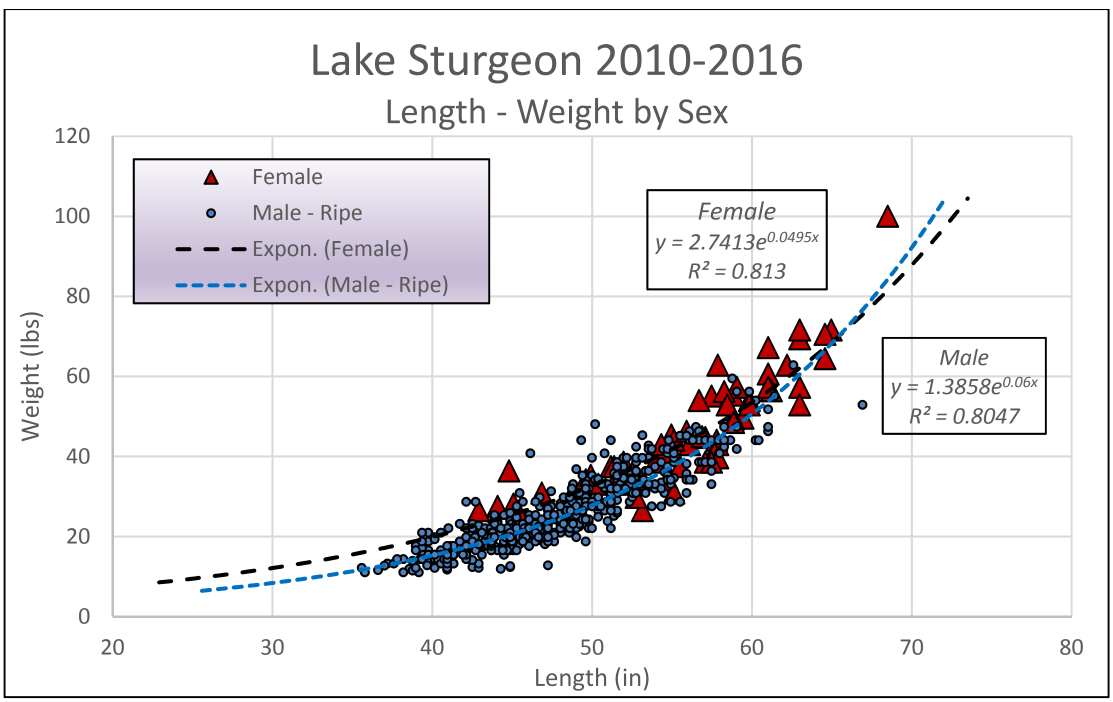


Figure 3. Length-weight relationship for Lake Sturgeon collected by DEC from 2010-2016 separated by sex. Fish from the St. Lawrence River, Lake Ontario, and the Black River were combined. Only female and ripe male sturgeon are presented.

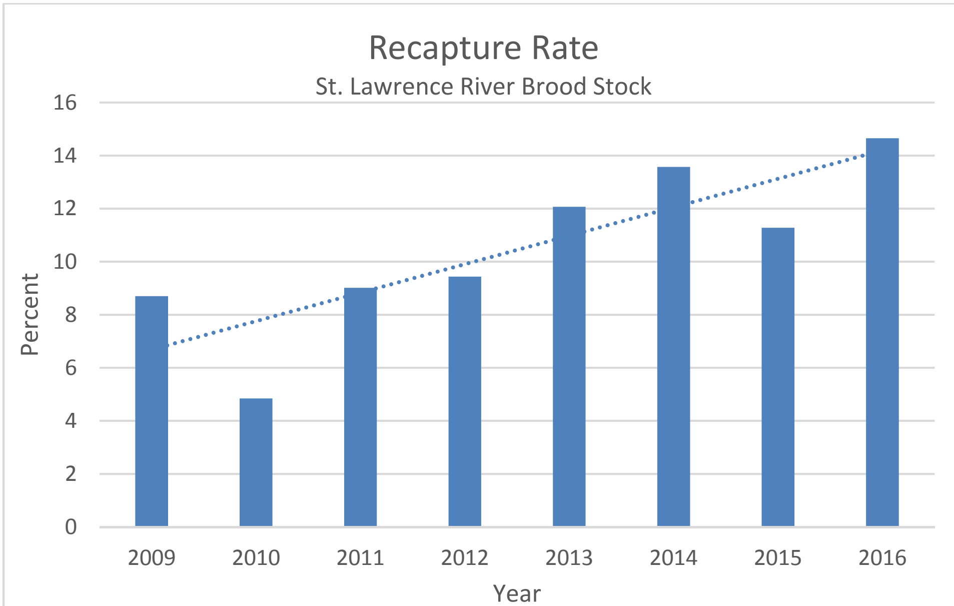


Figure 4. Lake sturgeon recapture rates from 2009-2016 for brood stock collection on the St. Lawrence River at the South Channel, Massena NY.

Table 1. Specifications of nets used for collecting Lake Sturgeon in 2016. Net target refers to the general size of sturgeon anticipated to be collected: A=adult or B=both adult and juvenile.

| Name | Net Target | Net Code | Length(ft) | Depth (ft) | Stretch Mesh (in) | Material |
|---|---|---|---|---|---|---|
| R6 Sturgeon | A | GN1 | 300 | 8 | 10 | monofilament |
| R6 Sturgeon | A | GN2 | 300 | 8 | 12 | monofilament |
| SLR | B | GN3 | 200 | 8 | 1.5-6 (8 panel) | monofilament |
| LO | B | GN4 | 400 | 8 | 2-6 (8 panel) | monofilament |

Table 2. Relative effort and success rate of Lake Sturgeon collection attempts on the St. Lawrence River, Lake Ontario, and the Black River in 2016. Targeted surveys specifically attempted to collect sturgeon. Existing project surveys targeted the major fish assemblage with sturgeon as a possible component. (A=adult or B=both adult and juvenile)

| Location | Dates | # Sites | Target | Net Code | Effort (hrs) | Catch | CUE (fish/hr) |
|---|---|---|---|---|---|---|---|
| ***Targeted*** | | | | | | | |
| Lake Ontario @ Black River Bay | 4/13-5/10/2016 | 12 | A | GN1 & GN2 | 878.9 | 39 | 0.04 |
| Black River | 4/18-5/3/2016 | 2 | A | GN1 & GN2 | 261.5 | 17 | 0.07 |
| SLR@ South Channel | 5/26-6/2/2016 | 4 | A | GN1 & GN2 | 359.0 | 157 | 0.43 |
| ***Existing projects*** | | | | | | | |
| SLR- TI | 7/24-28/2016 | 32 | B | GN3 | 616.2 | 3 | 0.01 |
| LO Gill Net | 8/1-15/2016 | 28 | B | GN4 | 520.9 | 2 | 0.01 |
| SLR- LSL | 9/12-15/2016 | 32 | B | GN3 | 595.5 | 0 | 0.00 |

Table 3. Total unique Lake Sturgeon catch from 2010-2016. Fish listed as Male or Female were confirmed via direct evidence of gametes. Fish that did not produce gametes through palpation or direct examination were listed as Unknown.

| Sex | Number | Percentage |
|---|---|---|
| Male | 509 | 41.9 |
| Female | 66 | 5.3 |
| Unknown | 670 | 53.8 |

Table 4. Tagging and recapture locations for ten study fish that relocated substantial distances from initial capture. The "Dam" column indicates whether the fish had an interaction with a hydroelectric dam to reach its Recapture Point. Distance is the approximate straight line water distance (miles) from initial tagging to the recapture point. Tag type indicates the tag used to identify the fish.

| Initial Tagging Location (year) | Recapture Point (year) | Dam | Distance (mi) from Tag Location | Tag Type |
|---|---|---|---|---|
| Black River (2006) | SLR, Mth Oswegatchie River (2010) | N | 85 | Floy |
| SLR, Coles Creek (2008) | SLR, South Channel (2011) | Y | 18.5 | PIT |
| SLR, Mth Oswegatchie River (2009) | SLR, South Channel (2011) | Y | 43 | PIT |
| St. Regis River stocking at Brasher Falls (2003) | SLR, South Channel (2013) | Y | 30 | Floy |
| Oneida Lake (2005) | Black River Bay (2014) | Y | 92 | PIT |
| Oswegatchie River blw Eel Weir (2009) | SLR, South Channel (2014) | Y | 45 | PIT |
| SLR, Mth Oswegatchie River (2010) | SLR, South Channel (2015) | Y | 43 | Floy |
| Oneida Lake (2004, stocking) | Black River Bay (2016) | Y | 92 | Carlin |
| Genesee River (2004, stocking) | Black River Bay (2016) | N | 100 | PIT |
| Cayuga Lake Outlet (2008) | Black River Bay (2016) | Y | 114 | PIT |

Table 5. Lake Sturgeon stocking for New York in 2016. All fish stocked received a coded wire tag (CWT) in the rostrum or under the 1st scute right side for the purpose of identifying their origin (hatchery vs. wild). Fish stocked were stocked on October 4 & 7, 2016.

| Water | Number | Avg. Length at Stocking (in) | Mark |
|---|---|---|---|
| Black Lake | 500 | 6.8 | CWT |
| Cayuga Lake | 650 | 6.8 | CWT |
| Genessee River | 500 | 6.8 | CWT |
| Oneida Lake | 500 | 6.8 | CWT |
| Oswegatchie River (Oxbow, Elmdale) | 500 | 6.8 | CWT |
| Raquette River | 500 | 6.8 | CWT |
| Salmon River (Franklin Co.) | 500 | 6.8 | CWT |
| St Regis River | 500 | 6.8 | CWT |
| St.Lawrence River (Massena, blw dam) | 500 | 6.8 | CWT |

## Lake Ontario Commercial Fishery Summary, 2000 – 2016

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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 2016. Commercial harvest generally targets yellow perch (*Perca flavescens*), however, harvest of cisco (*Coregonus artedii*), whitefish (*Coregonus* clupeaformis), and white perch (*Morone americana)* was also reported in 2016. Cisco harvest went unreported for a number of years, and fishers were reminded of reporting requirements (all fish caught, whether sold or not) in 2009. Of four licensed commercial fishermen, only two actively fished in 2016 (Table 2). Data from 1991-1999 are reported by LaPan (2005).

### References

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***Table 1. Approximate reported value ($US) of the 2015 commercial catch from the New York waters of Eastern Lake Ontario (*estimated, weighted mean value, as price fluctuates throughout the year).***

| SPECIES | TOTAL POUNDS | PRICE/POUND* | TOTAL VALUE |
|---|---|---|---|
| Yellow Perch | 67,405 | $2.42 | $ 162,806 |
| White Perch | 494 | $0.75 | $ 371 |

***Table 2. Reported* commercial fish catch in pounds from the New York waters of Eastern Lake Ontario, 2000-2016.***

| | # Lic. | YP | BBH | WP | RB | SF | CRP | WTF | 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 |
| 2013 | 3 | 20,589 | - | 1,820 | - | - | - | - | 12 |
| 2014 | 2 | 44,143 | 63 | 815 | 22 | - | - | - | 20 |
| 2015 | 2 | 46,473 | - | 859 | - | - | - | 11 | 52 |
| 2016 | 2 | 67,405 | - | 494 | - | - | - | 210 | 1,806 |

*does not include documented illegal and/or unreported harvest
**known harvest in previous years was not reported
# Lic. = number of active fishers
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= Cisco

## 2016 Angler Survey of the Upper and Lower Niagara River

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The Niagara River is a Great Lakes connecting channel forming the international boundary between New York State and the Province of Ontario. The Niagara River flows northward from Lake Erie to Lake Ontario for a distance of approximately 37 miles (59.5 km). The elevation difference between the two Great Lakes is approximately 328 feet (100 m), with slightly more than half of this height difference occurring at Niagara Falls. Niagara Falls divides the river into two distinct areas based on river basin morphometry and the fact that the Falls constitute an impressive natural barrier to upstream migration of fishes.

The upper Niagara River is best known for its warmwater fishery focused on smallmouth bass and muskellunge, while the lower Niagara River is best known for its coldwater fishery focused on migratory salmonids from Lake Ontario.

Assessment of the Niagara River sport fishery has been sporadic, with long periods of time between surveys. The most recent binational angler survey of the Niagara River occurred in 1999 (Einhouse et al. 2002), however, this survey only covered the upper Niagara River. A survey of New York anglers took place on both the upper and lower Niagara River during 2003 (NYPA 2005a and NYPA 2005b). Other angler surveys of the Niagara River were done by New York in 1984 (NYSDEC 1989) and Ontario in 1973, 1974 and 1980 (Craig 1976, Lewis and Dimond 1982)

This report summarizes the results of a binational angler survey conducted on the upper and lower Niagara River during 2016.

### Methods

<u>Boat fishery</u>

This survey primarily targeted the Niagara River boat fishery, and ran from May 16 through October 16, 2016. We employed four creel agents (two in Ontario and two in New York) that worked three weekdays and two weekend days per week. The survey used a modified aerial-access design that was patterned after Einhouse et al. (2002). The survey was broken into three seasonal strata. The spring season ran from May 16 to June 17, the summer season ran from June 18 to September 5, and the fall season ran from September 6 to October 16, 2016.

We used instantaneous boat counts to estimate angler effort and performed completed trip interviews at representative sites along the New York and Ontario shoreline to estimate catch and harvest (Figures 1 and 2). We estimated daily angler effort using the instantaneous boat counts multiplied by the number of hours in the sampling period and the probability that the period was included in the sample. The daily effort estimates were calculated for both weekdays and weekend days, then expanded to spring, summer, and fall season estimates and summed to calculate the total fishing effort (Pollack et al. 1994).

*Boat counts*

Einhouse et al. (2002) used aerial boat counts via fixed wing aircraft. However, we were unable to employ an aircraft for the survey in 2016. Instead we used a combination of boat counts both from vantage points and by driving a vehicle along roads following the river. The boat count route took approximately two hours for the upper river and an additional two hours to complete the lower river. As such, the counts were not instantaneous. However, we believe the vehicle based boat counts represent a near instantaneous count, and assumed such for data analysis. Boat counts were conducted on one week day and one weekend day per week. Boat counts were randomly assigned to

AM or PM shifts, and to either the first half of the shift or the last half of the shift. Only boats actively engaged in fishing were counted. On two occasions the accuracy of the vehicle based boat count method was checked by conducting a boat based count concurrent with the vehicle based count on the upper Niagara River. The comparison was not done on the lower river because the vantage points used here allowed for better viewing of fishing boats than those on the upper river.

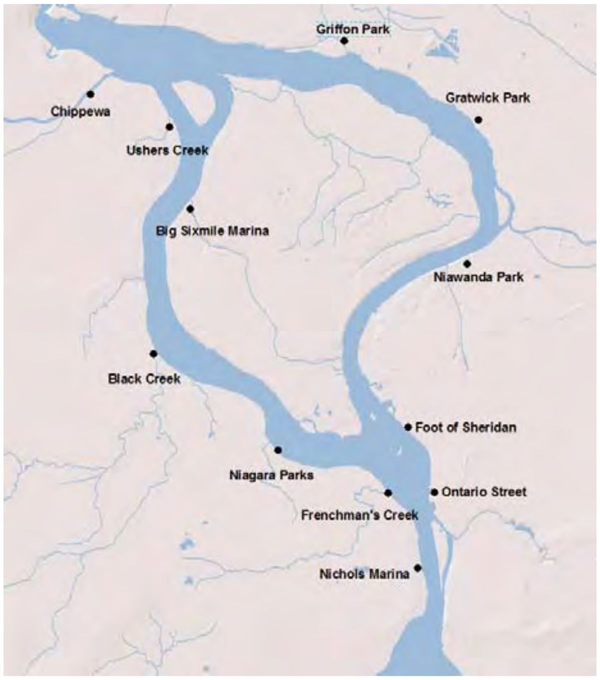


***Figure 1. Locations where angler interviews were conducted on the upper Niagara River in 2016***


***Figure 2. Locations where angler interviews were conducted on the lower Niagara River in 2016***

*Interviews*
On the upper river, interviews were conducted at six locations each in New York and Ontario (Figure 1). On the lower river, interviews were conducted at three locations in New York and one location in Ontario (Figure 2). Creel agents were randomly assigned three locations per day to conduct interviews at each location for two hours. If no boat trailers were present at the assigned location, they would move to the next location on the list.

Shore fishery
This survey was primarily focused on the boat fishery, however, we did sample the shore fishery on an opportunistic basis. Shore fishing effort was estimated using instantaneous counts of shore anglers present at interview locations when the creel agent first arrived. Incomplete trip interviews were used to estimate catch and harvest. All of the interview locations were boat launches that also offered some form of shore fishing. The lone exception was the New York Power Authority (NYPA) fishing platform on the lower river, which only allowed shore fishing.

*Calculations*
Estimates of fishing effort, mean catch and harvest rates, and catch and harvest of fish by species were estimated for each survey stratum, along with associated standard errors, according to the following formulae reported in Pollack et al. 1994 and Einhouse et al. 2002:

***Fishing Effort***

$$E = \sum \left(\frac{e_i}{\pi_i}\right)$$

$$S_i^2 = \left(\frac{1}{n-1}\right) \sum (e_i - \overline{e_i})^2$$

$$Var(\overline{e_i}) = \frac{S_i^2}{n_i}$$

$$Var\ (E) = N_i^2\ (Var(\overline{e_i}))$$

$$SE\ (E) = \sqrt{Var(E)}$$

Where:
E = Total fishing effort
$e_i$ = Daily fishing effort in the ith day
$\pi_i$ = The probability of the sampling period being included in the sample
$S_i^2$ = Standard error square of the mean daily fishing effort

***Catch Rate and Harvest***

$$CR = \frac{\left\{\left(\frac{\sum F_i}{n}\right)\right\}}{\left\{\left(\frac{\sum H_i}{n}\right)\right\}} = \frac{\sum F_i}{\sum H_i}$$

$$Y = P * (CR)$$

Where:

CR = mean catch rate in fish harvested per angler-hour
$H_i$ = number of angler-hours expended by i-th party
$F_i$ = number of fish caught by i-th party
n = number of parties interviewed
P = fishing effort in angler-hours
Y = harvest in number for particular species

$$S_{CR^2} = CR^2 * [\left(\frac{S_{F^2}}{F^2}\right) + \left(\frac{S_{H^2}}{H^2}\right) - \left(\frac{\{2COV(F*H)\}}{(F*H)}\right)]$$

$$S_{Y^2} = \left(S_{p^2} * CR^2\right) + (S_{CR^2} * P^2)$$

$$S_{F^2} = \left\{\frac{1}{n(n-1)}\right\} * [\sum F_i^2 - \left\{\frac{(\sum F_i)^2}{n}\right\}]$$

$$S_{H^2} = \left\{\frac{1}{n(n-1)}\right\} * [\sum H_i^2 - \left\{\frac{(\sum H_i)^2}{n}\right\}]$$

$$COV\ (F*H) = \left\{\frac{1}{n(n-1)}\right\} * \left\{\sum F_i H_i - \left[\frac{\{\sum F_i * \sum H_i\}}{n}\right]\right\}$$

Where:

$S_{CR}^2$ = standard error square of the mean catch rate
$S_Y^2$ = standard error square of estimated harvest
$S_F^2$ = standard error square of the mean number of fish
$S_H^2$ = standard error square of mean hours
$S_p^2$ = standard error square of estimated fishing effort
Cov (F x H) = covariance of fish and hours
F = mean number of fish per party
H = mean number of angler-hours per party

**Results and Discussion**

Boat fishery

*Upper Niagara River angler effort*

A total of 754 boats actively engaged in fishing were counted during 45 boat counts on the upper Niagara River (9 counts during the spring season; 24 counts during the summer season; and 12 counts during the fall season). On two occasions we compared the vehicle based boat counts; to a count conducted by running a boat down the river. The difference between the boat and vehicle counts on the first run was two boats (total n = 26), and the difference on the second run was one boat (total n = 5). Based on these results we believe that the vehicle based boat counts were an accurate method that had the added benefits of being much cheaper than aerial counts, and were less likely to be cancelled due to weather or scheduling issues.

The total estimated boat fishing effort on the upper Niagara River was 61,965 angler hours (Table 1). This is a considerable increase in angler effort from the 1999 survey, which reported 39,350 angler hours (Einhouse et al. 2002), but is similar to the 65,050 angler hours reported by NYPA (2005a) for the 2003 season. The average length of boat trips on the upper river was 3.2 hours and the average number of anglers per boat was 1.93. The summer season contained the bulk of the boat fishing effort, which is not surprising given that it covered a much larger period of time.

Boat anglers on the upper Niagara River primarily targeted smallmouth bass during all seasons, followed by anglers targeting "anything," muskellunge and walleye (Figure 3). Anglers in New York and Ontario both targeted similar species (Table 2).

***Table 1. Estimated fishing effort expended in the upper Niagara River during 2016 (SE= standard error).***

| Season | Total fishing effort (angler hours) | SE |
|---|---|---|
| Spring (05/16/16 – 06/17/16) | 9,294 | 3,290 |
| Summer (6/18/16 – 09/05/16) | 45,748 | 6,507 |
| Fall (09/06/16 – 10/16/16) | 6,923 | 1,738 |
| Total (05/16/16 – 10/16/16) | 61,965 | 7,496 |

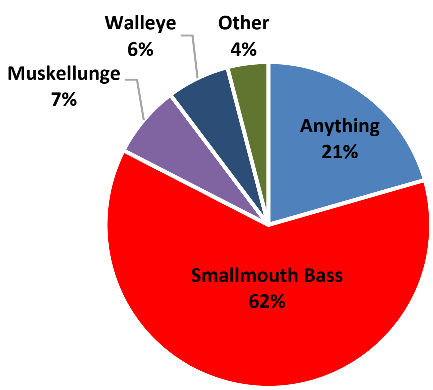


***Figure 3. Percent of total fishing effort directed towards each species in the upper Niagara River (NY and Ontario data combined) during 2016***

***Table 2. Percent of total fishing effort directed towards each species by New York and Ontario anglers in the upper Niagara River during 2016***

| Species | New York effort |
|---|---|
| Smallmouth bass | 65% |
| Anything | 22% |
| Muskellunge | 5% |
| Walleye | 4% |
| Other species | 5% |

| Species | Ontario effort |
|---|---|
| Smallmouth bass | 59% |
| Anything | 19% |
| Muskellunge | 10% |
| Walleye | 9% |
| Other species | 3% |

*Upper Niagara River catch and harvest*

Interviews of boat anglers identified 13 species caught and 7 species harvested in the upper Niagara River during 2016.

Boat anglers on the upper Niagara River caught an estimated 25,228 fish and harvested an estimated 3,472 fish for an overall catch and harvest rate of 0.4 fish per hour and 0.06 fish per hour, respectively. The catch was dominated by smallmouth bass, followed by yellow perch, freshwater drum, largemouth bass, walleye and muskellunge (Table 3).

Anglers targeting smallmouth bass had a catch rate of 0.42 bass per hour for the entire survey. Catch rates were highest in spring and lowest in the fall. Ontario anglers experienced higher bass catch rates than New York anglers during all seasons (Table 4). The catch rate of smallmouth bass on the upper Niagara River in 2016 was considerably lower than the catch rates of 0.84 fish per hour reported by NYPA (2005a) and 0.8 fish per hour reported by Einhouse et al. (2002). The total estimated catch of smallmouth bass was slightly less than half of the estimate in 2003 (NYPA 2005a), but similar to the number caught in 1999 (Einhouse et al. 2002).

Reasons for the decline in the catch rate of smallmouth bass in the upper Niagara River are unknown. The lack of fishery assessment information for the upper Niagara River makes it difficult to infer population trends based on this survey alone. There were drought conditions across the region during 2016 and it is possible that the low catch rates experienced this year were due to poor fishing conditions and not related to a decrease in the smallmouth bass population. The catch rate of smallmouth bass in Lake Erie also declined in 2016 (Robinson 2017), which provides some evidence for the decline being related to poor fishing conditions.

Average length of smallmouth bass harvested in the upper Niagara River was 15.7 in (399 mm), which is approximately one inch larger than the average length in 1999 (Einhouse et al. 2002). The largest smallmouth bass identified in the interviews was 20 in (508 mm).

Anglers targeting muskellunge in the upper Niagara River were restricted to fishing only during the summer and fall seasons due to the muskellunge fishing season being closed during the spring portion of the survey. All muskellunge catches reported in the interviews occurred during the summer season. Muskellunge anglers were interviewed during the fall season but no catches were reported.

Muskellunge anglers had an overall catch rate of 0.07 fish per hour for the entire survey period. During the summer season New York anglers had a catch rate of 0.19 fish per hour and Ontario anglers had a catch rate of 0.02 fish per hour. The combined summer season catch rate for all muskellunge anglers was 0.11 fish per hour (Table 5).

Muskellunge catch rates in the upper Niagara River indicate a high quality muskellunge fishery, and are similar to the catch rates of 0.06 and 0.07 fish per hour reported in 1999 and 2003, respectively (Einhouse et al. 2002 and NYPA 2005a). The estimated catch rate in 2016 is also very similar to the catch rate of 0.08 fish per hour reported through an angler diary study done by the Niagara Musky Association in 2016 (Tony Scime, Niagara Musky Association, personal communication).

The sustained high quality muskellunge catch rate in the upper Niagara River is truly remarkable and presents a unique opportunity to experience excellent muskellunge fishing in an urban setting.

***Table 3. Total estimated catch and harvest by boat anglers in the upper Niagara River during 2016 (SE=standard error).***

| Species | Number caught | SE | Number harvested | SE |
|---|---|---|---|---|
| Smallmouth bass | 17,497 | 2,158 | 1,058 | 479 |
| Yellow perch | 1,926 | 234 | 705 | 86 |
| Freshwater drum | 1,492 | 181 | --- | --- |
| Largemouth bass | 868 | 105 | --- | --- |
| Walleye | 352 | 43 | 217 | 30 |
| Muskellunge | 272 | 59 | --- | --- |
| Other species* | 2,577 | 313 | 1,492 | 200 |
| Total | 25,228 | | 3,472 | |

* Other species include bluegill, *Catostomidae spp.* (suckers), common carp, northern pike, pumpkinseed, rock bass, round goby and white bass

***Table 4. Catch rates by anglers targeting smallmouth bass in the upper Niagara River during 2016***

| Season | New York anglers | Ontario anglers | All anglers |
|---|---|---|---|
| Spring | 0.73 | 1.15 | 0.92 |
| Summer | 0.29 | 0.39 | 0.33 |
| Fall | 0.19 | 0.33 | 0.27 |
| Total | 0.36 | 0.5 | 0.42 |

***Table 5. Catch rates by anglers targeting muskellunge in the upper Niagara River during 2016***

| Season | New York anglers | Ontario anglers | All anglers |
|---|---|---|---|
| Summer | 0.19 | 0.02 | 0.11 |
| Fall | 0.00 | 0.00 | 0.00 |
| Total | 0.14 | 0.01 | 0.07 |

*Lower Niagara River angler effort*

We conducted a total of 43 boat counts on the lower Niagara River and counted 242 boats actively engaged in fishing (8 counts during the spring season; 23 counts during the summer season; and 12 counts during the fall season). The average length of boat trips on the lower river was 4.1 hours and the average number of anglers per boat was 2.1.

The total estimated boat fishing effort on the lower Niagara River was 21,963 angler hours (Table 6). This is a considerable decrease in angler effort from the New York Power Authority survey that was conducted in 2002-2003, which reported 138,154 angler hours (NYPA 2005b). These two surveys are not directly comparable because the NYPA survey covered an entire year (spring 2002 to spring 2003). However, they reported 58,009 angler hours during the summer season alone.

The reason for the dramatic decline in warmwater angler effort on the lower Niagara River is unknown, but could be related to the quality of smallmouth bass fishing. Smallmouth bass anglers had extremely high catch rates (2.46/hr) in the lower Niagara River during 2002 (NYPA 2005b). This time period also corresponds to the highest catch rate of smallmouth bass ever recorded in Lake Ontario (2/hr). The catch rate of smallmouth bass has dramatically declined in Lake Ontario since that time (Lantry and Eckert, 2016). It is possible that the NYPA (2005b) survey occurred during a period of unusually high angler activity on the lower Niagara River that was driven by record high catches of smallmouth bass.

In 2016, boat anglers on the lower Niagara River primarily targeted smallmouth bass, followed by salmonids, “anything” and walleye (Figure 4). Smallmouth bass were the most targeted species during spring and summer, and salmonids were the most targeted during the fall. New York and Ontario anglers targeted similar species, but New York anglers directed more effort toward salmonids and Ontario anglers directed more effort toward “other species” (Table 7).

***Table 6. Estimated fishing effort expended in the lower Niagara River during 2016 (SE=standard error).***

| **Season** | **Total fishing effort (angler hours)** | **SE** |
|---|---|---|
| Spring (05/16/16 – 06/17/16) | 3,840 | 1,654 |
| Summer (6/18/16 – 09/05/16) | 7,019 | 1,422 |
| Fall (09/06/16 – 10/16/16) | 11,104 | 2,791 |
| Total (05/16/16 – 10/16/16) | 21,963 | 3,542 |

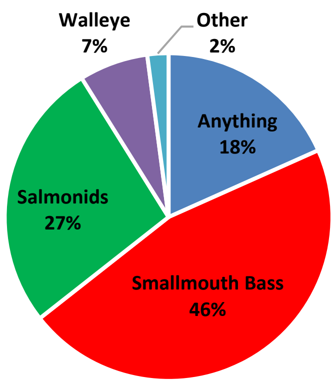


***Figure 4. Percent of total fishing effort directed towards each species in the lower Niagara River during 2016***

***Table 7. Percent of total fishing effort directed towards each species by New York and Ontario anglers in the lower Niagara River during 2016***

| Species | New York effort |
|---|---|
| Smallmouth bass | 45% |
| Salmonids | 30% |
| Anything | 18% |
| Walleye | 7% |
| Other species | 1% |

| Species | Ontario effort |
|---|---|
| Smallmouth bass | 56% |
| Anything | 15% |
| Salmonids | 11% |
| Walleye | 7% |
| Other species | 11% |

* Other species include muskellunge, longnose gar, and yellow perch

*Lower Niagara River catch and harvest*

Interviews of boat anglers identified 18 species caught and 10 species harvested in the lower Niagara River during 2016.

Boat anglers on the lower Niagara River caught an estimated 15,170 fish and harvested an estimated 3,315 fish for an overall catch and harvest rate of 0.69 fish per hour and 0.15 fish per hour, respectively. The catch was dominated by smallmouth bass, followed by yellow perch, Chinook salmon, white bass, freshwater drum, walleye, steelhead and lake trout (Table 8).

Anglers targeting smallmouth bass had a catch rate of 0.59 bass per hour for the entire survey. Catch rates were highest in summer and lowest in the spring. New York anglers had higher bass catch rates than Ontario anglers during all seasons (Table 9). The targeted catch rates for bass anglers in the lower Niagara River were higher than in the upper river. However, the overall catch rate was still lower than the catch rate of 0.8 fish per hour reported in 1999 for the upper river (Einhouse et al. 2002) and is dramatically lower than the catch rate of 2.46 fish per hour reported for the lower river in 2003 (NYPA 2005b).

Smallmouth bass catch rates in the lower Niagara River appear to have mirrored those in Lake Ontario. Catch rates were at record high levels in Lake Ontario during the late 1990s and early 2000s, with a peak catch rate in 2002. Since then the smallmouth bass catch rate in Lake Ontario has dramatically declined and was 0.49 fish per hour in 2015 (Lantry and Eckert 2016). Reasons for the decline are unknown but may be related to invasive species, Viral Hemorrhagic Septicemia virus (VHSv) and/or environmental changes.

The average length of smallmouth bass harvested from the lower Niagara River was 15 in (381 mm), similar to the length reported for the upper river in 1999 (Einhouse et al. 2002). The largest smallmouth bass reported in the interviews was 18 in (457 mm).

Boat anglers targeting Chinook salmon experienced a catch rate of 0.18 fish per hour during the fall season. This catch rate is driven almost entirely by New York anglers as only one fishing party targeting Chinook salmon was interviewed in Ontario during the fall season. In contrast, 41 parties that targeted Chinook salmon were interviewed in New York. The 2016 catch rate was considerably higher than the 0.04 fish per angler hour and 0.035 fish per angler hour reported for all New York anglers (boat and shore) on the lower Niagara River in 2015

(Prindle and Bishop 2016) and in 2011 (Prindle and Bishop 2012), respectively. The difference in the catch rate in 2016 is likely due to boat anglers having higher catch rates than combined boat and shore anglers for Chinook salmon in the lower Niagara River.

Catch rates of steelhead and lake trout were generally low, due to the timing of the survey. The steelhead and lake trout fishery occurs mostly within the winter season. This survey ran from spring through fall and, as a result, only covered the very beginning and end of this fishery.

***Table 8. Total estimated catch and harvest by boat anglers in the lower Niagara River during 2016 (SE=standard error).***

| Species | Number caught | SE | Number harvested | SE |
|---|---|---|---|---|
| Smallmouth bass | 6,334 | 1,027 | 555 | 547 |
| Yellow perch | 3,377 | 545 | 727 | 117 |
| Chinook | 1,454 | 235 | 1,393 | 225 |
| White bass | 1,171 | 189 | 234 | 38 |
| Freshwater drum | 850 | 137 | 12 | 2 |
| Largemouth bass | 382 | 62 | -- | -- |
| Walleye | 333 | 54 | 160 | 29 |
| Steelhead | 148 | 24 | --- | --- |
| Lake trout | 86 | 14 | --- | --- |
| Other species* | 986 | 160 | 234 | 43 |
| Total | 15,170 | | 3,315 | |

* Other species include brown trout, channel catfish, *Catostomidae spp.* (suckers), coho salmon, common carp, pumkinseed, rock bass, round goby, and white perch.

***Table 9. Catch rates by anglers targeting smallmouth bass in the lower Niagara River during 2016***

| Season | New York anglers | Ontario anglers | All anglers |
|---|---|---|---|
| Spring | 0.33 | --- | 0.33 |
| Summer | 0.75 | 0.31 | 0.68 |
| Fall | 0.5 | 0.47 | 0.48 |
| Total | 0.63 | 0.35 | 0.59 |

<u>Shore fishery</u>

Estimating the fishing effort, catch and harvest of the shore fishery on the Niagara River was a secondary component of this survey. Shore anglers were counted and interviewed as they were encountered during the boat fishing survey but there was not a dedicated effort to sample the entire shore fishery. The results presented here should be taken as an observation of a portion of the Niagara River shore fishery and not as an estimate of the entire fishery.

*Upper Niagara River*

The estimated shore fishing effort at the 12 interview sites on the upper Niagara River was 3,696 angler hours (*SE* = 615) for the entire survey period. The actual shore fishing effort for the upper river is likely much higher. The 12 sites that were used for boat interviews all allow some type of shore fishing. However, they represent only a small fraction of the shore fishing locations available on the upper Niagara River, and do not include many of the most popular locations. In comparison, NYPA (2005a) sampled a large portion of the shore fishery of the upper Niagara River and reported a shore fishing effort estimate of 91,530 angler hours.

Upper Niagara River shore anglers that were interviewed during this survey primarily targeted "anything," followed by smallmouth bass, walleye and yellow perch.

The total estimated catch and harvest by shore anglers at the 12 interview locations on the upper Niagara River appears in Table 11.

*Lower Niagara River*

The estimated shore fishing effort on the lower Niagara River was 10,492 angler hours (*SE* = 1,260) for the entire survey period. The shore fishing effort estimate for the lower river is likely more accurate than that for the upper river. The lower Niagara River has fewer shore fishing access locations than the upper river, and the NYPA fishing platform, one of the most popular shore access sites, was included in the survey. However, there were still many popular shore fishing locations that were not covered, and, as a result, our effort estimate still likely underestimates the total shore fishing effort.

Lower Niagara River shore anglers primarily targeted "anything," followed by smallmouth bass, salmonids, walleye and white bass.
The estimated catch and harvest by shore anglers at four locations on the lower Niagara River appears in Table 12.

It is difficult to draw meaningful conclusions about trends in the Niagara River fishery when there are long periods of time between surveys. In this case it has been 17 years since the last bi-national angler survey and 11 years since the last survey of New York anglers in the Niagara River. There were large differences in catch rates and angler effort in 2016, compared to the earlier surveys. Many ecological changes have occurred over the last 17 years and without angler or fish population survey data for these years it is virtually impossible to identify potential causes for decreases in angler effort or angling quality.

***Table 11. Total estimated catch and harvest by shore anglers at 12 sites on the upper Niagara River during 2016 (SE=standard error).***

| Species | Number caught | SE | Number harvested | SE |
|---|---|---|---|---|
| Smallmouth bass | 557 | 93 | 24 | 4 |
| Yellow perch | 4,383 | 729 | 1,187 | 197 |
| Other species* | 3,148 | 2,746 | 2,349 | 2,576 |
| Total | 8,088 | | 3,560 | |

* Other species include *Catostomidae spp.* (suckers), channel catfish, freshwater drum, pumpkinseed sunfish, white bass and white perch

***Table 12. Total estimated catch and harvest by shore anglers at 4 sites on the lower Niagara River during 2016***

| Species | Number caught | SE | Number harvested | SE |
|---|---|---|---|---|
| Smallmouth Bass | 2,081 | 362 | 779 | 584 |
| Yellow Perch | 413 | 50 | 365 | 43 |
| Chinook | 268 | 32 | 207 | 26 |
| White Bass | 1,461 | 182 | 1265 | 156 |
| Steelhead | 122 | 21 | 37 | 4 |
| Lake Trout | 85 | 10 | 12 | 2 |
| Other species* | 1,789 | 288 | 742 | 119 |
| Total | 6,220 | | 3,407 | |

* Other species include brown trout, common carp, channel catfish, gizzard shad, rock bass, round goby, freshwater drum, *Catostomidae spp.* (suckers), white perch and walleye

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