The Fisheries and Limnology of Oneida Lake 2014

New York Federal Aid in Sport Fish Restoration
Study 2
F-61-R

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Introduction

Oneida Lake is the largest lake by area entirely within the borders of New York State and is second only to Lake Ontario in total angling effort (Connelly and Brown (2009) estimated 786,000 angler hours/year on Oneida Lake, compared to 1.3 million/year on Lake Ontario). Effort estimates conducted by the Cornell Biological Field Station show annual effort in excess of 200,000 boat hours, and have increased since 2002. Angling effort in 2014 was more than 217,000 boat hours. Angling on Oneida Lake generates revenues of over 12 million dollars annually, and as such represents an important resource both locally and across the state (Connelly and Brown 2009). Traditionally, walleye *Sander vitreus* has been the primary focus of the Oneida Lake fishery, with yellow perch *Perca flavescens* and black bass (smallmouth bass *Micropterus dolomieu* and largemouth bass *M. salmoides*) also providing popular fisheries. Walleye continue to be the most frequently targeted sport fish in Oneida Lake, but the bass fishery has grown in popularity in recent years (see below).

The walleye population is intensively managed on Oneida Lake, including annual stockings of 150 million walleye fry, double-crested cormorants *Phalacrocorax auritus* management, and angling regulations that have been imposed and relaxed with the goals of retaining both a high walleye yield and a yellow perch population capable of providing forage for walleye and larger fish attractive to anglers (Forney 1980). Angling regulations are based on intensive monitoring of the walleye and yellow perch populations and predicted walleye recruitment. Oneida Lake has been the subject of research by the Cornell Biological Field Station (CBFS) since its establishment in 1956. Work on Oneida Lake is an important part of the collaboration between Cornell's Department of Natural Resources and New York State Department of Environmental Conservation's Bureau of Fisheries (NYSDEC). Research and monitoring on Oneida Lake is designed to encompass a range of trophic levels, from nutrients to fish and anglers, and these data are used to improve our understanding of the interactions between the ecosystem and the fishery in Oneida Lake.

During the time span that data have been collected on Oneida Lake, several perturbations have resulted in fundamental changes in the lake and how it functions. This report provides a summary of the standard monitoring data for 2014, along with an appendix with standardized methods for data collection and standard data tables. In our report of 2008 results, we presented results of analyses of long-term trends in the lake and interpreted them in light of observed perturbations (Rudstam et al. 2009). The occurrence of shifts in conditions over the long-term is unquestionable, particularly decreased productivity and increased water clarity resulting from international water quality agreements and establishment of dreissenid mussels. In our recent reports, we have presented analyses of trends in lake biology over more recent years (2000-) to assess whether the lake continues to demonstrate changing trends in physical and biological features. Here we expand those analyses of recent trends to include data from 2014. While changes continue on the lake, dreissenid biomass stabilized in the late 1990s so the period of 2000 forward should capture a relatively static period in the lake's limnology. With this approach, we hope to be able to separate documented trends that were a result of past changes from those that may suggest a response to new changes (e.g., round goby *Neogobius melanostomus*).

Several of our data sets are available on the web through the Knowledge Network for Biocomplexity (http://knb.ecoinformatics.org/index.jsp) a data repository that is also a member node of theNational Science Foundation DataONE portal (www.dataone.org). A single search for "Oneida Lake" as of 15 April 2015 showed the ten available data sets, which include limnology, phytoplankton, zooplankton, benthos, mussels, ice cover, walleye, yellow perch, gill net and trawl catches.

Collection of data to maintain the long-term database and directed studies aimed at understanding the effects of ecosystem change on the fish populations were continued in 2014 by the Department of Natural Resources of Cornell University as part of the activities of CBFS. Funding was provided by NYSDEC through the Federal Aid in Sport Fish Restoration Program and from the CBFS endowment. Additional support for limnological sampling was made available from a Hatch grant from Cornell University.

Oneida Lake in 2014

Limnology

In many recent years, initial formation of ice cover has often been followed by one or more episodes of break-ups and refreezing, acting to shorten the period of complete ice cover despite only small changes in average ice on and ice off dates. The winter of 2013-2014 was more typical of the early years of our data record with a relatively early and persistent freeze. First complete lake ice cover was observed on 17 December 2013 and persisted through 13 April 2014. Total ice duration of 118 days for the winter of 2013-2014 tied with 1976-1977 and 1981-1982 as the second longest in our data series (longest 121 days in 1977-1978) and was above the average of 89 days observed since 1975 (Appendix Table A1).

Long-term records of the lake's winter ice conditions exhibit trends consistent with global patterns. Date of first complete ice cover since 1976 is trending later, although the trend is only marginally significant (linear regression: df = 36; F-ratio = 2.67; $r^2 = 0.07$; $p = 0.11$). Ice off date exhibits no trend (linear regression: df = 37; F-ratio = 0.40; $r^2 = 0.01$; $p = 0.53$). Recent patterns of multiple freeze and break-up events have resulted in a significant decline in the number of days the lake has complete ice cover (Figure 1; linear regression: df = 37; F-ratio = 4.94; $r^2 = 0.12$; $p = 0.03$).

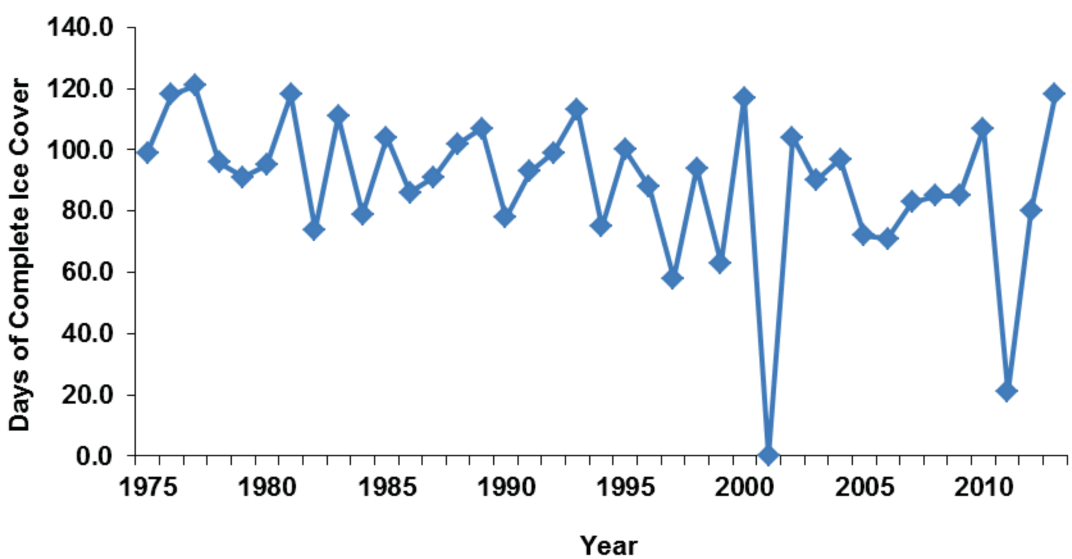

Figure 1. Days of complete ice cover, Oneida Lake, New York, 1975-2014.

June-August water temperatures at 2 m depth averaged 22.3 ^{o}C (72.1 ^{o}F) in 2014, just above the long-term average (Appendix Table A1). Sixteen of the last 20 years have exhibited above average temperatures (based on our data series since 1975) and 3 of the 4 warmest years in our period of record have occurred since 2010.

Summer water temperatures are consistent with patterns of climate change observed regionally and globally. Average June-August water temperatures since 1975 exhibit a strong and significant increase (Figure 2; linear regression: df = 38; F-ratio = 28.25; r^2 = 0.43; $p < 0.0001$). On average over the period 1975-2014, summer water temperatures have increased at a rate of 0.06° C/year (0.1°F). Mean summer water temperatures have exceeded our long term average all but three years since 1997.

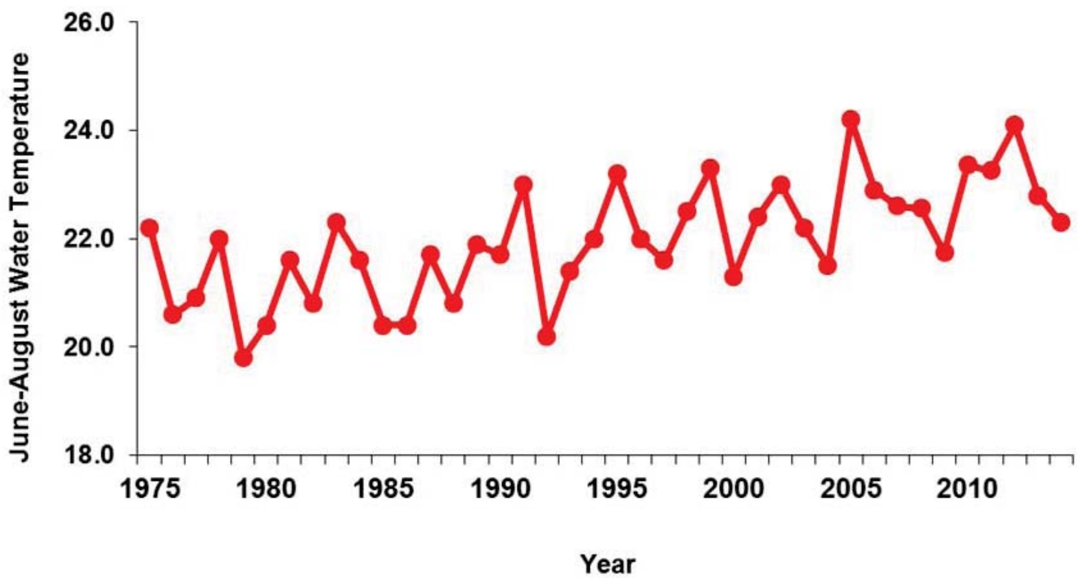

Figure 2. Average daily water temperature at 2 m depth at the Shackelton Point station from June 1 to August 31, Oneida Lake, New York, 1975-2014.

Mean annual Secchi depth in 2014 was 3.3 m, similar to the average over our period of record (Figure 3, Appendix Table A1). The mean chlorophyll-*a* concentration of 4.2 µg/L, was up slightly from 2013, but still well below the long term average (Figure 4). High water clarity and low chlorophyll-*a* concentrations have been typical of the lake since 1992, when zebra mussels (*Dreissena polymorpha*) became abundant in Oneida Lake (Zhu et al. 2006). In approximately 2005, quagga mussels (*Dreissena rostriformis bugensis*) entered Oneida Lake, and by 2008 began displacing zebra mussels. To date, displacement of zebra mussels by quagga mussels has not resulted in an increase in total dreissenid biomass at sites historically sampled for zebra mussels, but quagga mussels have colonized softer substrates considered uncolonizable by zebra mussels, resulting in a potential increase in dreissenid biomass lakewide (CBFS unpublished data). Increased filtering capacity by mussels likely plays a large role in the significant decrease in chlorophyll-*a* concentrations observed since 2000, but water clarity has not increased over the same time period (Table 1). Soluble reactive phosphorus (SRP) concentrations in 2014 were near the long term average at 11.1 µg/L, and total phosphorus (TP) has been relatively stable for the past five years (Figure 5). SRP concentrations show no significant trend over the period since 2000, while TP shows a marginally significant increase (Table 1). Following water quality improvement efforts in the 1970s and establishment of dreissenids, the productivity of the lake is overall typical of a mesotrophic lake (Wetzel 2001; Idrisi et al. 2001; Zhu et al. 2006). However, various indicators provide inconsistent pictures of trophic state. Using the criteria proposed by Carlson (1977), Secchi disc readings would place Oneida Lake with a trophic state index (TSI) at the upper end of oligotrophic, chlorophyll-*a* at a TSI in the lower mesotrophic range, and total phosphorus at a TSI in the lower range for a eutrophic lake. These inconsistencies are most likely due to grazing by mussels, which keeps chlorophyll-*a* lower than expected based on phosphorus inputs (Mayer et al. 2014).

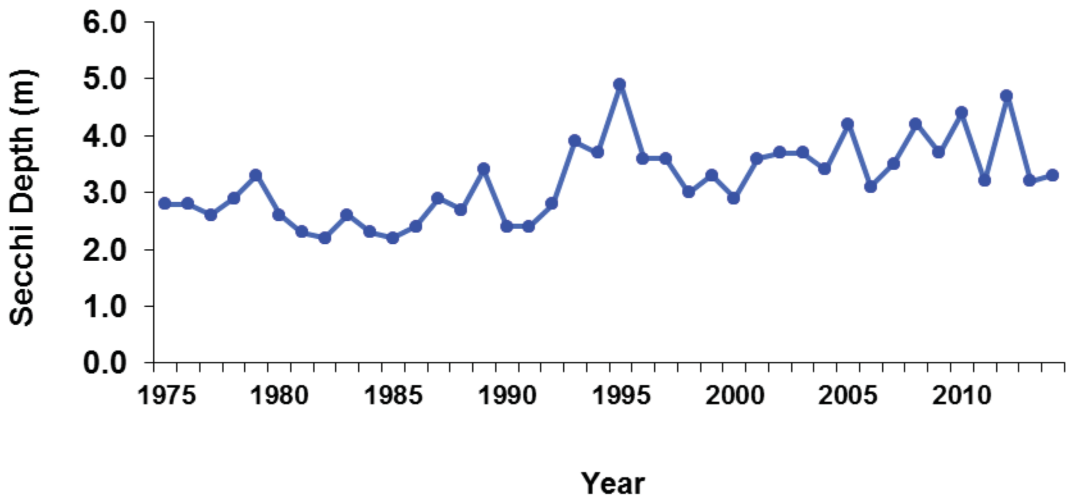

Figure 3. Time trends in Secchi disc measurements in Oneida Lake, New York, 1975-2014.

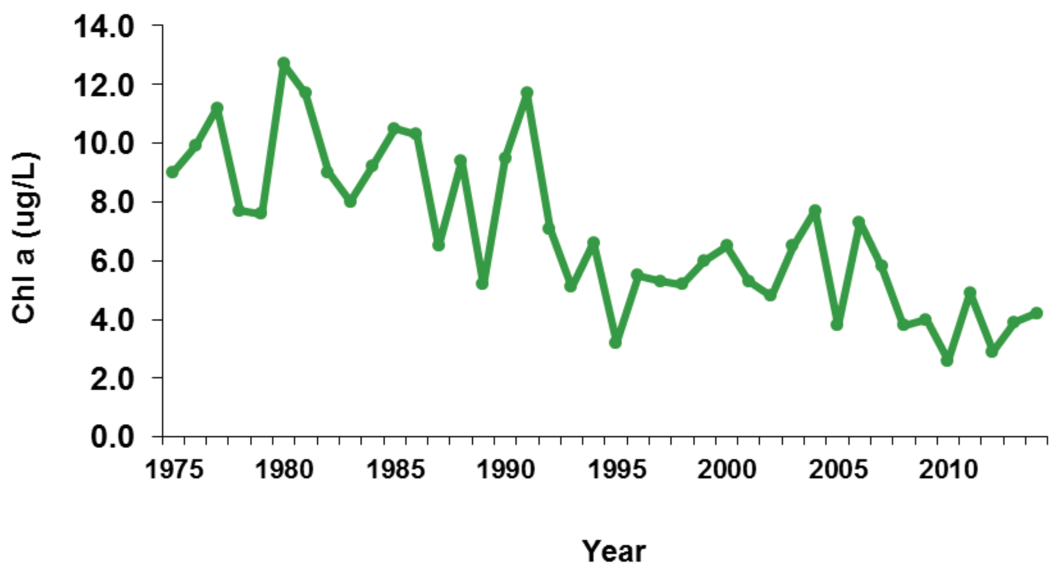

Figure 4. Time trends in Chl-*a* concentration in Oneida Lake, New York, 1975-2014.

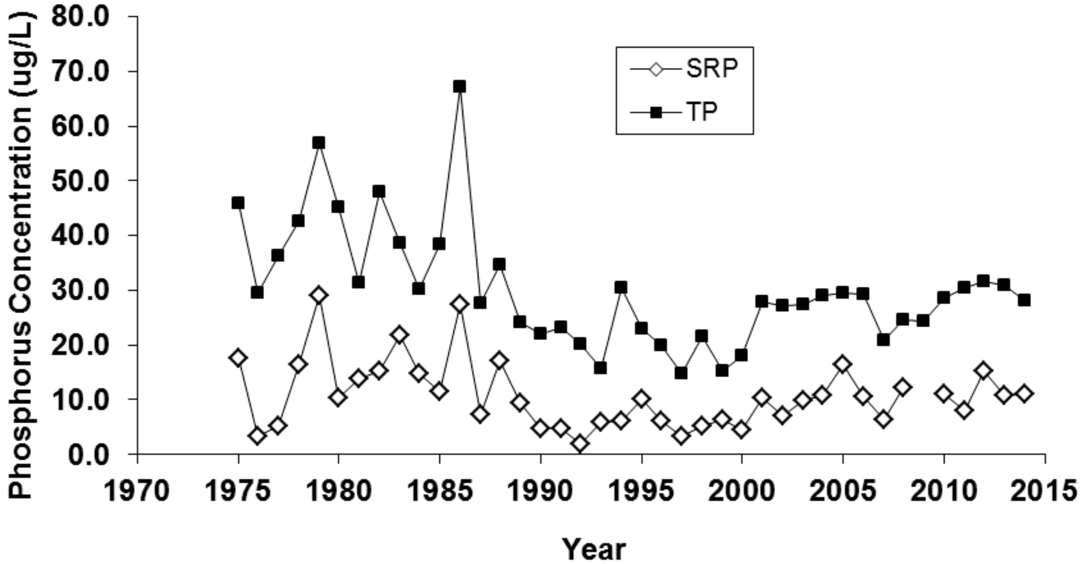

Figure 5. Time trends in phosphorus concentration in Oneida Lake, New York, 1975-2014.

Total zooplankton and *Daphnia* spp. both exhibited sharp decreases relative to the previous two years and were well below the long-term average (Figure 6; Appendix Table A1). Analyses of the years since 2000 indicate significant declines in *Daphnia* spp. biomass and a marginally significant decline in total zooplankton biomass (Table 1). These trends are consistent with initial expectations following establishment of dreissenid mussels and declines in phytoplankton biomass (as indexed by chlorophyll-*a*). Whereas *Daphnia* spp. have typically accounted for 55-65% of total zooplankton biomass over much of our data series, in recent years their contribution has fallen below 35%, and in 2014 was at 23%, the second lowest in our period of record (Figure 7). While further study is needed, initial indications are that declines in *Daphnia* spp. production are taking place largely with reduced early spring blooms which are frequently driven by diatoms, which appear to be declining in density in spring. Levels of silica in water samples have exhibited a significant increase since 2000, suggesting that diatoms, which take up silica, may be on the decline (linear regression: df = 11; F-ratio = 13.57; $r^2 = 0.55$; $p = 0.004$). Increased sampling of late winter and early spring conditions has been instituted to better understand the mechanisms behind declining *Daphnia* spp. production. Despite declines in *Daphnia* spp. biomass, we have observed a significant decline in chlorophyll-*a* concentrations, which might be expected to increase under reduced grazing pressure by *Daphnia* spp. This is likely due to grazing by dreissenids, which could offset reduced grazing by *Daphnia* spp. Observed reductions in *Daphnia* spp. production are of concern, as *Daphnia* spp. are a critical food for supporting growth of early life stages of fish. We will continue to monitor zooplankton levels and look for changes in growth rates of planktivorous fishes.

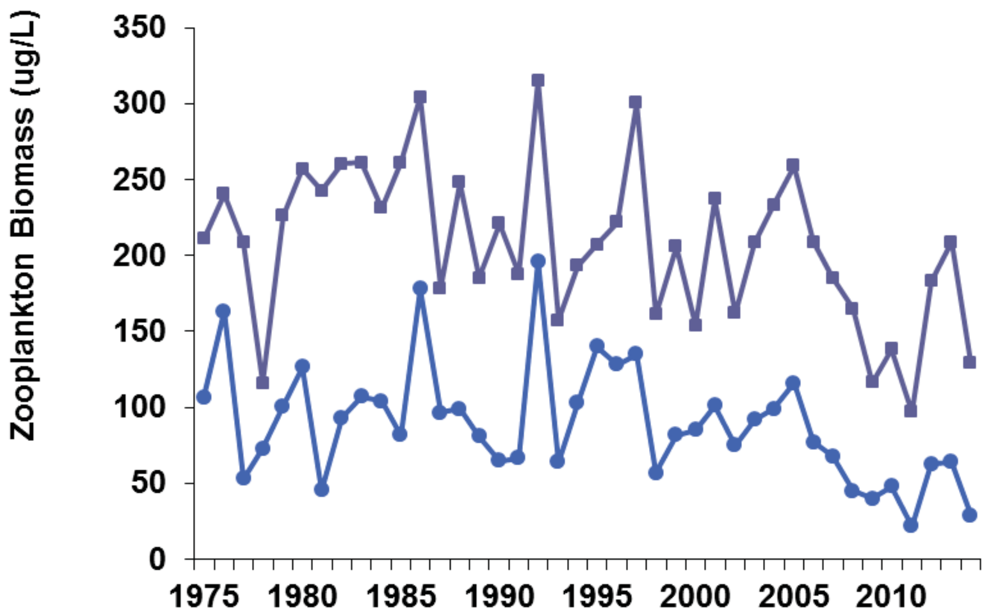

Figure 6. Time trends in total zooplankton biomass (upper line, with squares) and *Daphnia* biomass (lower line, with circles) in Oneida Lake, New York, 1975-2014.

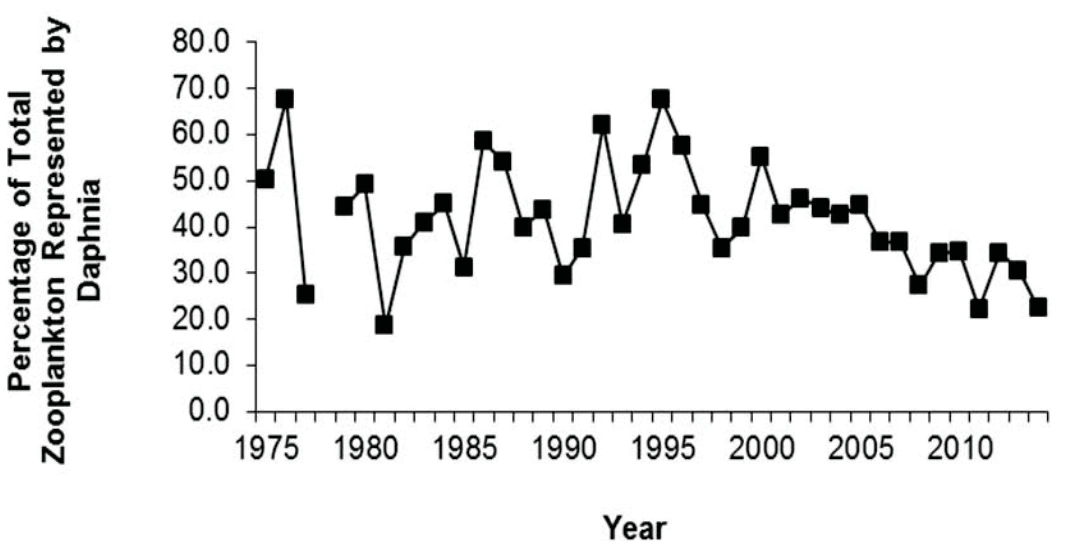

Figure 7. Time trend in percentage of total zooplankton biomass represented by *Daphnia* spp. in Oneida Lake, New York, 1975-2014.

Our analyses of long-term trends in physical and limnological features in Oneida Lake show a lake at a lower state of productivity than when limnological studies were initiated in the 1970s. Reduced nutrient loading, combined with grazing by introduced dreissenid mussels, have led to reduced chlorophyll-*a* concentrations as compared to the 1970s through 1980s. We will need to monitor whether the expansion of the quagga mussel in Oneida Lake will further increase grazing rates and reduce algal concentrations and increase water clarity, but so far water clarity is not showing a dramatic response to quagga mussels. While Oneida Lake was once classified as a eutrophic lake, it now possesses characteristics of a mesotrophic lake. However, summer bluegreen algal blooms still occur in the lake, sometimes causing beach closings, which have received increased media attention. Recent trends in phosphorus suggest increases, and more attention is now being paid to phosphorus inputs from streams and releases from lake sediments, which would be predicted from longer stratification of the water column associated with warming (Heatherington et al. 2015). To date, average May-October chlorophyll-*a* levels have not responded to apparent increases in available nutrients. While *Daphnia* spp. biomass did not initially decrease as a result of decreased productivity or establishment of zebra mussels, recent trends show declines, and this may have implications for production of fish.

The discovery of *Hemimysis anomala* in the lake in 2009 was also a cause for concern, as this exotic shrimp may exert additional predation on zooplankton (Brooking et al. 2010), but sampling in both 2010 and 2011 revealed no *Hemimysis* in fish diets. In 2012, *Hemimysis* were observed in the diet of a single white perch *Morone americana*. In 2013, *Hemimysis* was observed in the diets of 26 fish, 25 white perch and one yellow perch. However, in 2014 no *Hemimysis* were observed in any fish diets. To date, there is no indication that *Hemimysis* will become abundant on Oneida Lake.

Water temperatures in recent years continue to be above long-term averages and ice duration has been below average for 6 of the last 7 years. These climate-related physical conditions show significant long-term trends. Increases in water temperatures are predicted to increase periods of summer stratification, resulting in anoxic bottom waters and increased phosphorus release from the sediments (Heatherington et al. 2015). With increases in water clarity, we have observed increases in the area of lake bottom covered by submerged macrophytes. These changes could result in shifts in the fish community and the limnology of the lake will require continued monitoring.

Table 1. Recent trends (2000-2014) in physical and limnological measurements in Oneida Lake, New York. Significance levels are based on simple linear regression. Limnological variables are averages of weekly whole water column samples from May through October (Appendix Table A1). Trend indicates direction (+ or -) over time, with r^2 and p reported for regressions. Significant trends are indicated by bold type.

		2000-2014	
Variable	Trend	r^2	p
Total Phosphorus (µg/L)	+	0.20	0.09
Soluble Reactive Phosphorus (µg/L)	+	0.14	0.18
Chlorophyll-*a* (µg/L)	-	0.37	**0.02**
Secchi disk depth (m)	+	0.04	0.47
Daphnia spp. biomass(µg/L)	-	0.55	**0.002**
Total zooplankton biomass (µg/L)	-	0.19	0.10
Percentage of zooplankton biomass as Daphnia	-	0.77	**<0.0001**

Fish Community Changes

Gill net catches in Oneida Lake are typically dominated by yellow perch, white perch and walleye. These three species have represented over 80% of total gill net catch in all but four years of our sampling (all four exceptions were during the 1990s). In 2014, walleye represented 32% of the total gill net catch, exceeding both yellow perch and white perch, the first time in our data series when walleye were the most commonly caught species (Figure 8). High representation of walleye reflects, in part, a large 2010 year class, but also a decline in both yellow perch and white perch catches relative to past years. The catch of yellow perch was less than half of that observed in 2013, representing only 26% of the total catch, and the lowest observed since 1994. The white perch catch was also low relative to most recent years, and accounted for 25% of the total. Total number of fish caught in the standard gill nets in 2014 was 1,293, the lowest observed since 2003. More common species such as bluegill *Lepomis macrochirus*, pumpkinseed *L. gibbosus*, golden shiner *Notemigonus crysoleucas,* smallmouth bass, gizzard shad *Dorosoma cepedianum* and channel catfish *Ictalurus punctatus* were captured in numbers within the range of recent years, but freshwater drum *Aplodinotus grunniens* catches declined sharply (lowest observed since 1987) while white sucker *Catastomus commersonii* catches more than doubled over most recent years.

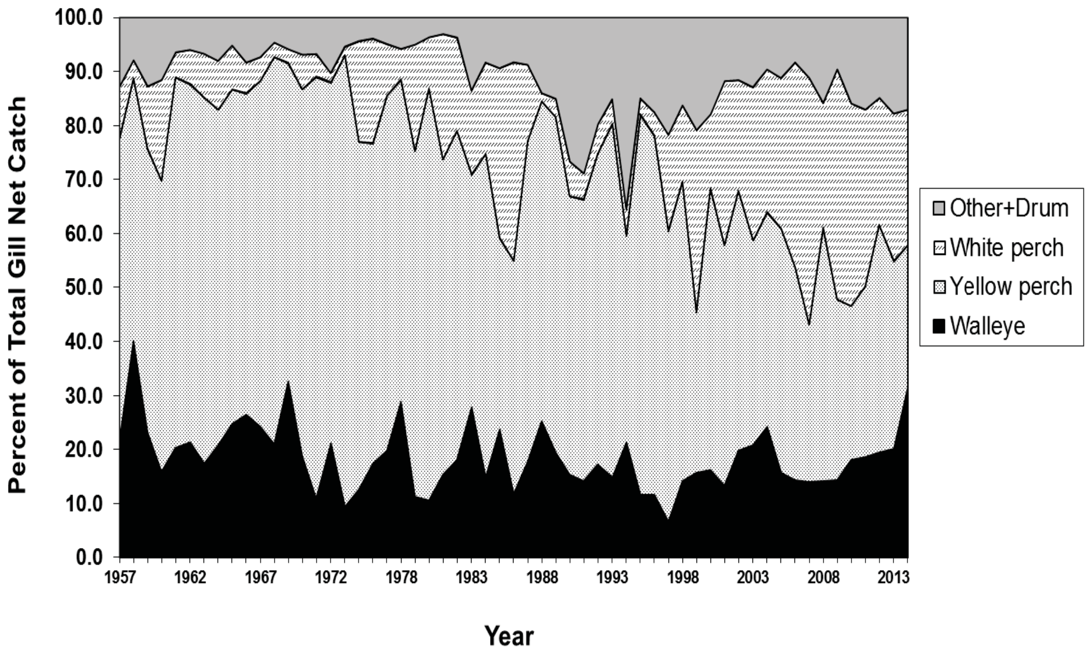

Figure 8. Proportion of three major fish species in standard gill net sets in Oneida Lake, New York, 1957-2014.

Walleye

We assess the walleye population in Oneida Lake at several life stages: as larvae (lengths of 9 to 13 mm) with Miller high-speed samplers; as juveniles in the spring, summer and fall with bottom trawls; and as juveniles, sub-adults and adults with gill nets in the summer, supported with mark-recapture for adult fish (age-4 and older) at regular intervals (currently every 3 years, last conducted 2013).

Results of Standard Sampling

Abundance of adult walleye (age-4 and older) for 2014 is based on the mark-recapture estimate from 2013 with a 20% annual mortality rate. (Figure 9; Appendix Table A2). The increase in the adult population from 2013 results from recruitment of the relatively large 2010 year class in to the fishery. Of the estimated 442,000 adult walleye in the population, 36% are age-4 fish from the 2010 year class. This represents the largest year class at age-4 since 1987. Some caution should be exercised with projections from mark-recapture estimates based on estimated mortality rate. While we apply an annual mortality of 20% based on the most recent string of alternate year mark-recapture studies, it is more difficult to assess changes in mortality on the 3-year mark-recapture schedule because only one year class can be followed completely through the fishery with a 2 year gap. There is some indication following the 2007 year class through the 2010 and 2013 mark-recapture studies that high recent harvest rates may have increased annual mortality above 20%. Over the full span of our data series, the adult walleye population has exhibited a significant decrease, but has shown a significant increase since 2000 (Table 2). However, the increasing trend in adult walleye numbers since 2000 is influenced by the recovery associated with initiation of full season hazing of double-crested cormorants in 2004. Looking only at years with year classes that developed with full hazing in place (2007 and on), there is no trend in adult walleye numbers (Figure 9; linear regression: df = 6; F-ratio = 0.0008; r^2 = 0.0001; p = 0.98).

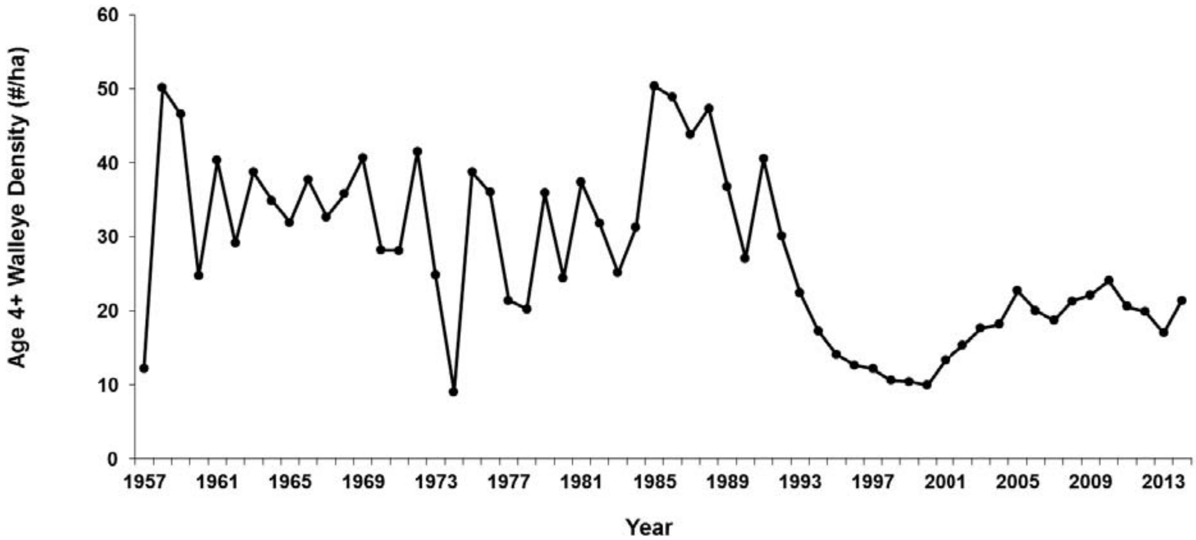

Figure 9. Density of adult walleye in Oneida Lake, New York, 1957-2014.

Table 2. Recent trends (2000-2014) in measurements of walleye abundance in Oneida Lake, New York. Significance levels are based on simple linear regression. Data are presented in Appendix Tables A2 and A4. Trend indicates direction (+ or -) over time, with r^2 and p reported for regressions. Significant trends indicated by bold type.

		2000-2014	
Variable	Trend	r^2	*P*
Adult (age 4+) population size	+	0.50	**0.003**
Larval density	-	0.02	0.60
October 1 age-0 density	-	0.03	0.53
Spring age-1 density	-	0.37	**0.02**

In past years, we predicted future walleye recruitment using the average of catches in trawls and gill nets of age-1 and age-2 walleye (Appendix Table A2). We estimate density of age-1 to 3 walleye from the average of the estimates from the trawl and the gill net using the age and gear specific catchabilities derived by Irwin et al. (2008) and predict future recruitment using the catchability-adjusted catches of age-1 and age-2 walleye (see Appendix Table A2). In the absence of a significant cormorant effect, the “best” model (determined using the Akaike Information Criterion) given the data for year classes 1957- 2004 includes the natural logarithm of age-1 and age-2 walleye abundance:

$$\mathrm{Ln(Age\text{-}4)} = -0.059 + 0.239\ \mathrm{Ln(Age\text{-}1)} + 0.593\ \mathrm{Ln(Age\text{-}2)} \qquad (1)$$

where Age-1, Age-2 and Age-4 are densities of walleye age classes in fish/ha.

Based on these relationships, our prediction for recruitment to age-4 in 2015 of walleye produced by the 2011 year class is 81,700 fish. Recruitment to age-4 of walleye produced by the 2012 year class in 2016 is predicted to be 121,700 fish. Projections for the 2012 year class should be viewed with caution, as they are driven by high catch at age-2. Indications at age-1 were that this year class was below average for recent years, so ultimate recruitment may differ from the current projection. Our harvest estimates for 2011-2014 (see below), when current regulations were in effect, have ranged from 54,000 to 60,000 fish annually. Over the long term, these harvest rates may be sustainable, but the population is not likely to increase substantially with only periodic large recruitment years.

Adult walleye length-at-age is determined from fish collected in fall (mid-September and later). For much of the data series, samples were primarily collected by bottom trawl, but electrofishing samples were integrated into length-at-age estimates during mark recapture years and during all years since 2010. Aging was conducted using scales through 2009, after which otoliths have been used. Long-term trends show a significant increase in fall length-at-age for age-4 fish (linear regression: df = 52; F-ratio = 22.47; $r^2 = 0.30$; $p < 0.0001$), and age-5 fish (linear regression: df = 52; F-ratio = 14.29; $r^2 = 0.22$; $p = 0.0004$) and a marginally significant increase for age-6 walleye (linear regression: age-5 - df = 50; F-ratio = 3.17; $r^2 = 0.06$; $p = 0.08$) (Figure 10). No significant trends in growth occurred over the period 2000-2014, although a marginally significant increase has occurred in length-at-age of age-5 fish (linear regression: age-4 - df = 12; F-ratio = 0.92; $r^2 = 0.07$; $p = 0.36$; age-5 - df = 13; F-ratio = 3.88; $r^2 = 0.23$; $p = 0.07$; age-6 - df = 13; F-ratio = 2.31; $r^2 = 0.15$; $p = 0.15$). Walleye growth has historically been dependent on availability of yellow perch, with gizzard shad and white perch providing additional forage in recent decades. The increase in the long-term length-at-age for age-4 walleye may be a result of the increased availability of food for younger walleye resulting from relatively regular production of summer-hatched gizzard shad year classes, which began in the late 1980s and early 1990s (He et al. 2005). With the establishment of round goby (see below), it is possible that we will observe increases in walleye growth. However, establishment of round gobies in Lake Erie did not result in changes in walleye growth (Johnson et al. 2005), and improved condition of only the largest walleye (>550 mm) was observed in Lake Ontario (Crane et al. 2015). Lake Erie walleye tend to rely more heavily on pelagic prey (Johnson et al. 2005) than in Oneida Lake where walleye have traditionally depended on demersal yellow perch, so it is possible round goby could play a more significant role in walleye diets in Oneida Lake than observed in Lake Erie.

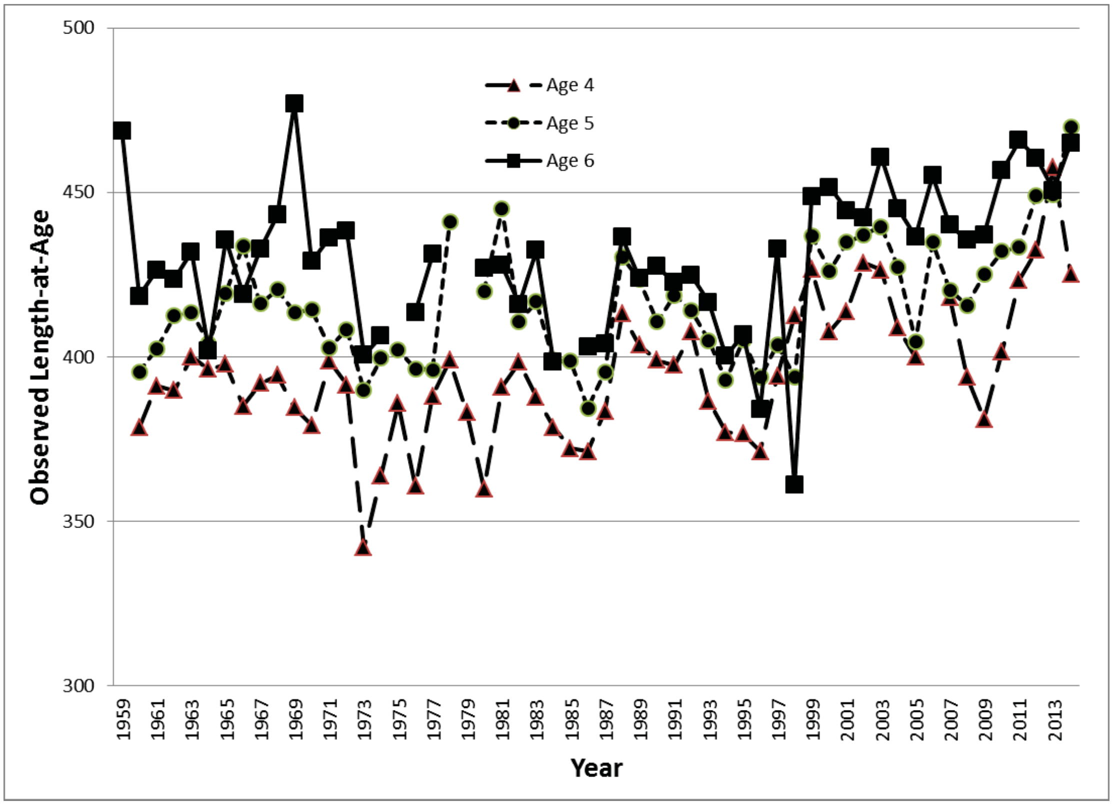

Figure 10. Observed length-at-age for ages 4-6 walleye from trawls in Oneida Lake, 1961-2014.

The Oneida Fish Cultural Station (OFCS) stocked 153 million walleye fry from 5-12 May 2014. The CBFS Miller sampler estimate of larval walleye density is conducted together with our first estimate of yellow perch larvae (at 8 mm length). In a subset of past years, walleye were assessed earlier, when average lengths were approximately 9 mm (9.4 mm, range 9.0-10.2 mm, N=18). In years when both the 9 mm survey and the yellow perch 8 mm survey were conducted, the larval walleye estimates from the two surveys were correlated ($r^2 = 0.58$, $p = 0.010$, N=10). With one outlier removed (2002, when few stocked walleye larvae survived a cold period after an early stocking date), the correlation improves ($r^2 = 0.88$, $p = 0.0002$, N=9). The equation is

$$WD_{YP} = 203.6 + 0.722\ WD_{9mm} \qquad (2)$$

where WD_{YP} is walleye density at the 8 mm yellow perch survey and WD_{9mm} is walleye density at the 9 mm survey, both in fish/ha. Our walleye larval index (Appendix Table A4) is the number of walleye larvae at the time of the 8 mm yellow perch survey, either measured directly or calculated from the 9 mm survey with this equation (years 1966, 67, 69, 99, 2000, 03, 04). The walleye larval abundance in 2014 was 1,457 fish/ha, similar to the long-term average of 1,581 larvae/ha (30 years, 1966 – 2014; Figure 11). There is a time trend of increasing larval walleye abundance over the entire time series, but no trend since 2000 (Table 2).

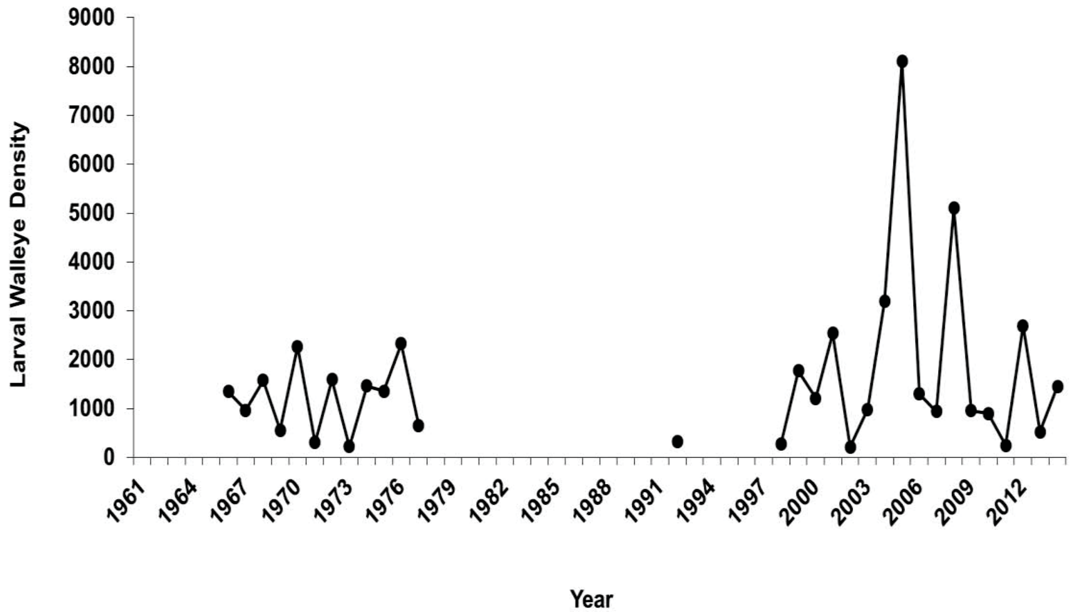

Figure 11. Time trends in density of larval walleye, Oneida Lake, New York, 1961-2014.

Age-0 walleye are monitored with weekly bottom trawl surveys at 10 standard stations from July through October. Catch per unit effort is translated to density in fish/ha assuming that each trawl samples an area of 0.1 ha and there is no avoidance by young fish. The 2014 age-0 fall walleye density estimate was 11.8 fish/ha on October 1. Average length on October 1 was 146 mm. Abundance was the highest observed since the 2010 year class, and the fourth highest since 2000 but still well below the long-term average of 30.4 fish/ha (Figure 12, Appendix Table A4). Since 2000, there is a declining, but non-significant trend in fall age-0 walleye density (Table 2). During recent years, poor walleye year classes are common, and "good" years represent much smaller year classes than observed prior to the 1990s when zebra mussels first established in the lake. The three largest year classes since 2000 (as measured by trawling) ranged from 14.3-19.2 fish/ha, whereas catches of 30 or more fish/ha were occurring at least every five years prior to 1992 (Figure 12).

The 2013 walleye year class density on October 1 was the fourth smallest on record (Figure 12), and captures from this year class in May 2014 trawling were also low compared to most other years of record (Figure 13). Densities of yearling walleye in the spring show a significant declining trend since 2000 (Table 2).

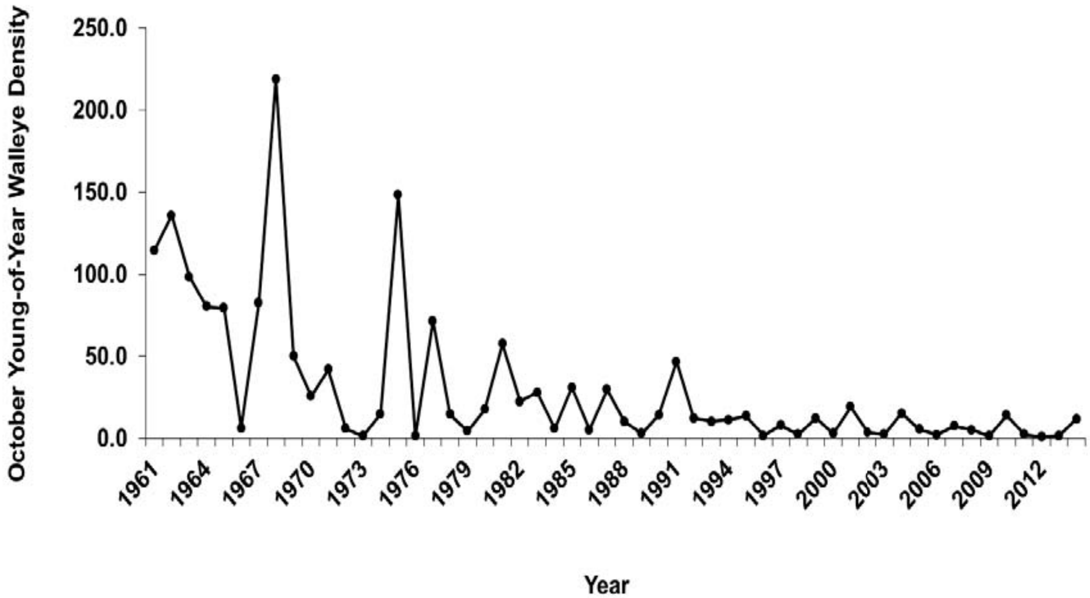

Figure 12. Time trends in density of age-0 walleye on October 1 based on bottom trawls, Oneida Lake, New York, 1961-2014.

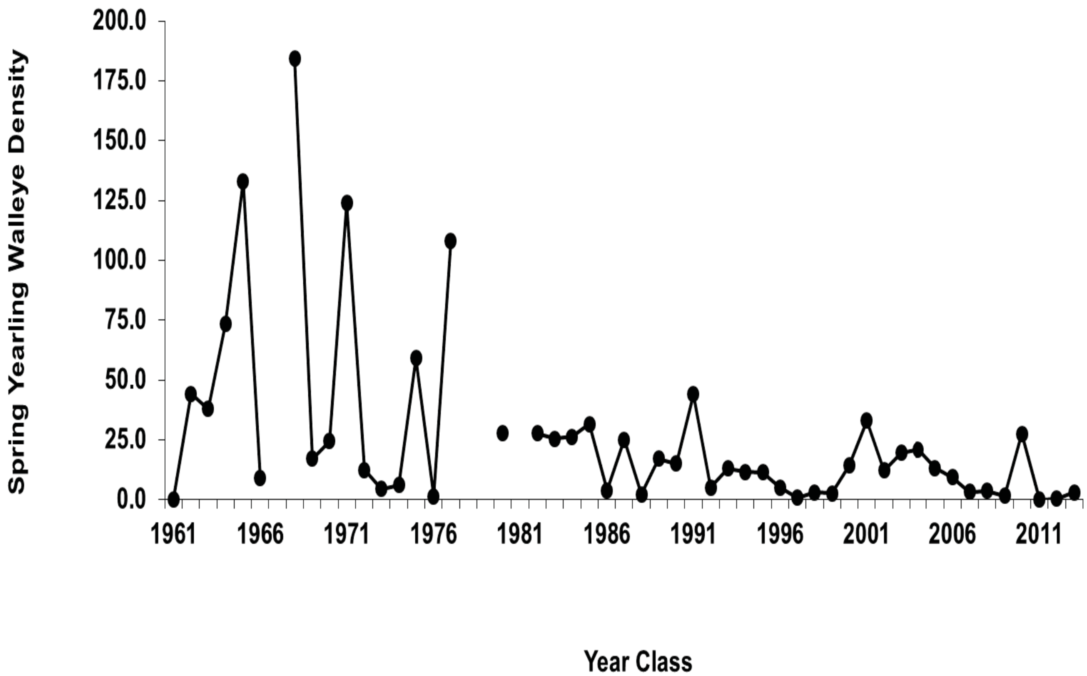

Figure 13. Time trends in density of yearling walleye in May based on bottom trawls, Oneida Lake, New York, 1961-2014.

The adult walleye population in Oneida Lake declined through the 1990s, and the current population has remained below 500,000 fish despite aggressive cormorant management. The 2014 adult walleye population estimate of 442,000 fish is similar to levels observed over the past 10 years, despite recruitment of a relatively large 2010 year class into the fishery. The 2011 year class appears to be modest in size, but the 2012 year class has shown good survival through age-2. Survival of age-0 walleye is low compared to years prior to establishment of zebra mussels, with higher mortality between the larval and demersal stages. Reduced first year survival may be attributable to higher predation mortality experienced as a result of clearer water following establishment of zebra mussels. Similarly, reduced production of age-0 yellow perch (see below) may increase predation pressure on fingerling walleye. In addition, increasing numbers of littoral predators such as smallmouth and largemouth bass may increase competition for forage. With current open water harvest rates conservatively estimated at 60,000 adult walleye and average recruitment to age-4 of 80,000 during the post-cormorant years, it is unlikely that the population will grow substantially. Nonetheless, even under the current levels of recruitment and an adult population consistently below historic levels, the walleye fishery appears sustainable, at least over the short term. Barring an increase in mortality rates, our analyses suggest that recruitment is sufficient to maintain a walleye population of between 300,000 and 500,000 adult fish over the next several years. With round goby now establishing in the lake (see below) we will need to assess if angler harvest rates are negatively impacted by the addition of an abundant food resource for walleye. If harvest rates decrease substantially, it is possible that even at current recruitment levels the walleye population could increase above current levels.

Yellow perch

Adult yellow perch numbers are estimated from the catches in standard gill nets and estimates of catchability (Irwin 2008). The yellow perch population in 2014 was estimated to be 596,000 age-3 and older fish (Figure 14, Appendix Table A5). While the adult yellow perch population had exhibited an increasing trend over the previous four years, 2014 catches suggest a 64% reduction in adult yellow perch numbers. Because our estimates are based on gill net catches, variability can be relatively high between years, and the dramatic nature of this decline may reflect, to some extent, this variability. Nonetheless, age-1 catches from the 2009-2011 year classes, which would represent the most recent recruits into the 2014 adult population, suggested consistent relatively small year classes. Additionally, the 2013-2014 ice fishing season was the first in some time that allowed an extended period of access to the entire lake, and ice fishing frequently accounts for much of the annual yellow perch harvest. The increases observed through 2013 likely resulted from relatively strong year classes produced from 2005-2008, and could also have benefited from limited ice fishing opportunities over several winters. Given the recent low recruitment of year classes and at least one year of enhanced harvest opportunity, it is reasonable to conclude that the decline in population size observed in 2014 is real, but additional years of netting will be required to assess the true magnitude of the decline. Catches of adult yellow perch in spring electrofishing (see below) have exceeded 90/hr in two of the three years that sampling has taken place, suggestive of a high abundance population (Forney et al. 1994). However, the 2012 electrofishing catch rate was 19/hr, more consistent with a low abundance population. Continuation of the long-term electrofishing will allow a better understanding of the relationship between our standard gill net survey and spring electrofishing catch rates. Long-term trends show a significant decline in adult yellow perch population size, but no trend is detectable since 2000, suggesting a more or less stable, but much smaller population over this time period than was present in the lake in the1960s-1980s (Table 3).

Table 3. Recent trends (2000-2014) in measurements of yellow perch abundance at various stages in Oneida Lake, New York. Significance levels are based on simple linear regression. Data are presented in Appendix Tables A5. Trend indicates direction (+ or -) over time, with r^2 and *p* reported for regressions. Significant trends indicated in bold type.

		2000-2013	
Variable	Trend	r^2	*p*
Adult (age 3+) population size	-	0.04	0.48
Larval density	-	0.02	0.63
October 1 age-0 density	-	0.005	0.81
October 1 Mean Length	-	0.04	0.48
Spring age-1 density	-	0.30	**0.04**
Summer age-1 density	+	0.11	0.25

We measure the abundance of yellow perch at the larval stage (two surveys - 8 and 18 mm), and as juveniles in bottom trawls through the summer, and again as yearlings in the trawls centered on May 1 (Appendix Table A6). We use the decline in catches in the bottom trawl to estimate age-0 yellow perch abundance on October 15. Larval yellow perch density in 2014 was nearly double that observed in 2013, but still indicative of a small year class (Figure 15). Fall densities of age-0 yellow perch were the highest since 2010, but lower than the 2007-2010 year classes, which presumably contributed to the increase in adult yellow perch numbers through 2013 (Figure 16). Spring yearling catches of yellow perch from the 2013 year class were the highest since 2008 (Figure 17). Long-term numbers show that the yellow perch population has exhibited a significant decline in larval production, fall age-0 densities and summer catches of age-1 fish (Irwin et al. 2009). As with walleye, the last decade has shown some moderation of the declining trends observed over the long-term, with no significant trends in abundance (with the exception of spring age-1 catches, which show a significant declining trend) detectable at any life stage (Table 3). The current level of annual production of young yellow perch does not appear sufficient to allow an increase in the adult population. In as much as yellow perch still represent the primary forage for adult walleye prior to gizzard shad recruiting to their diets in late summer and fall, mortality of age-0 yellow perch may remain high, and small yellow perch year classes could contribute to increased angler catch rates of walleye in the early season (see below) and act to limit growth of the walleye population. Establishment of round goby (see below) may provide an alternate forage for walleye and could ultimately benefit yellow perch recruitment.

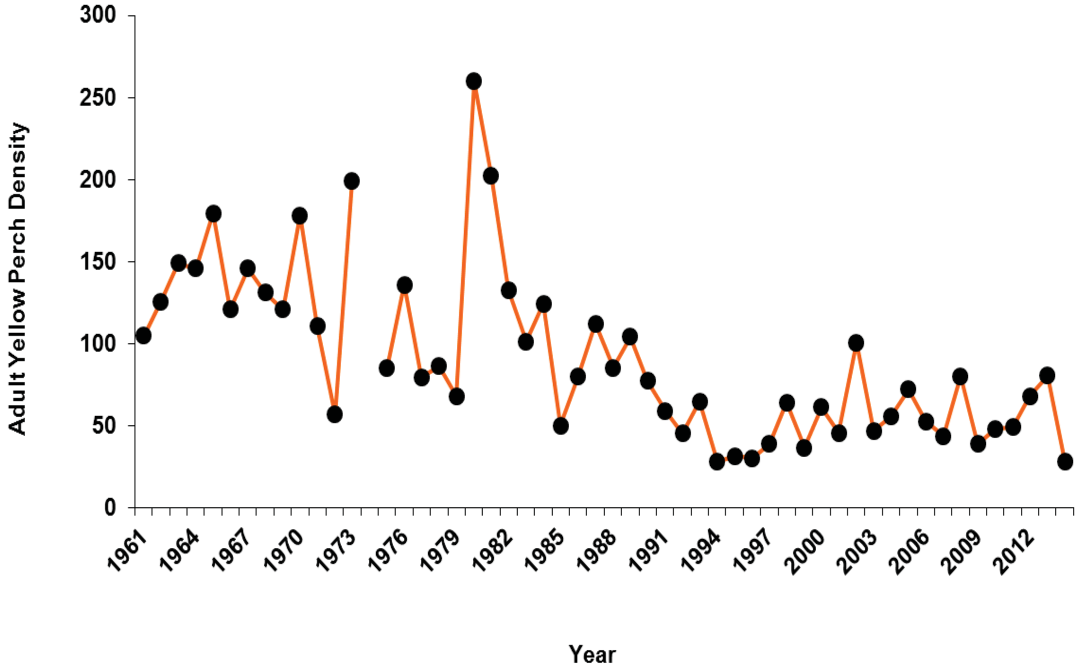

Figure 14. Time trends in age 3+ yellow perch densities (#/ha), Oneida Lake, New York, 1961-2014.

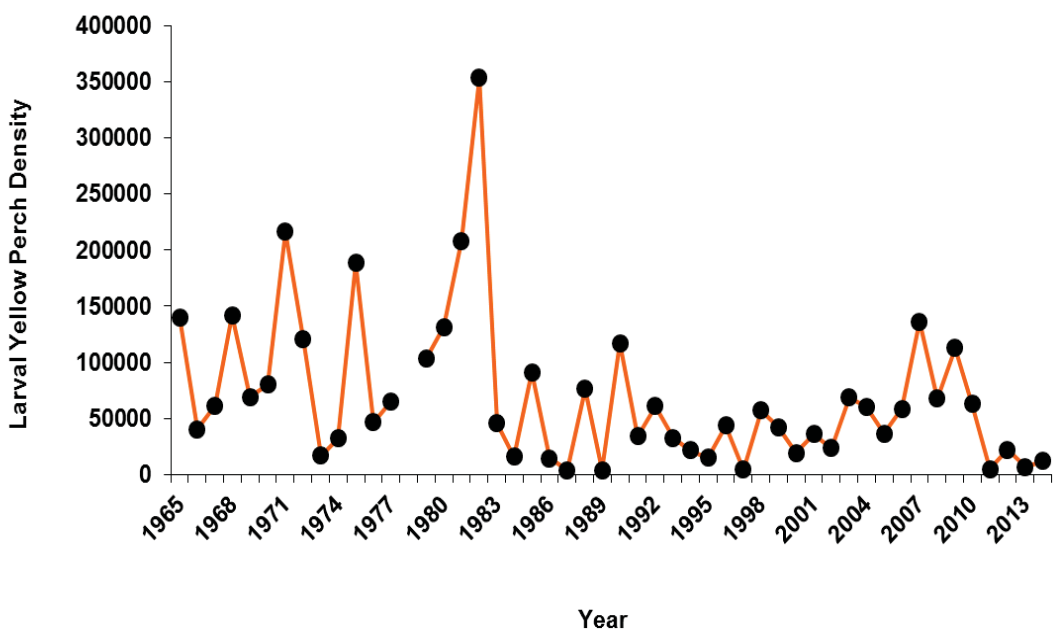

Figure 15. Time trends in larval yellow perch densities (#/ha), Oneida Lake, New York, 1961-2014.

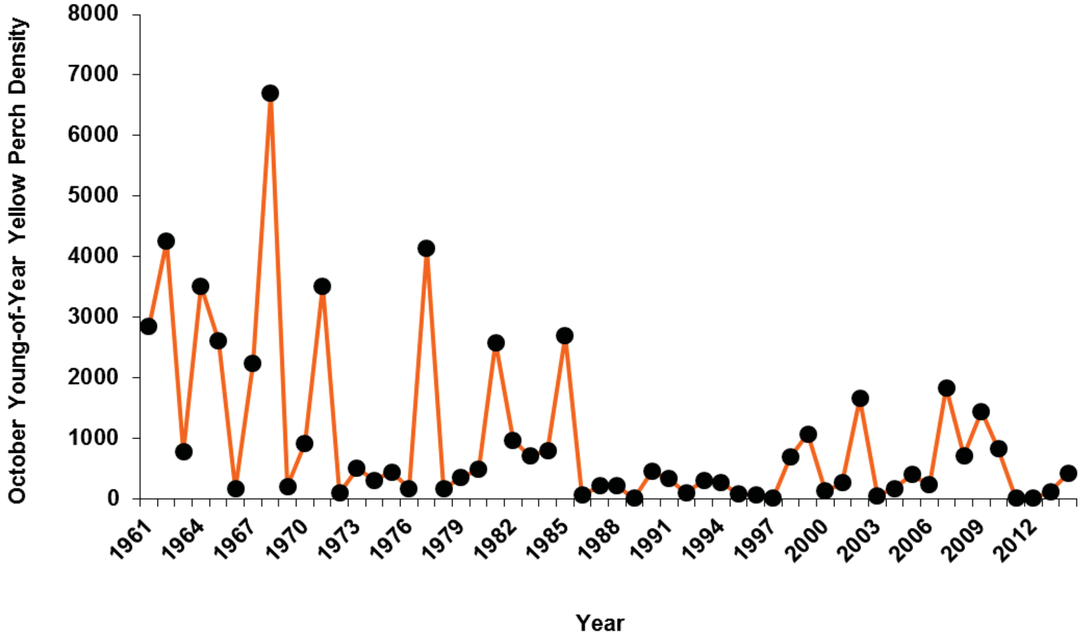

Figure 16. Time trends in fall age-0 yellow perch densities (#/ha), Oneida Lake, New York, 1961-2014.

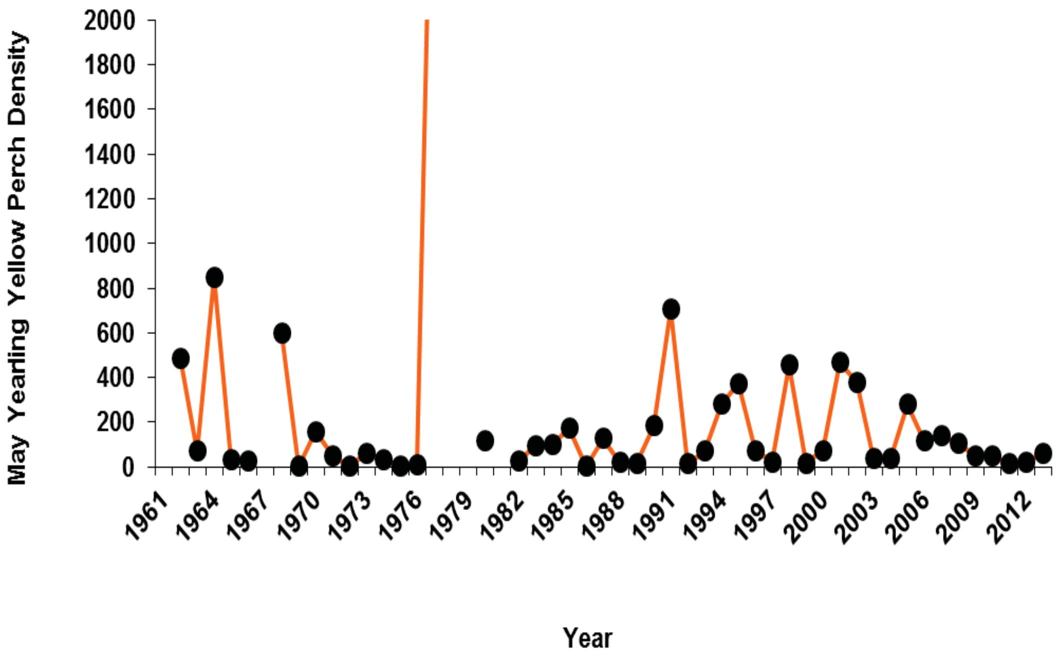

Figure 17. Time trends in spring age-1 yellow perch densities (#/ha), Oneida Lake, New York, 1961-2014.

White perch

Based on gill net catches, the white perch population in Oneida Lake increased sharply through the late 1990s and early 2000s (Figure 18). White perch catches in gill nets exceeded yellow perch in 2007, and 2009-2011 (Appendix Table A7). Recruitment is variable, but white perch produced age-0 catches suggestive of successful year classes at least once every three years from the early 1990s through 2004, but only one large year class has been observed since 2004 (2011, Figure 19, Appendix Table A7). Although catches of white perch have increased significantly following post die-off lows observed through much of the 1990s, we have seen no significant trends in catches of age-0 or adult white perch over the period 2000-2014 (linear regression: age-0 - df = 13; F-ratio = 0.84; $r^2 = 0.06$; $p = 0.38$; adult - df = 13; F-ratio = o.80; $r^2 = 0.06$; $p = 0.39$). White perch diets are similar to yellow perch, although they appear to feed more on larval and juvenile fish. Increases in white perch could therefore be part of the explanation for increased early mortality of larval percids. Given the relatively small year classes of white perch produced most years since 2005, it is reasonable to expect a decline in adult numbers over the next several years, which may benefit survival of larval percids.

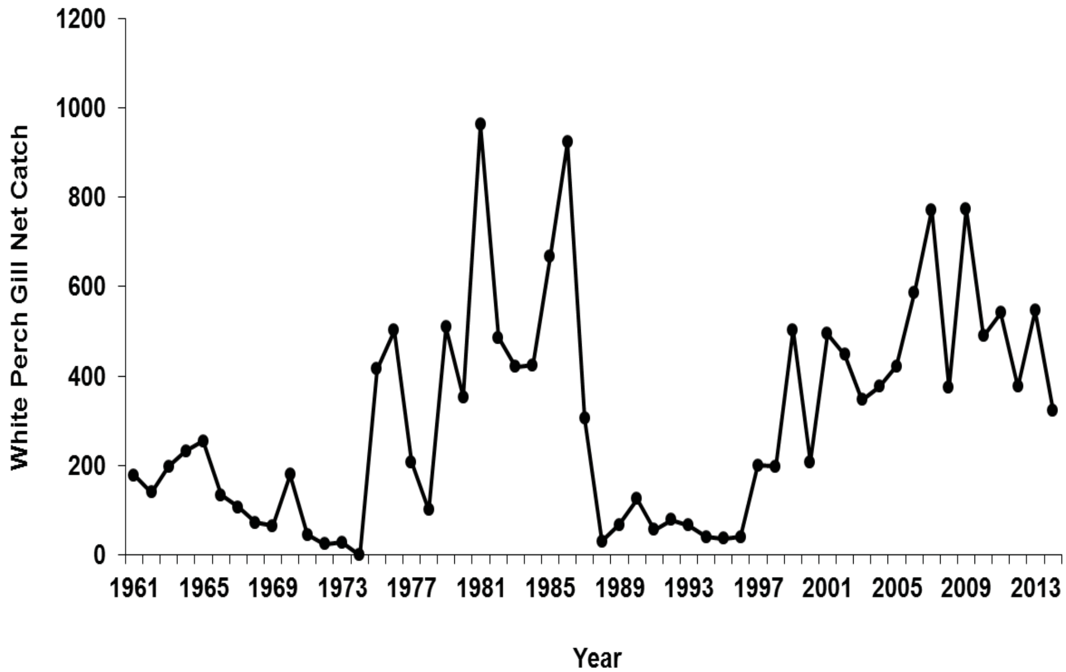

Figure 18. Time trends in gill net catches of white perch, Oneida Lake, New York, 1961-2014.

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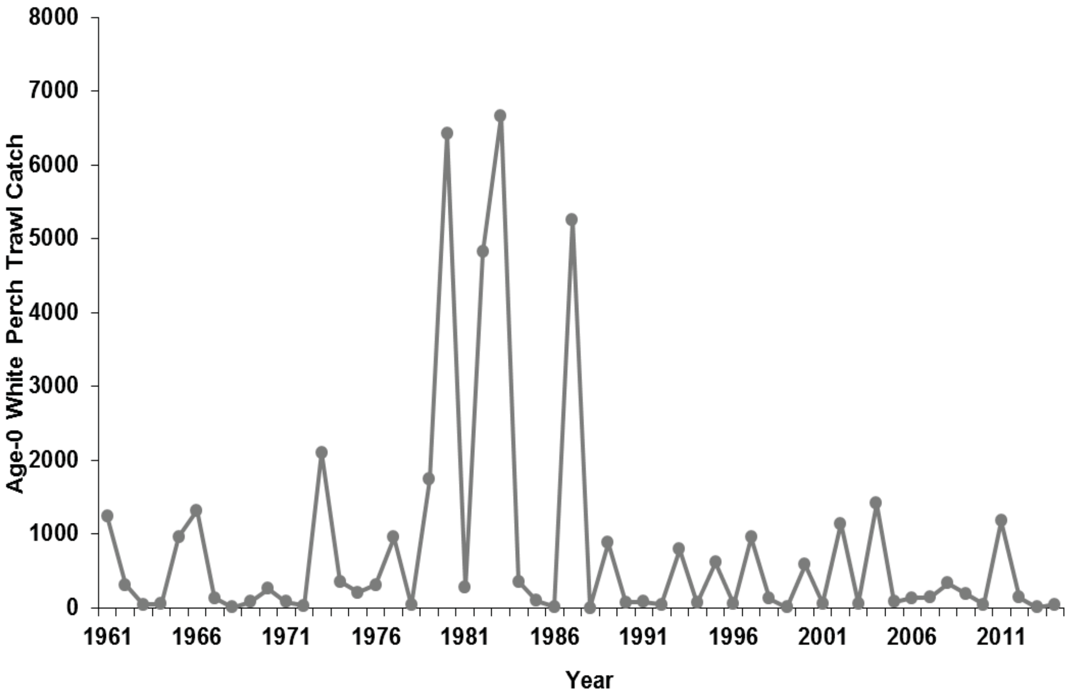

Figure 19. Time trends in age-0 white perch densities (#/ha), Oneida Lake, New York, 1961-2014.

Smallmouth bass

Smallmouth bass have become an increasingly important sport fish in Oneida Lake, and can also have large effects on littoral fish communities when abundant (VanderZanden et al. 1999; Lepak et al. 2006). Opening of a spring catch-and-release fishery in 2007 was met with some concern about potential impacts on young-of-year bass production, but our studies of potential impacts of spring fishing showed catches of age-0 smallmouth bass over the first six years following the opening of spring fishing were significantly higher than those from the six years preceding the regulation change (Jackson et al. 2015). Following a low catch of young-of-year smallmouth bass in 2013, catch in 2014 was the second highest on record (Figure 20). Catches of adult smallmouth bass in standard gill nets have been variable over recent years, but remain high relative to the 1970s and early 1980s. Catches in 2014 were well within the range observed over the period of increased population size (Figure 21). Over the period 2000-2014, we have observed a significant increasing trend in young-of-year catches (df = 13; F-ratio = 5.16; $r^2 = 0.28$; $p = 0.04$), and no trend in adult catches (df = 13; F-ratio = 0.06; $r^2 = 0.004$; $p = 0.81$). It appears that changes in lake condition, likely both clearer water facilitating foraging and warmer summer water temperatures contributing to increased year class success, have allowed the smallmouth bass population to reach a higher level than observed in the 1960s-1980s. We anticipate they will continue to be an abundant and important species in the lake's ecology and fisheries, and it is possible that round goby could enhance smallmouth bass populations. Lake Erie smallmouth bass showed improved condition at all ages after establishment of round goby (Steinhart et al. 2004a; Johnson et al. 2005). However, round goby do pose a potential threat to smallmouth bass as egg predators, and we will continue to monitor year class production to determine if there is a negative impact of round goby on smallmouth bass recruitment (Steinhart et al. 2004b).

Investigation of diets of smallmouth bass from June through October show that fish (age-0 and age-1 yellow perch, age-0 gizzard shad) are common, but a large part of the diet of smallmouth bass also consists of crayfish. Walleye are more piscivorous than either black bass species in Oneida Lake. The number of young walleye in the black bass diets (both species) is substantially less than the number found in adult walleye. More detailed analyses of this data set can be found in Fetzer (2013). While there is substantial diet overlap between the black bass and walleye, it is unlikely that competition is a key driver in the population dynamics of these species, but rather responses to physical and limnological conditions.

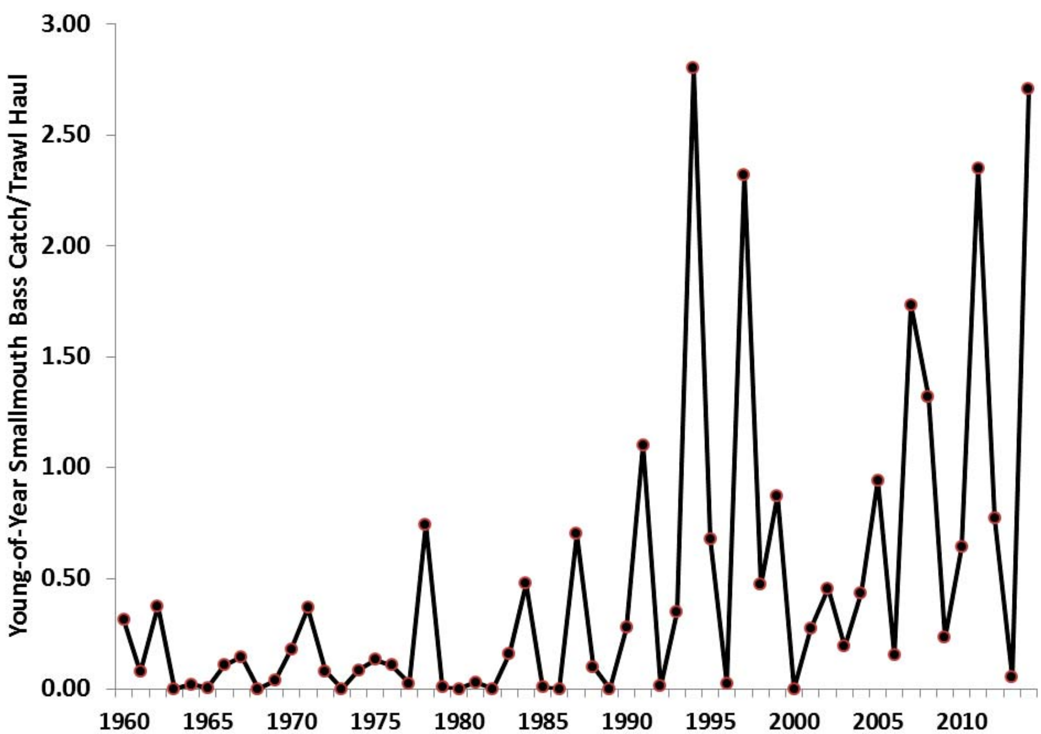

Figure 20. Time trends of age-0 smallmouth bass catches in bottom trawls, Oneida Lake, New York, 1960-2014.

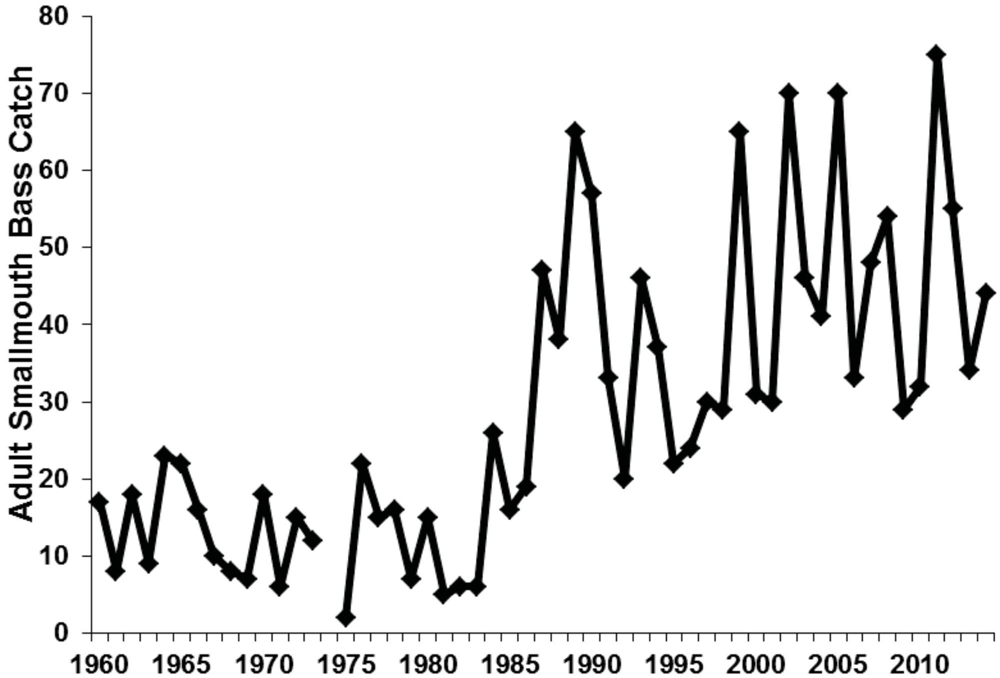

Figure 21. Time trends of adult smallmouth bass catches in gill nets, Oneida Lake, New York, 1960-2014.

Open water forage fish (gizzard shad and emerald shiner)

Pelagic fish biomass is estimated in the fall using hydroacoustics with supporting gill nets and mid-water trawling. Total pelagic fish density in 2014 was estimated to be 7,754 fish/ha of which 2,031 fish/ha were age-0 emerald shiner *Notropis atherinoides*, 774/ha were age-1 and older emerald shiner, and 4,946/ha were age-0 gizzard shad (Figure 22; Appendix Table A8). Biomass was estimated at 16.0 kg/ha, of which 11.4 kg/ha was gizzard shad. While gizzard shad abundance was the highest seen since 2010, biomass was the lowest observed since 2002 a result of slow growth (mean length 62 mm). Emerald shiner biomass was also below the long-term average. Gizzard shad were the most common diet item of walleye in October in 2014, accounting for 74% of identifiable diet items (Appendix Table A3). Observed density of gizzard shad shows a non-significant increase over the period 2000-2014, and biomass does not exhibit a pronounced trend (density - df = 13; F-ratio = 0.94; r^2 = 0.07; p = 0.36; biomass – df = 13, F-ratio = 0.03; r^2 = 0.002; p = 0.87).

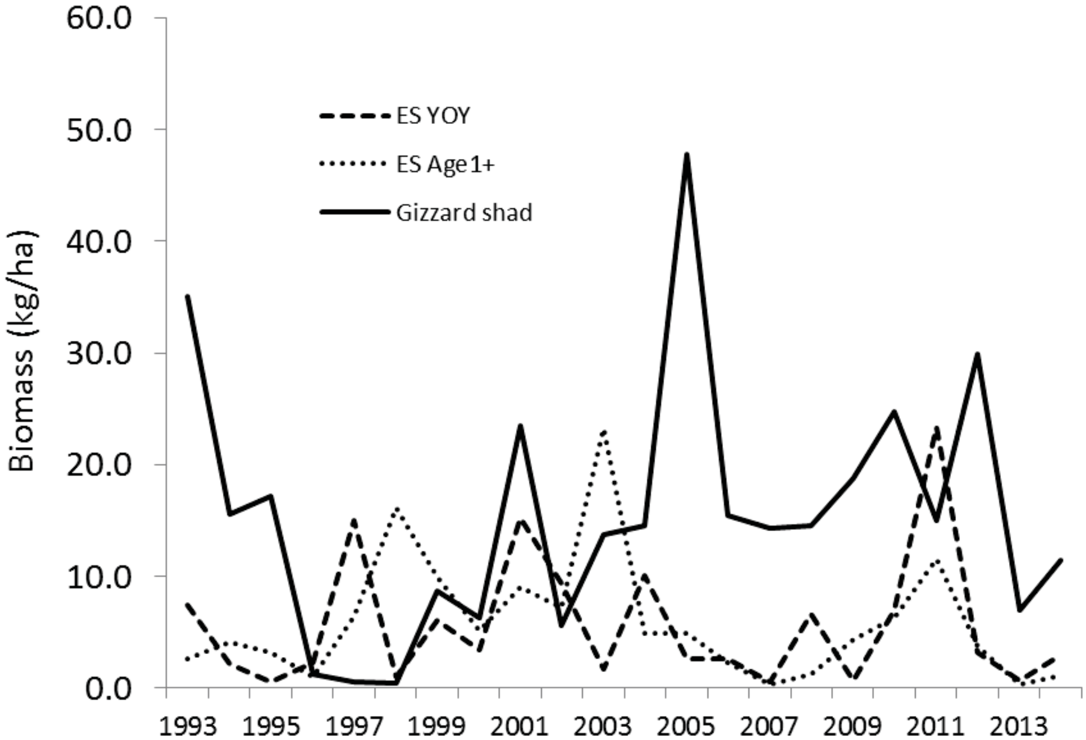

Figure 22. Time trends in biomass of open water forage fish from hydroacoustic estimates, Oneida Lake, New York, 1993-2014.

Lake Sturgeon

May and June lake sturgeon *Acipenser fulvescens* catches from directed sampling with large mesh gill nets in 2014 were the lowest and second lowest observed since sampling was initiated in 2002 (Appendix Table A9). The May gill net catch in 2014 was 0.09/hr (lowest previous catch was 0.17/hr in 2008), and June catches were 0.06/hr (lowest 0.04/hr in 2011). Prior to a stocking of 500 fish in 2014, no stockings had been conducted since 2004, so catches might be expected to decline. Length and weight data from collected sturgeon still indicate a population with fish in excellent condition that are growing at high rates. Positive evidence of successful reproduction by the stocked sturgeon population was obtained in July 2013 when a juvenile sturgeon was captured by standard gill netting. The fish hatched in 2011, indicating that some reproduction occurred in the lake when the oldest females were only 16 years old. An additional juvenile from the same year was captured by USGS personnel in Fish Creek in fall 2013. There is every reason to believe that some spawning now takes place annually in Fish Creek and possibly other tributaries to the lake, but no sturgeon produced by natural reproduction were captured in 2014.

Double-crested Cormorants

Double-crested cormorant management evolved through the 2000s, with seasonal management of nesting success and fall migrants during the early 2000s; near complete removal of cormorants from the lake with no successful nesting allowed from 2004-2009; nest control and fall hazing from 2010-2013; and full season hazing in 2014. Management since 2010 has been conducted by DEC following a period of management administered by the USDA Wildlife Services on Oneida Lake (2004-2009). Funding for the USDA program was lost prior to the 2010 season. The initial seasons after cessation of the USDA program saw low summer numbers of cormorants and no efforts to nest, but fall hazing was conducted by NYSDEC to push migrants off the lake. In 2013, summer cormorant counts and nesting efforts (12 nests produced chicks) exhibited increases and NYSDEC began implementing a full season hazing program in 2014 with a target goal of no more than 100 cormorants on the lake and no successful nesting. NYSDEC conducted weekly counts beginning 19 May 2014 through 29 October 2014. The average weekly count over the season was 204 birds. During the spring and summer (pre-fall migration), counts averaged 136 birds, and during the migration (19 August onwards) counts averaged 286 birds. Diets of 190 cormorants collected throughout the season were examined in 2014. Of the 1,117 diet items, 1,027 were identifiable to species. Diets were diverse throughout the season, with gizzard shad becoming most common by late August. Of the identifiable items recovered from stomachs, 72% were young-of-year or adult gizzard shad, 10% were yellow perch, and 7% were emerald shiner. No other species accounted for more than 3% of the total and only nineteen walleye were found in cormorant diets. Our analyses of cormorant diets over a 15-year span have found positive selection for schooling, soft-bodied prey such as gizzard shad when they are available, so buffering of potential impacts on percids by fall migrating cormorants should be realized in years when gizzard shad reproduce successfully (DeBruyne et al. 2013). Evidence from other systems suggests that round goby could act as an additional buffering species should they become abundant in Oneida Lake (Johnson et al. 2010). Given the increased hazing efforts and heavy use of gizzard shad, cormorants likely had a minimal impact on percids in 2014.

Round Goby

Round goby were confirmed in the Oneida River at the last barrier before Oneida Lake as early as 2010, but no confirmed reports came from within the lake until 2013, when anglers found them in yellow perch stomachs. No sampling by CBFS produced gobies in 2013 and none were observed in fish diets. In 2014, directed sampling for gobies with minnow traps and electrofishing at various sites in the lake in early summer produced gobies in the river section of the lake, but no gobies beyond the western most extremes of the lake. However, by late July, round gobies began to show up in standard trawl samples and by mid-August were encountered regularly throughout the lake (Figure 23). A single round goby was observed in a white perch diet and one in the diet of a young-of-year walleye during the season. These results suggest that gobies were present throughout most of the lake by the end of 2014, but at low densities. If they follow the pattern in other systems, we would expect to see an expanding population over the next few years. Continued sampling should allow us to detect any responses in terms of fish diets, growth and angler catch rates. We should be well-positioned to detect any longer-term changes in the fish community given both pelagic and littoral sampling have been underway for some time in advance of the arrival of gobies. In Lake Erie, round goby were detected in the diets of all piscivorous species examined, but significant increases in growth were only documented for smallmouth bass, yellow perch and burbot (Steinhart et al. 2004; Johnson et al. 2005).

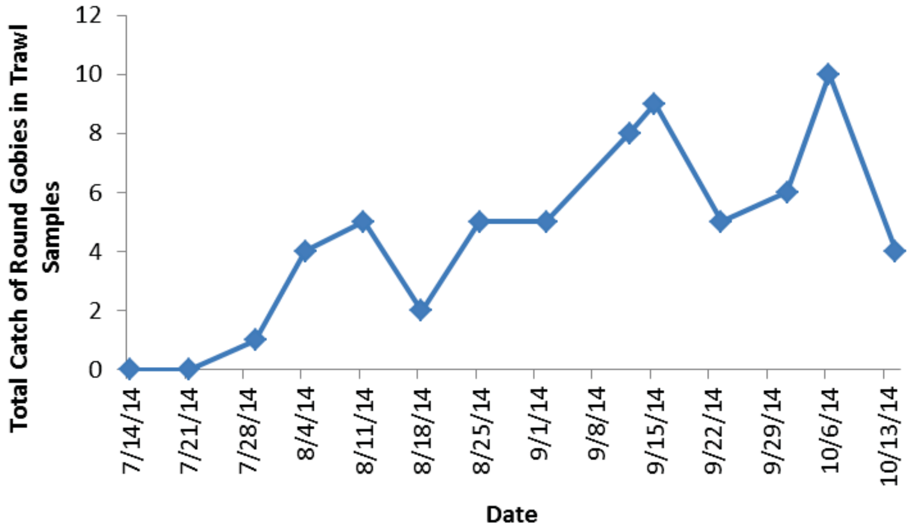

Figure 23. Catches of round gobies in standard bottom trawling in Oneida Lake, New York, 2014.

Nearshore Fish Community

<u>Fall Fyke Nets</u>

Catches in fyke nets in 2014 produced similar results to past years, with a total of 30 unique species represented. Catches of most species were within the range of past years (Appendix Tables A10 and A11). Catches in the 1/4" mesh nets averaged 145 fish/net-night, well within the range previously observed. Annual catches in this mesh are driven by production of young-of-year *Lepomis*, and 2014 produced only modest catches of these fish. Most commonly caught species were young-of-year *Lepomis* at 89/net-night, young-of year smallmouth bass at 9/net-night, pumpkinseed *Lepomis gibbosus* at 5.8/net-night, bluegill *L. macrochirus* at 4.7/net-night, rock bass *Ambloplites rupestris* at 4.2/net-night and young-of-year largemouth bass at 2.9/net-night. Catch in the ½" mesh nets averaged 436 fish/net-night, the lowest since we began sampling with this gear in 2007. Most commonly caught species were age 1+ yellow perch at 15/net night, pumpkinseed at 7/net-night, bluegill at 5/net-night, rock bass and young-of-year largemouth bass at 3/net-night and smallmouth bass at 1.9/net-night. In contrast with the adult gill net samples, catches of age 1+ yellow perch in fyke nets do not show a trend over the 8 years we have been collecting these data, and as with adult yellow perch electrofishing catches, further work will be needed to better understand the relationship between inshore and offshore catches of yellow perch. Catches of young-of-year largemouth bass in 2014 were the highest observed since sampling began in both mesh sizes, and young-of-year smallmouth bass catches were 2nd highest observed in the small mesh and 4th highest in the large mesh. Chain pickerel *Esox niger* catches in the larger mesh remained higher than when we first experimented with this gear, consistent with angler reports of increased pickerel numbers.

The fyke nets continue to produce catches of littoral species not represented in the traditional gears used in our long-term studies. They have provided our only index of young-of-year largemouth bass production, and also show potential as an index for sunfish and esocids. Fyke nets do not show potential as an index of adult bass, and an index of largemouth bass, in particular, requires shoreline electrofishing. Given increases in littoral vegetation, the fyke nets represent a potentially important index of species using these habitats, and will also provide valuable data on production of nesting centrarchids to assess potential impacts of round gobies, which were confirmed in the lake in 2013. Two round goby were captured in fyke nets in 2014, and as the population grows we will assess the utility of fyke nets as a potential index gear for them.

<u>Spring Electrofishing</u>

In spring 2011, we initiated a shoreline electrofishing survey directed at centrarchids. Sampling was initiated when water temperatures reached 20ºC. Eight sites were selected to both proportionally represent typical shoreline habitats in the lake and achieve spatial coverage of both the north and south shores. Each site is comprised of an initial 15 minute all fish pick up followed by a 1 hour predator sample and concluded with another 15 minute all fish pick up. Site selection was also designed to achieve overlap with as many fyke net sites as feasible in order to facilitate comparisons of community samples once a sufficient number of years of sampling have been completed. Spring centrarchid surveys are scheduled to be conducted 2 of every 3 years, with walleye mark-recapture years excluded.

After a skipped year due to the 2013 walleye mark-recapture study, spring electrofishing was conducted in 2014. Composition of the 2014 catch was similar to the initial years of this survey (Figure 24). Predator runs were dominated by largemouth bass (12/hr), followed by chain pickerel *Esox niger* (6.6/hr), walleye (4.8/hr), and smallmouth bass (3.7/hr; Figure 23). All fish runs were dominated by adult yellow perch (98/hr), age-1 yellow perch (51.5/hr), brown bullhead *Ictalurus nebulosus* (44/hr), pumpkinseed (42/hr), and rock bass (15/hr). While electrofishing catches of adult yellow perch in 2014 suggest a population at high abundance, our gill net index suggests a sharp decline in yellow perch numbers – a better understanding of the relationship between these two gears will require more years of electrofishing data.

Spring electrofishing provides a good compliment to fyke nets for assessing the nearshore fish community, particularly *Lepomis* spp. and provides our only index for adult largemouth bass and best index for chain pickerel. Timing of our initiation of electrofishing surveys is fortuitous, as we now have three years of surveys in advance of establishment of round goby to facilitate assessment of any community responses to this new invader.

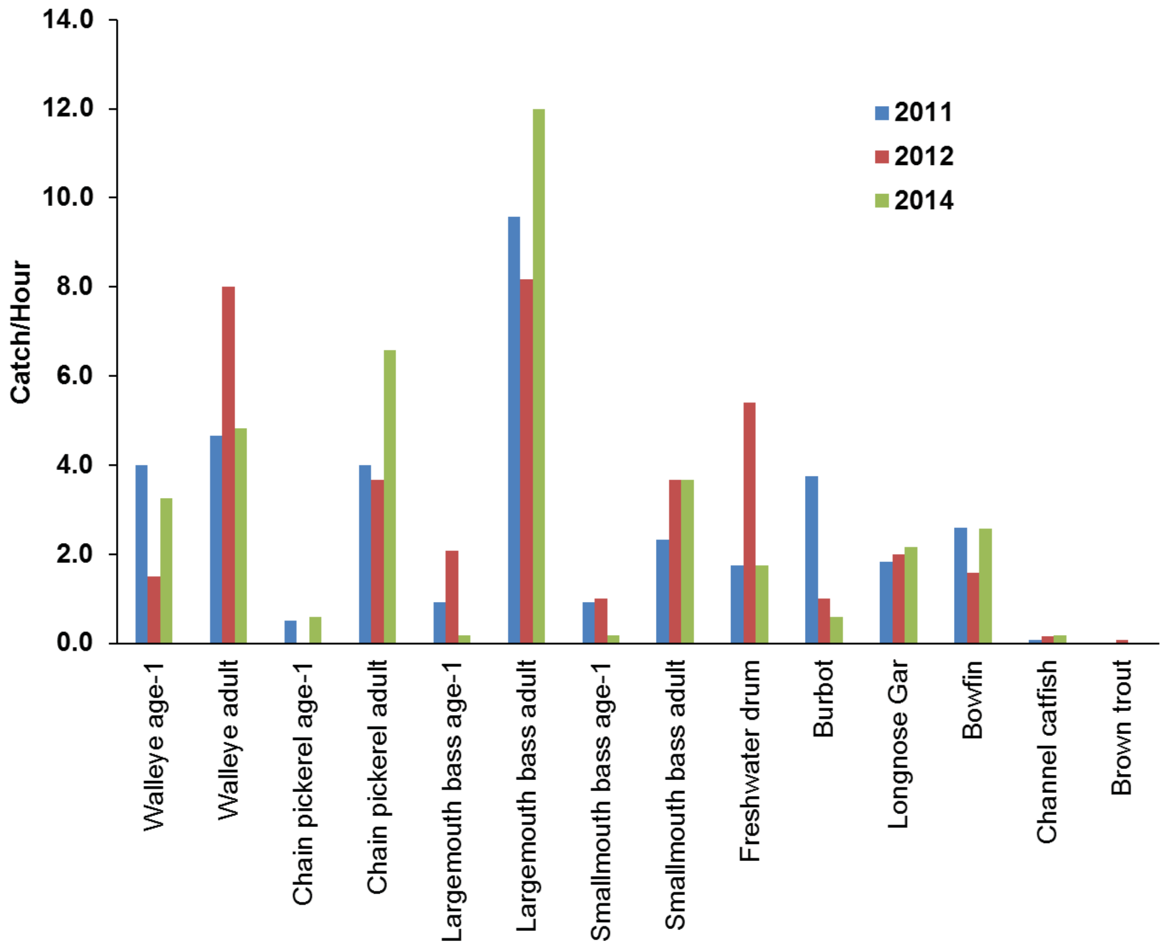

Figure 24. Catch rate (#/hour) of predators in spring electrofishing samples, Oneida Lake, New York, 2011-2014.

Creel Survey – Full Season Survey and Walleye Harvest

Methodology and General Results

Following the 2002-2007 creel survey (Krueger et al. 2009), we wished to develop a "low cost" survey that would allow monitoring of annual effort and walleye harvest without the dedication of resources required for a full scale survey. Analyses of seasonal patterns in walleye catch and harvest rates estimated during roving surveys for the entire open water season indicated a good predictive relationship existed between rates observed in

June and July and full open water season rates. Season walleye catch rate was predicted by the relationship:

$$CR = 0.694(JJCR) + 0.047$$

Where CR is the catch rate predicted for the entire open water season and JJCR is the mean of June and July catch rates ($r^2 = 0.94$; $p = 0.001$). Season walleye harvest rate was predicted by the relationship:

$$HR = 0.757(JJHR) + 0.012$$

Where HR is the harvest rate predicted for the entire open water season and JJHR is the mean of June and July harvest rates ($r^2 = 0.85$; $p = 0.009$).

While season walleye catch and harvest rates were predictable from summer data, no reliable relationship was identified for bass or yellow perch.

The current approach is to conduct the summer survey each year, using exit interviews conducted during June and July, with a complementary full open water roving survey every fifth year. The most recent roving survey year was 2013. For both surveys, effort is estimated by fixed point counts conducted from a tower from the opening of walleye season through the end of September. Counts are conducted at two random times on two randomly selected weekdays and both weekend days through the season and effort in boat hours calculated following the methods described in Krueger et al. (2009). Boat hours are converted to angler hours by multiplying by 1.98, the average party size calculated from exit interviews in June and July 2014. Exit interviews are conducted on two randomly selected weekdays and both weekend days during either a morning shift (0800-1400) or afternoon shift (1400-2000), also randomly selected. Exit interviews are conducted at three boat launches, South Shore Boat Launch, Godfrey Point Boat Launch and Oneida Shores, and location for each day is randomly selected. Catch and harvest rates are calculated using the ratio of means following methods described by Krueger et al. (2009). For the year 2014 we report results of the access survey.

Angler Effort

Effort during the 2014 open water season was estimated at 217,548 boat hours (Appendix Table A13). Effort in all four years of our new creel survey has been higher than observed in any year during the 2002-2007 creel survey, and exhibit a trend of generally increasing effort for the period 2010-2014. As is typical, effort was highest in spring and early summer, dropping off quickly through August and September.

Species Sought

Total number of access interviews conducted during June and July was 475. Of these anglers, 236 (50%) strictly sought walleye, while 165 (35%) sought only black bass. Anglers who sought some combination of walleye, bass, yellow perch and panfish comprised the rest of the sample. Of anglers seeking black bass, 61 (37% of bass anglers) indicated they were fishing in a tournament.

Based on past comparisons, access interviews can tend to reflect a higher percentage of effort directed at bass than roving interviews, likely because bass fishing attracts a higher percentage of anglers from outside the immediate lake area than walleye have historically. Nonetheless, 2014 data continue to show a higher level of effort targeting bass than we observed during the 2002-2007 survey, and may well account for much of the overall increase in effort we have documented since instituting the new survey.

Catch and Harvest Rates and 2014 Walleye Harvest Estimate

Festa et al. (1987), based on a survey of walleye fisheries in New York, suggested that walleye catch rates of 0.10-0.25/hr were characteristic of good to very good fisheries, with catch rates exceeding 0.25/hr considered excellent. For targeted catch rates, rates exceeding 0.20/hr were above average and rates approaching 0.50/hr were considered excellent.

Estimated catch rate for walleye (all anglers) from access surveys in the 2014 open water season was 0.16/hr in June and 0.33 in July (mean targeted catch rate for the June was 0.31/hr and for July 0.59/hr). Smallmouth bass catch rate (all anglers) was 0.49/hr in June and 0.25/hr in July (mean targeted catch rate was 0.89/hr in June and 0.51/hr in July).

Open water harvest rate for walleye for the June/July period used to predict harvest was 0.14/hr. Estimated total harvest of walleye for the 2014 open water season was 60,192 fish. Smallmouth bass harvest rate was 0.01/hr for the June/July period.

Angler Opinion and Behavior Survey

As a complement to the catch and harvest rate data collected from angler interviews, we added additional survey questions in 2013 directed at assessing angler opinions about the quality of the Oneida Lake fishery and its management as well as angler activities in areas of recent or current management concern. Five questions were developed with NYSDEC staff and incorporated in to angler interviews. Some questions were designed to allow tracking of opinions over time, and we report here the results of the first two years of the program. Over the long term, access responses will be collected every year, but roving surveys will only be conducted once every five years.

Question 1. On a scale of 1 to 5, with 5 being very satisfied, how satisfied are you with the overall quality of fishing on Oneida Lake?

Anglers indicated a high level of satisfaction with the quality of angling on Oneida Lake (Figure 25). Mean score in 2013 was 3.96 and in 2014 mean score was 4.14.

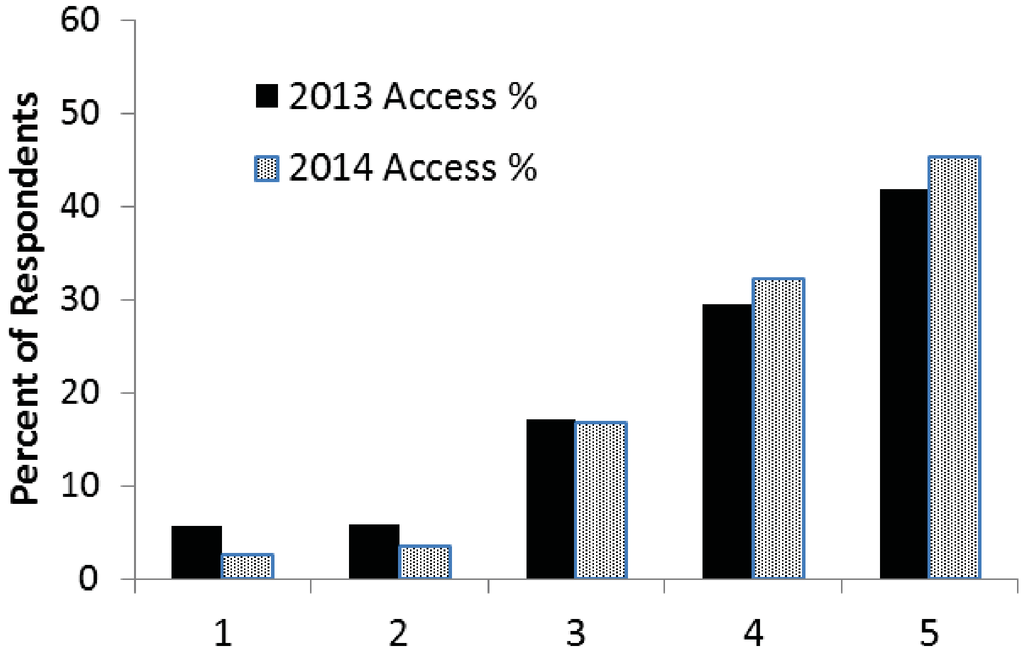

Figure 25. Angler level of satisfaction with overall quality of fishing on Oneida Lake from access interviews. 2013 survey N=489, 2014 N=475.

Question 2a,b. Have you fished for black bass during the spring catch and release season on any New York waters since the regulation changed? Have you fished the spring season for black bass on Oneida Lake?

Responses indicated substantial participation in the spring catch and release season for black bass (Figure 26). Interviews indicated that 32% of 2013 Oneida anglers had taken advantage of the spring bass season on at least one New York water, and 34% of 2014 anglers had. Responses showed a lower percentage of anglers interviewed had fished Oneida Lake for black bass during the catch and release season (Figure 27; 2013 – 17%, 2014 – 22%). The lower use of the spring season on Oneida Lake relative to other waters may reflect that anglers are less apt to travel for the catch and release season, and tend to fish waters closer to home prior to the tournament season.

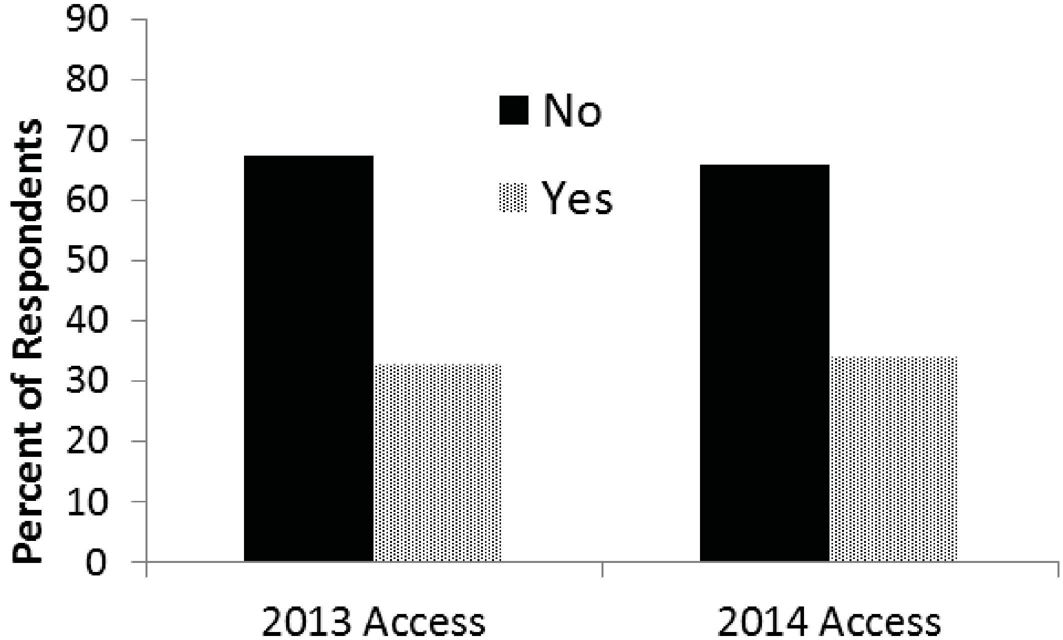

Figure 26. Percent of anglers interviewed who indicated they had fished for black bass during the spring catch and release season on at least one New York water since the regulation changed. 2013 N=490, 2014 N=475.

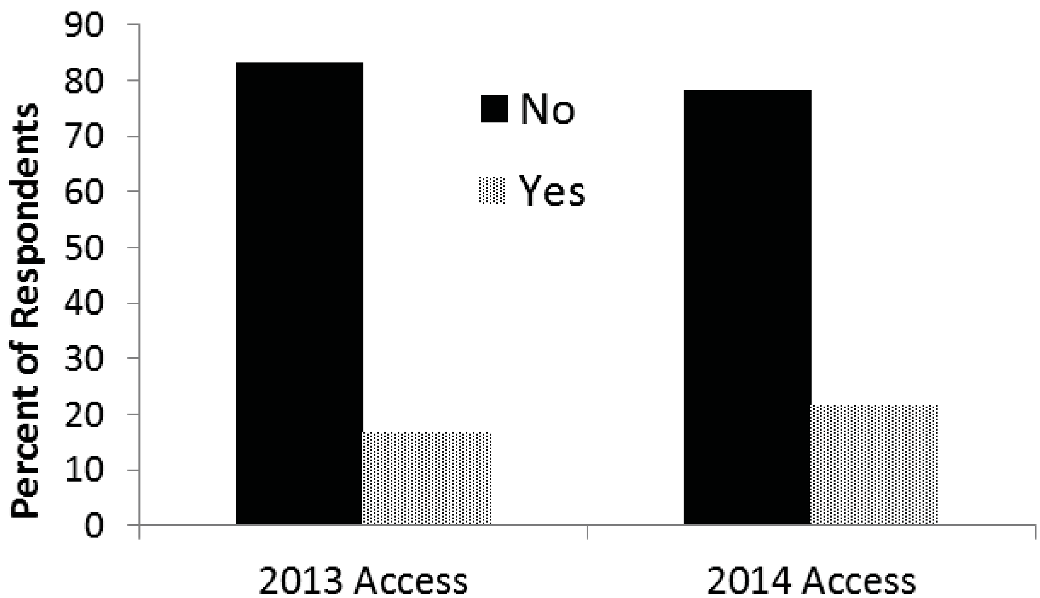

Figure 26. Percent of anglers interviewed who indicated they had fished for black bass during the spring catch and release season on Oneida Lake. 2013 N=489, 2014 N=475.

Question 3. What is your opinion about the current daily possession limit for walleye on Oneida Lake? a – continue as is, b – change to statewide possession limit.

Results indicated that a majority of anglers from both years of interviews felt the current 3 fish possession limit for walleye should continue (Figure 28).

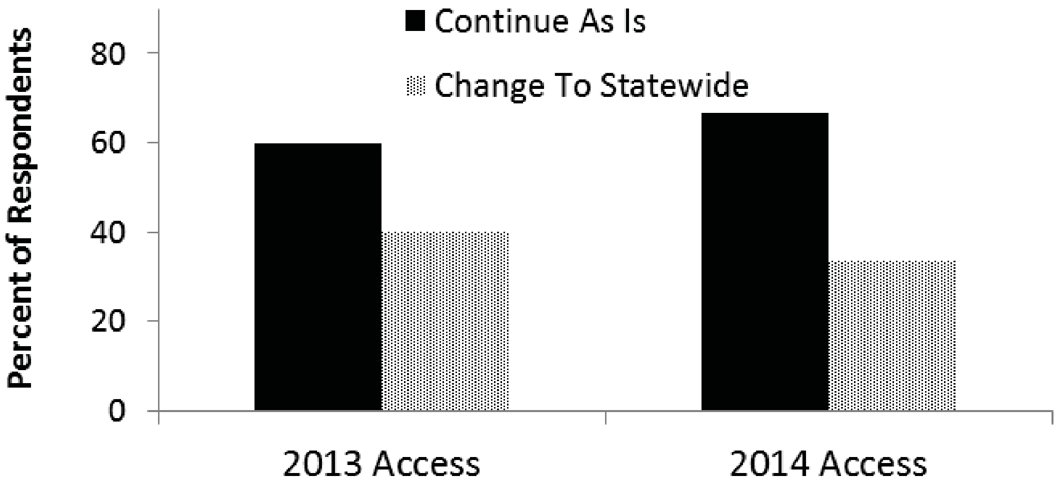

Figure 28. Angler opinions on the current daily possession limit for walleye on Oneida Lake (3 fish) as opposed to a change to the statewide limit (5 fish). 2013 N=399, 2014 N=338.

Question 4. On this fishing trip, which of the following have you fished with? a – artificial lures, b – natural baits, c – both.

Artificial lures were the most commonly used technique in both years of interviews (Figure 29). Natural baits were commonly used and a quarter or more anglers reported using both, likely a function of the popularity of worm harnesses and jigs tipped with worms in the Oneida Lake walleye fishery. Of natural baits used in 2014, interviews revealed 216 anglers using worms, 2 using crayfish, 6 using baitfish, and 2 using leeches.

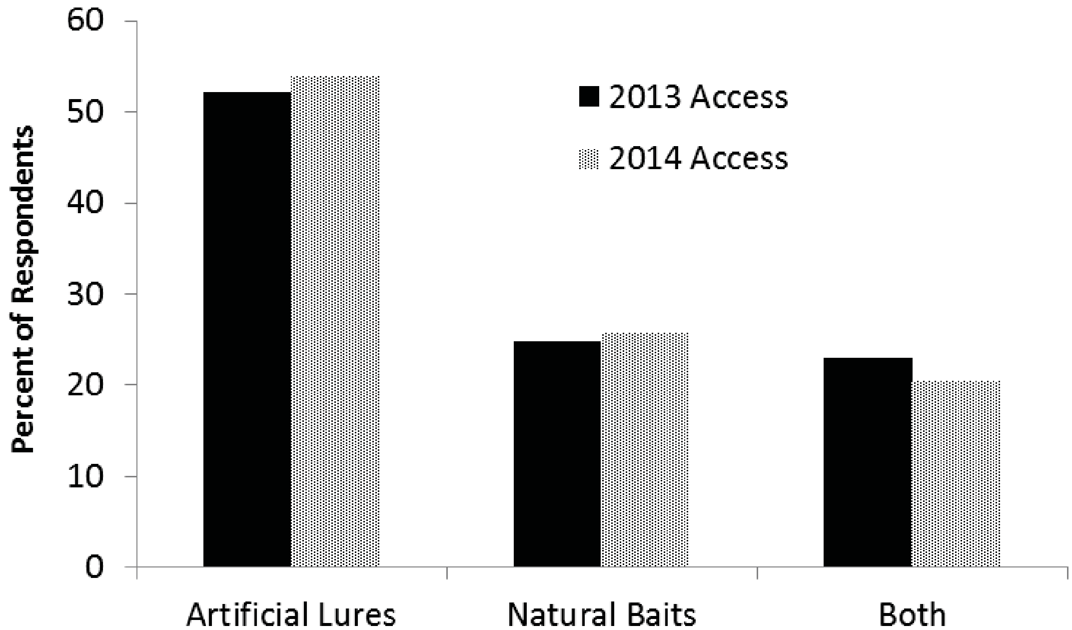

Figure 29. Percentage use of artificial lures and natural baits by anglers on Oneida Lake. 2013 N=736, 2014 N=475.

Question 5. On a scale of 1 to 5, with 5 being very satisfied, how satisfied are you with the job the DEC Bureau of Fisheries does managing Oneida Lake?

Anglers indicated a high level of satisfaction with DEC's management of Oneida Lake, with an average satisfaction score of 4.22 out of 5 (Figure 30). Satisfaction with DEC management of Oneida Lake has exceeded satisfaction with the quality of the fishery from both years of interviews.

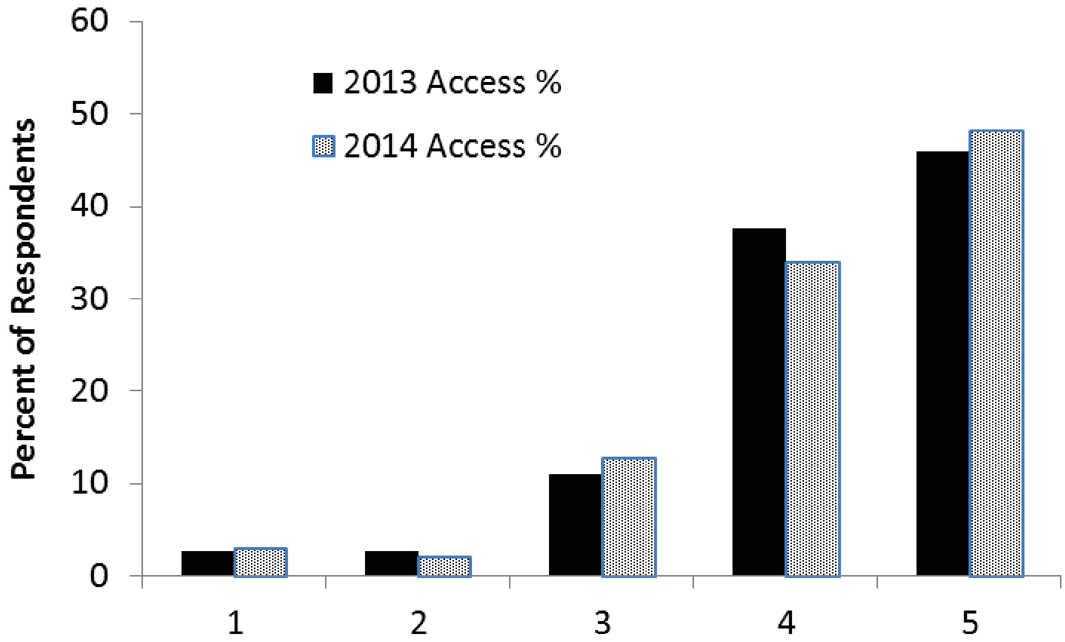

Figure 30. Angler level of satisfaction with management of Oneida Lake by the DEC Bureau of fisheries. 2013 N=899, 2014 N=438.

Recommendations for management and future research directions.

Over the duration of our research on Oneida Lake, we have identified several ecological changes, most ongoing, that are likely to affect the fish community in Oneida Lake. These have included warming water temperatures, species invasions, and increased water clarity resulting from dreissenid mussels and reduced nutrient inputs. The data collected in 2014 are consistent with previous indications that the lake has undergone changes in physical characteristics and productivity at the lower trophic levels. Water temperatures and ice duration continued to reflect warmer conditions than when studies were first initiated, and water clarity remained well above levels observed in the earliest years of our studies. Oneida Lake presently fits the overall characteristics of a mesotrophic system (although phosphorus levels are in the lower eutrophic range, this has not translated to higher phytoplankton production or reduced water clarity), with reduced primary production from early decades of our studies when the lake was classified as eutrophic. Much of the productivity has shifted from the pelagic to the littoral zones, including dramatic increases in littoral macrophytes and benthic algae production (Cecala et al. 2008), with concomitant increases in abundance of nearshore fish species. We are now seeing signs of reduced *Daphnia* spp. production, a typical response to dreissenid colonization, but one that was not evident in the first decade following mussel establishment. Clearer water conditions appear to have reduced survival of pelagic walleye and yellow perch fry, resulting in lower average year class size and recruitment to subadult stages than was typical of the lake before major ecological changes were observed.

Cormorant predation on subadult stages resulted in decreases in recruitment to the fishery, and the establishment of a cormorant management program contributed to increases in adult walleye numbers, but we have not seen an increase in yellow perch numbers as cormorant management has continued. During the first three post-management years, summer cormorant numbers were low, and little or no nesting effort was observed. In 2013, we observed an increase in the summer cormorant population to around 300 birds, and 20 active nests were observed with some production of chicks. In 2014, NYSDEC hazing efforts expanded to include the entire season and no successful nesting was allowed, and these efforts reduced the resident numbers of cormorants to numbers more consistent with the years prior to 2013. NYSDEC hazing efforts contribute to keeping predation pressure by cormorants at levels that are well below those observed prior to any management being implemented, and gizzard shad commonly buffer much of the impact in the fall. At present, cormorant management efforts have likely minimized impacts. While the lake supports an excellent fishery for walleye, and should continue to do so even under the new conditions, our analyses suggest that recruitment is no longer sufficient given current harvest rates to expect the population to rebuild to levels observed in the 1960s and 1970s. Similarly, yellow perch recruitment has also declined to a new, lower, average level in the last decade, and it is likely that the adult perch population will also stay well below its historic highs. If yellow perch densities are in part limited by productivity, it is also possible that increases in the white perch population may act as a constraint on the size of the adult yellow perch population. Both yellow perch and white perch have experienced multiple years of poor recruitment recently, and declines in the adult populations appear likely. Smallmouth bass have benefited from changes in the lake, and the population has reached higher levels than were observed in the 1960s and 1970s. Based on trends in young-of-year production, there is no reason to think this will not remain the case. Oneida Lake offers diverse, high quality fishing opportunities, and should continue to do so, but all indications are that the fish community has changed as a result of larger ecological events. With increased production of littoral species and reduced abundances of pelagic species, it does not appear practical to use benchmarks established in the 1960s and 1970s as gauges of what is realistic today. While the walleye fishery remains predominant, the black bass fishery has received national attention and gained in popularity. The increased abundance of pickerel also offers an alternative to the traditional fisheries of Oneida Lake, but we see little evidence that pickerel are a popular target for anglers.

The round goby is now establishing in the lake, and if it reaches high densities we may see several responses in our data series. Growth of adult walleye, yellow perch and bass may increase if gobies provide an abundant food resource. The round goby spawns multiple times in a growing season, and may provide a prey resource for young-of-year walleye and bass throughout the summer which could improve growth, and presumably survival. Predation on young-of-year yellow perch may decrease if goby provide a buffer, and we may see enhanced recruitment. Cormorants may also shift to feeding on gobies, which, in conjunction with continued hazing, would further reduce their impacts on walleye and yellow perch. However, round gobies have potential to negatively impact native fishes through egg predation, particularly nesting species such as the centrarchids. Gobies could also negatively impact angler catch rates by providing an abundant food source for piscivores Continuing analysis and monitoring of the Oneida Lake data set should give us information on the response to these ongoing ecological changes that are relevant not only to Oneida Lake, but also to the northeastern US and southeastern Canada.

A baseline data series is essential for evaluating system responses to ecological change. In addition, we have recently completed analyzing cormorant-percid interactions by observing the response of the Oneida Lake fish community, in particular walleye and yellow perch, to the removal of most cormorants from the lake. This represents a whole lake management experiment, and it is important that this effort is evaluated thoroughly. Results will be submitted for publication soon. These results should inform similar cormorant management activities that are ongoing in other lakes in the US and Canada.

Angler harvest of walleye in 2014 was the third in a row with an estimated harvest of nearly 60,000, the highest we have recorded in the modern era. High harvest in Oneida Lake could result from both increased effort and high early season catch rates. It is likely that high spring and early summer catch rates result from low densities of yearling yellow perch, with late summer catch rates sensitive to the size of the age-0 yellow perch year class. Catch rates typically decline precipitously once gizzard shad recruit to walleye diets in the fall. With continued low recruitment of yellow perch to age-1, walleye catch rates in the early season could continue at high levels, resulting in harvest that will limit population growth and could result in declines in the walleye population. Establishment of round goby could change this dynamic, but until that time, high spring and early summer harvests of walleye could become the norm. The large 2010 walleye year class has pushed the population to near 450,000 fish, but with modest year classes following and high angler harvest rates, the increase in adult walleye numbers could be short-lived.

Recommendation for current management: Fisheries management on Oneida Lake includes stocking of walleye larvae, size and creel limits for walleyes, black bass, and other species, and control of cormorants. We recommend maintaining these efforts and regulations at current levels in 2015-2016.

Stocking of walleye larvae. Continue stocking at current levels. This will maintain a consistent supply of walleye larvae to the lake and makes walleye less sensitive to potential increases in egg predation from a future abundant gobid population. Our best estimates suggest that the number of naturally produced walleye larvae in the lake is about 33% of the numbers stocked.

Size and creel limits for walleye. The adult walleye population was estimated at 442,000 fish in the spring of 2014. High harvests in recent years likely act to offset recruitment from the smaller year classes observed in many years, and large year classes capable of sustaining multiple years of harvest are now rare. Despite the declines in walleye numbers, we still do not see large year classes of yellow perch surviving through the first year of life, suggesting that predation pressure is still high. Poor survival of yellow perch in the lake does not indicate a need for building the current population of walleye without first observing improvement in the annual production of yellow perch. Therefore, we suggest maintaining the current size limit for Oneida Lake walleye at 15 inches. The 3 fish creel limit is a conservative approach to reduce impacts of poor walleye recruitment. The 2010 year class has added to the population, but the increase is not likely to last long enough to consider implementation of a 5 fish creel limit.

Cormorant control. We have observed an increase in the walleye and yellow perch populations concomitant with more intensive cormorant control, although not to historic levels. This suggests that removing cormorants does increase percid recruitment to the fishery. More intensive cormorant control by APHIS was conducted from 2004-2010. Our data do show that a rebuilding of summer cormorant numbers will likely reduce subadult walleye and yellow perch survival, and potentially reduce populations to the point where current harvest rates are not sustainable (DeBruyne 2014). Initial response of cormorant numbers to absence of hazing has led to only modest increases in summer numbers, and fall hazing combined with buffering by gizzard shad has reduced the potential impacts of the migrant population. Higher summer cormorant numbers in 2013 resulted in instituting full season hazing and nest control in 2014. Continued efforts should be made to find a workable approach to limiting cormorant numbers and preventing the rebuilding of a large summer population.

Given the results and discussion in this report, we recommend the following research and monitoring activities in 2015:

1) Continue standard sampling program. This program includes limnological surveys, two larval fish sampling surveys (8 and 18 mm yellow perch surveys), 15 standard gill nets, weekly trawl surveys from mid-July through October, pelagic prey fish survey with acoustics, midwater trawl and pelagic gill nets at the end of August, spring electrofishing in years when no walleye mark-recapture study is being conducted, fyke net sampling for nearshore fish in September, and large mesh gill nets for sturgeon.

2) Complete preparation of the manuscript resulting from the evaluation of cormorant management on percid populations by PhD student Robin DeBruyne. This has been a collaborative project with USDA-APHIS.

3) Increase attention to the importance of changing spatial distributions of age-0 yellow perch. Add summer seining to complement trawling in order to sample yellow perch in both offshore and nearshore habitats. Replace one weekly trawl sample per month with a seine survey one week per month from June to September. Combined trawling and seining may also provide a potential inshore/offshore index of round goby.

4) Continue fyke net sampling as a means to monitor changes in the nearshore fish community, particularly with the arrival of round gobies. Continue spring centrarchid electrofishing surveys in non-walleye mark-recapture years. Ultimately, when sufficient years of spring electrofishing are available, conduct comparisons of fyke net and electrofishing as means to assess nearshore fish communities.

5) Continue the low cost creel survey for monitoring of catch rates and angler use of the lake.

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Appendix 1: Data collection methods

Limnology. Zooplankton samples are collected weekly (May-October) from 1-5 sites with a 153 um mesh nylon net (0.5 m diameter) using a vertical tow from 0.5 m above the bottom to the water surface. Samples are preserved in 70% ethyl alcohol (8% sugar-formalin solution 1975-1996). Zooplankton are identified, counted, and measured (to the nearest µm) using a digitizing tablet and microscope (1998 – present). Previous methods include use of a dissecting microscope and calipers (1975-1982), and a touch screen setup with computer-assisted plankton analysis system WSAM (1983-1997) (Hambright and Fridman 1994). Mean May-October biomass is calculated from weekly averages using the length – weight regressions in Watkins et al. (2011). These values are in dry weight. Integrated water samples for total phosphorous (TP) and soluble reactive phosphorous (SRP) are collected using a 1.9 cm inside diameter Nalgene tube lowered to a depth of 1 meter above bottom, and frozen for later analysis. In the lab, a 50 mL aliquot of unfiltered water is analyzed for TP using the persulfate digestion method (Menzel and Corwin 1965). For SRP, lake water is filtered through a Whatman 934-AH glass fiber filter and a 50 mL aliquot is analyzed using the molybdate method of Strickland and Parsons (1972). For chlorophyll-*a* measurements, lake water (up to 2.0 L) is filtered through Whatman 934-AH glass fiber filters and the filters are assayed using the acetone extraction method (Strickland and Parsons 1972). Annual averages are calculated as the average of weekly values collected at 1 to 5 stations from May to October. All 5 stations are included when available, except for Secchi depth from the shallow station (Three Mile Bay) because the Secchi disk is sometimes observed on the bottom. Beginning in 2010, one site (Buoy 117) was dropped from standard sampling and a new sampling protocol for water chemistry was developed. Four sites were sampled each week, and on week 1 water samples were processed by individual stations as in 1975-2009. On weeks 2-4, water from all four sites was pooled for analysis. This rotation was maintained throughout the sampling season. Samples were pooled for water chemistry only, not zooplankton. Beginning in 2009, nutrients samples were analyzed at the Upstate Freshwater Institute (UFI). This EPA approved laboratory uses SM 18-20 4500-P E for TP and SRP, and SM 20 4500-SiO2 C for SRS (APHA). Beginning in 2013, chlorophyll were analyzed with a Turner Design fluorometer after extractions following the EPA standard operating procedure LG405 with the exception that all samples are run during the winter after the completion of the .

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EPA LG405 Standard Operating Procedure for In Vitro Determination of Chlorophyll *a* in Freshwater Phytoplankton by Fluorescence

Larval fish surveys: Miller high-speed sampler surveys are designed to estimate abundance of larval walleye and yellow perch. Larval walleye and yellow perch are sampled when yellow perch reach approximately 8 mm and again at approximately 18 mm. For each survey, the lake is divided into two or more horizontal and vertical depth strata and samples taken at a total of 46 randomly selected sites within designated strata. At each site, four Miller samplers are towed simultaneously at different depths and catches are pooled by stratum. Distance towed is about 1.6 km at a speed of 3.6 m/s. Larval fish captured are identified, counted, and measured. Density estimates are calculated for each strata based on catch and volume of water strained. Catches of yellow perch in the 18 mm survey are adjusted for size-specific gear avoidance (Noble 1970).

Gill net surveys: Standard gill net catches provide an index of the adult walleye and yellow perch populations as well as relative abundance estimates of various other species. A variable mesh multifilament gill net is fished overnight at a different standard site each week for 15 consecutive weeks starting in the beginning of June and continuing through mid-September. The net consists of four gangs 45.75 m long by 1.83 m deep sewn together to form one 183 m long net. Each gang consists of six 7.6 m panels with 38, 51, 64, 76, 89 and 102 mm stretch mesh. The net is set around sunset, fished on the bottom, and retrieved in the morning at about 0730. The time fished varies somewhat with season but has been identical for each location each year. All fish (or a subsample of at least 60 individuals of a species) are measured (total length in mm), weighed (g), sexed, stomach contents recorded, and scales taken. Large mesh gill nets were used to monitor sturgeon reproductive status and abundance and growth in 4 different substrate types. Variable (152, 203, 254, and 305 mm stretch mesh) mesh monofilament gill nets 61 m in length were set for approximately 4 hours at 12 sites monthly in May and June. All sturgeon caught were examined for tags, measured, weighed, a fin ray section removed for age determination, diet recorded using gastric lavage, tagged with both a Carlin dangler tag and PIT tag, and released.

Trawl surveys: The catch in trawls provides an estimate of year class abundance for young-of-year (age-0) and yearling walleye as well as prey species, primarily young yellow perch. Trawling begins around the middle of July when age-0 yellow perch become demersal (at about 1 g in weight) and weekly surveys continue until three October surveys are completed. A 5.5 m otter trawl is towed for 5 minutes, sampling approximately 0.10 ha per haul. Ten standard sites are sampled in each survey. Age-0 fish are identified, counted, total weight by species recorded to the nearest gram, and a subsample of fish measured for length. Lengths are recorded and scale samples taken on all older fish. A series of three trawl surveys at the same sites centered around May 1 is also conducted to assess age-1 walleye and yellow perch abundance.

Hydroacoustic surveys: Pelagic fish biomass is estimated in the end of August–beginning of September using hydroacoustics. Surveys are conducted using a 123 kHz split beam unit (Biosonics DT-X, pulse length 0.4 ms, 7.8^{o} beam width) along a set of approximately 8 transects from the east to the west ends of the lake. Surveys are typically conducted during two consecutive nights starting one hour after sunset. Acoustic data are analyzed with EchoView (v4.7 in 2009). Echograms are checked for problems associated with

poor bottom detection, bubbles from waves, echoes from macrophytes, and other sources of noise. Questionable areas are removed from the analysis. Attempts are made to sample as close to the bottom as possible by re-defining the bottom at high magnification when needed. All densities are calculated from in situ backscattering cross section (average for targets larger than –60dB) and echo integration according to the standard operating procedure for Great Lakes acoustics (Parker-Stetter et al. 2009). Noise level at 16 m, the maximum depth in Oneida Lake is estimated to be –85 dB (uncompensated TS) thus satisfying a 15 dB signal to noise ratio throughout the water column for the smallest targets included in the analysis as recommended by Rudstam et al. (2009). Analyses are conducted using each transect as cluster of elementary sampling units 500 m in 2008 (1000 pings in some years – approximately 520 m). Cluster analysis was used to estimate mean density and standard error using standard formulas (Scheaffer et al. 2006) and a program available on the web site "Acoustics Unpacked" (www.acousticsunpacked.org, Sullivan and Rudstam 2008).
Fish are sampled in association with acoustic surveys using a midwater fry trawl and fine mesh gill nets. These gears are used to assess the species composition of young fish in the pelagic zone. The trawl measures 2 m x 2 m at the mouth and is mounted in a metal frame. The first 2 m of the net is comprised of 12.7 mm stretch mesh, the next 2 m of 6.4 mm stretch mesh, and the cod end of the net consists of a 0.5 m plankton net and bucket with 1 mm mesh. At each site, one haul divided into 2.5 minutes at 4.3 to 6.1 m depth and 2.5 minutes at 2 to 3.8 m depth (determined from rope angles) and a second 5 minute haul at the surface (sampling the top 2 m of the water column) are conducted. Two trawl hauls are completed at each of 10 sites, and fish are preserved in formalin and returned to the lab for species identification, enumeration, and measurement. Fine mesh gill nets, 21 m long, are set either on bottom or suspended from the surface. Each gill net consists of seven 3 m wide by 6 m deep panels of different mesh sizes (6.2, 8.0, 10.0, 12.5, 15.0, 18.7 and 25.0 mm bar mesh). Paired (1 surface and 1 bottom) gill nets are set at each of 4 deep stations, and 4 shallow stations are sampled with only 1 net that samples the entire water column.
Acoustic density estimates are apportioned to emerald shiners, gizzard shad, and other fish based on catches in vertical gill nets and midwater trawls after accounting for the relative length selectivity and effort of the two gears. Fish in the top 2 m of the water column are accounted for by calculating the average density of gizzard shad and emerald shiners caught in the top 2 m in vertical gillnets set.

Fyke Net Surveys: We sample 24 sites around the lake representative of nearshore habitat types. Sites were selected to represent the common substrates in the nearshore in the proportions they occur and distributed around both shores of the lake as evenly as possible while still achieving substrate representation. Each site is sampled via approximately 24 hour sets of a fyke net comprised of a 0.9 m x 1.5 m frame fitted with 12.7 mm (1/2") delta knotless mesh. In 2008, we concurrently sampled 14 sites with a fyke net comprised of a 0.9 m x 1.5 m frame fitted with 5 mm (1/4") delta knotless mesh From 2009-2012, all 24 sites were sampled with nets of both mesh sizes. Sampling is typically conducted in September of each year.

Appendix 2:

Standard Data Tables

Table A1. Physical, chemical and biological characteristics of Oneida Lake since 1975. Secchi depth (m), chlorophyll-*a* (µg/L), total phosphorous (TP, µg/L) soluble reactive phosphorous (SRP, µg/L), total zooplankton biomass (µg/L), and *Daphnia* spp. biomass (µg/L) are averages from 1 to 5 stations from May to October. Ice freeze day (day since Dec 1), ice duration and ice out day (day of year) are noted at CBFS and refer to the year of ice break-up. The lake was not completely frozen over in the winter of 2001. Summer temperature (^{o}C) is the average temperature from June to Aug measured every hour at 2 m depth at a site near Shackelton Point.

Year	Secchi	Chl-*a*	SRP	TP	Zoopl. Biomass	*Daphnia* Biomass	First Freeze Day	Ice Duration	Ice Out Day	Sum Temp
1975	2.8	9.0	17.6	45.9	211	107	no data	no data	87	22.2
1976	2.8	9.9	3.3	29.5	241	163	19	99	87	20.6
1977	2.6	11.2	5.2	36.2	209	53	3	118	90	20.9
1978	2.9	7.7	16.5	42.5	116	73	15	121	105	22.0
1979	3.3	7.6	29.0	56.9	226	101	29	96	94	19.8
1980	2.6	12.7	10.2	45.2	257	126	35	91	95	20.4
1981	2.3	11.7	13.8	31.3	243	45	15	95	76	21.6
1982	2.2	9.0	15.2	48.0	260	93	20	118	107	20.8
1983	2.6	8.0	21.7	38.6	261	107	13	74	87	22.3
1984	2.3	9.2	14.7	30.1	231	104	21	111	101	21.6
1985	2.2	10.5	11.6	38.3	261	82	40	79	88	20.4
1986	2.4	10.3	27.5	67.1	304	178	19	104	92	20.4
1987	2.9	6.5	7.3	27.6	178	97	35	86	90	21.7
1988	2.7	9.4	17.1	34.6	248	99	34	91	94	20.8
1989	3.4	5.2	9.4	24.1	185	81	16	102	84	21.9
1990	2.4	9.5	4.8	22.0	221	65	5	107	81	21.7
1991	2.4	11.7	4.6	23.2	188	67	31	78	78	23.0
1992	2.8	7.1	1.8	20.1	315	196	25	93	102	20.2
1993	3.9	5.1	5.9	15.8	157	64	24	99	105	21.4
1994	3.7	6.6	6.2	30.4	193	103	27	113	109	22.0
1995	4.9	3.2	10.0	22.9	207	140	39	75	97	23.2
1996	3.6	5.5	6.0	19.9	222	128	32	100	101	22.0
1997	3.6	5.3	3.3	14.7	300	135	39	88	96	21.6
1998	3.0	5.2	5.2	21.5	161	57	48	58	86	22.5
1999	3.3	6.0	6.3	15.2	206	82	33	94	96	23.3
2000	2.9	6.5	4.4	18.1	154	85	45	63	77	21.3
2001	3.6	5.3	10.4	27.8	237	101	12	117	103	22.4
2002	3.7	4.8	7.0	27.2	162	75	no freeze	0	no freeze	23.0
2003	3.7	6.5	9.8	27.3	209	92	10	104	105	22.2
2004	3.4	7.7	10.8	29.0	233	99	21	90	95	21.5
2005	4.2	3.8	16.4	29.4	259	116	26	97	98	24.2
2006	3.1	7.3	10.6	29.2	209	77	18	72	91	22.9
2007	3.5	5.8	6.4	20.9	185	68	54	71	94	22.6
2008	4.2	3.8	12.2	24.6	165	45	19	83	92	22.5
2009	3.7	4.0		24.4	117	40	24	85	81	21.7
2010	4.4	2.6	11.1	28.5	139	48	23	85	81	23.4
2011	3.2	4.9	7.9	30.5	97	22	17	107	94	23.3
2012	4.7	2.9	15.3	31.5	183	63	46	21	53	24.1
2013	3.2	3.9	10.7	30.8	209	64	30	80	91	22.8
2014	3.3	4.2	11.1	28.0	129	29	30	118	103	22.3
Average	3.2	6.9	10.7	30.2	207	89	25.9	88.8	90.9	21.9

[1] Shackelton Point site only.

Table A2. Walleye age-specific density estimates since 1957 (in fish/ha). Age 1, 2 and 3 are estimated from the average of trawl and gill net estimates using catchabilities in Irwin et al. (2008). Bold values are from mark-recapture estimates. Densities of walleyes for intervening years were approximated from the distribution of mortality between successive population estimates (for 2011 estimates annual mortality of 20% was used). Estimates from 1978-1987 and 1992-1994 from Irwin et al. (2008).

Year	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age ≥ 7	Total (age-4<)
1957	no data	no data	no data	**0.4**	**6.22**	**0.97**	**4.62**	**12.21**
1958	9.18	1.55	4.72	**37.82**	**0.6**	**6.12**	**5.59**	**50.13**
1959	0.60	12.23	3.72	**2.69**	**34.12**	**0.27**	**9.47**	**46.54**
1960	4.94	3.62	22.70	**1.8**	**2.36**	**15.74**	**4.8**	**24.7**
1961	27.87	18.72	4.76	**20.82**	**2.45**	**2.14**	**14.9**	**40.31**
1962	15.84	14.49	12.62	**3.15**	**13.93**	**1.71**	**10.35**	**29.14**
1963	24.58	16.31	17.92	**13.26**	**2.56**	**15.32**	**7.61**	**38.75**
1964	34.61	19.28	10.36	9.03	8.85	1.71	15.29	34.88
1965	43.68	19.15	12.78	**8.69**	**5.53**	**7.18**	**10.53**	**31.93**
1966	22.09	31.64	15.05	11.61	7.1	4.52	14.48	37.71
1967	3.99	19.27	29.23	**10.29**	**8.17**	**3.77**	**10.42**	**32.66**
1968	22.35	2.89	20.67	**17.37**	**5.66**	**3.88**	**8.88**	**35.79**
1969	93.66	31.11	4.87	12.74	13.83	4.65	9.44	40.65
1970	3.10	37.77	10.75	**1.18**	**8.41**	**9.53**	**9.05**	**28.16**
1971	4.07	0.53	8.00	9.53	1.01	5.48	12.1	28.12
1972	80.32	9.21	1.54	**23.09**	**6.19**	**0.86**	**11.42**	**41.55**
1973	0.65	43.68	4.58	1.41	12.63	3.63	7.17	24.84
1974	6.08	2.18	47.64	**2.65**	**0.37**	**2.52**	**3.48**	**9.02**
1975	1.56	3.68	1.08	29.91	2.6	0.36	5.88	38.76
1976	92.71	3.61	3.23	**1.08**	**27.76**	**2.11**	**5.06**	**36.00**
1977	0.70	55.05	2.56	**1.92**	**0.49**	**15.08**	**3.9**	**21.39**
1978	36.75	0.96	31.26	1.56	1.64	0.36	16.67	20.24
1979	3.35	30.20	1.04	22.17	1.24	1.23	11.27	35.91
1980	2.48	4.41	22.30	0.98	14.45	0.81	8.2	24.44
1981	39.70	4.52	5.71	21.39	0.64	9.45	5.87	37.35
1982	26.88	22.72	3.87	3.53	17.5	0.45	10.37	31.85
1983	14.32	33.19	30.66	2.58	2.88	12.55	7.12	25.13
1984	9.79	9.43	20.79	13.77	2.13	2.06	13.33	31.28
1985	10.23	6.85	14.32	26.89	11.68	1.55	10.27	50.4
1986	15.01	9.07	7.03	9.96	22.41	8.7	7.77	48.84
1987	3.09	13.46	6.31	7.89	8.05	16.75	11.13	43.82
1988	105.80	2.14	12.59	**10.34**	**5.02**	**9.66**	**22.32**	**47.34**
1989	3.88	50.90	2.80	8.16	7.58	7.68	13.29	36.71
1990	7.98	8.29	49.85	**1.16**	**5.99**	**5.41**	**14.54**	**27.1**
1991	12.22	7.31	3.91	19.75	2.78	4.84	13.15	40.52

1992	45.62	9.25	6.74	1.79	16.71	1.15	10.45	30.1
1993	3.55	26.66	2.87	1.8	1.42	11.57	7.57	22.36
1994	8.64	2.40	23.14	2.29	1.19	0.98	12.83	17.29
1995	5.81	5.31	1.14	**5.65**	**1.56**	**0.65**	**6.22**	**14.08**
1996	9.66	2.65	2.78	1.32	5.52	0.92	4.87	12.63
1997	3.67	4.82	3.01	**1.57**	**1.2**	**5.39**	**4.00**	**12.16**
1998	22.17	1.43	4.16	0.59	1.50	1.17	7.33	10.59
1999	13.65	7.68	1.88	**1.54**	**0.57**	**1.44**	**6.86**	**10.42**
2000	9.58	11.81	6.41	0.33	1.82	0.63	7.17	9.95
2001	7.26	12.47	5.99	**3.9**	**0.38**	**2.15**	**6.9**	**13.33**
2002	32.13	9.23	8.39	3.65	3.25	0.88	7.54	15.33
2003	10.87	14.43	3.65	**2.78**	**3.85**	**2.71**	**8.32**	**17.66**
2004	6.39	12.94	12.19	4.74	3.92	2.59	6.89	18.15
2005	8.52	1.59	4.65	**6.15**	**4.97**	**5.53**	**6.05**	**22.71**
2006	5.53	9.68	1.17	1.17	6.60	2.75	9.48	20.00
2007	9.24	6.67	4.41	**1.27**	**1.03**	**7.09**	**9.28**	**18.67**
2008	2.07	2.32	0.87	4.77	1.12	0.91	14.46	21.27
2009	0.11	5.51	2.67	3.32	4.21	0.99	13.58	22.11
2010	1.81	5.13	3.69	**4.52**	**2.94**	**3.72**	**12.88**	**24.06**
2011	8.37	2.73	6.95	2.60	3.38	2.20	12.40	20.57
2012	3.95	7.65	2.49	4.50	1.94	2.52	10.90	19.86
2013	5.54	6.43	9.71	**2.25**	**3.36**	**1.45**	**9.93**	**16.99**
2014	9.40	10.98	4.36	7.80	1.80	2.69	9.10	21.39

Table A3. Fish observed in stomachs of yearling and older walleye taken by trawls and electrofishing during October and November since 1971, expressed as numbers per kg of walleye.

Year	# examined	% empty	YP	Morone	Gizz	ES	Other	Unident	Total
1971	240	37	3.92	0.01	0.00	0.00	0.06	1.59	5.58
1972	163	58	1.02	0.10	0.00	0.00	0.62	0.89	2.63
1973	295	32	0.69	1.36	0.00	0.00	0.43	1.35	3.83
1974	228	27	2.11	1.15	0.01	0.11	0.38	1.76	5.52
1975	204	68	0.20	0.13	0.00	0.02	0.17	0.24	0.76
1976	156	36	1.31	0.89	0.00	0.16	0.75	1.17	4.28
1977	70	19	3.14	1.25	0.00	0.00	0.14	0.89	5.42
1978	85	56	0.51	0.12	0.00	0.00	0.47	0.74	1.84
1981	88	66	1.52	0.16	0.00	0.00	0.00	0.56	2.24
1982	122	11	0.38	5.27	0.00	0.00	0.00	0.54	6.19
1983	117	62	0.19	0.79	0.00	0.00	0.00	0.30	1.28
1984	148	59	0.21	0.45	0.97	0.00	0.07	0.46	2.16
1985	151	50	1.60	0.04	0.36	0.00	0.13	0.44	2.57
1986	193	45	1.60	0.16	0.05	0.00	0.15	0.49	2.45
1987	194	23	0.05	0.64	1.96	0.00	0.02	0.54	3.21
1988	180	55	0.36	0.00	0.30	0.00	0.07	0.33	1.06
1989	193	26	0.00	0.18	5.42	0.00	0.03	0.83	6.46
1990	179	28	0.03	0.00	4.91	0.01	0.00	0.66	5.61
1991	137	20	0.02	0.01	3.81	0.00	0.10	0.77	4.71
1992	65	58	0.17	0.02	0.22	0.00	0.07	0.32	0.80
1993	134	25	2.13	0.51	0.01	0.42	0.81	1.28	5.16
1994	120	55	0.36	0.06	0.71	0.17	0.04	0.75	2.09
1995	86	45	0.44	0.35	0.06	0.02	0.13	0.67	1.67
1996	184	32	0.85	0.37	0.10	0.07	0.52	1.39	3.30
1997	75	45	0.28	0.36	0.00	0.02	0.26	1.15	2.07
1998	78	40	0.28	0.15	0.00	0.10	0.18	0.66	1.37
1999	64	42	0.25	0.03	0.25	0.75	0.03	0.61	1.92
2000	134	21	0.04	0.28	2.32	0.01	0.01	0.92	3.58
2001	123	28	0.40	0.18	0.88	0.17	0.24	0.36	2.23
2002	83	41	0.03	0.04	1.03	0.16	0.03	0.31	1.60
2003	183	39	0.84	0.09	0.36	0.04	0.21	0.52	2.06
2004	135	13	0.30	0.38	2.36	0.57	0.06	0.91	4.58
2005	134	30	1.08	0.11	0.70	0.31	0.13	0.52	2.85
2006	110	25	0.37	0.29	2.50	0.15	0.09	0.51	3.91
2007	264	50	0.87	0.00	0.67	0.02	0.08	0.45	2.09
2008	324	16	0.58	0.08	3.54	0.02	0.08	1.39	5.69
2009	308	44	1.21	0.05	1.63	0.02	0.05	0.26	3.21
2010	164	13	0.03	0.01	3.93	0.04	0.01	1.12	5.15
2011	207	37	0.22	0.58	0.93	0.15	0.08	0.65	2.60
2012	206	21	0.03	0.00	2.25	0.03	0.02	0.93	3.25
2013	234	63	0.14	0.03	3.12	0.01	0.58	0.45	4.33
2014	196	30	0.49	0.09	1.84	0.00	0.07	1.08	3.56

Table A4. Young-of-year and age-1 walleye density estimates and mean lengths. Larval walleye density (at the time of the 8 mm perch survey) are from Miller sampler surveys at that time or calculated from the 9 mm larval walleye survey. Age-0 walleye densities (#/ha) and mean lengths (TL, mm) on October 1 are from trawl surveys surrounding the Oct 1 date (5 dates, 50 trawls), and age-1 walleye densities (#/ha) and mean lengths on May 1 are from trawl surveys around May 1 (3 dates, 30 trawls). Densities calculated based on area swept (0.1 ha per trawl) assuming no avoidance.

Year Class	Larval Density	Oct 1 Age 0 Density	Oct 1 Age 0 Length	May 1 Age 1 Density	May 1 Age 1 Length
1961		114.5	140.6		
1962		135.9	142.9	44.2	158.8
1963		98.5	124.2	37.9	153.6
1964		80.6	137.5	73.4	161.3
1965		79.4	153.8	133.0	163.7
1966	1,348	6.3	138.5	9.0	148.1
1967	967	82.4	126.6		
1968	1,580	219.0	143.9	184.2	163.8
1969	559	50.0	142.7	17.0	161.0
1970	2,271	25.8	120.7	24.5	166.7
1971	309	42.0	167.0	124	180.6
1972	1,599	6.0	120.6	12.5	156.0
1973	222	1.6	164.2	4.5	174.0
1974	1,464	14.8	99.6	6	143.6
1975	1,362	148.4	171.2	59	184.6
1976	2,327	1.6	133.2	1.5	158.5
1977	660	71.6	136.5	108	167.8
1978		14.6	123.0		
1979		4.6	145.9		
1980		17.8	154.5	28.0	165.1
1981		57.8	149.4		
1982		22.4	162.0	27.7	175.6
1983		28.0	154.9	25.5	166.8
1984		6.0	132.8	26.3	151.3
1985		31.0	141.0	31.5	159.1
1986		5.4	140.4	3.8	165.3
1987		29.8	176.7	25.0	186.5
1988		10.4	142.3	2.2	146.0
1989		3.0	160.3	17.0	154.2
1990		14.4	173.8	15.0	177.6
1991		46.7	173.2	44.0	175.2
1992	333	12.4	150.4	5.0	157.1
1993		10.4	147.1	13.0	168.2
1994		11.4	130.8	11.5	163.3
1995		13.6	135.4	11.3	165.7
1996		1.8	150.3	5.0	168.3
1997		8.0	158.8	0.7	141.5
1998	275	2.4	207.4	3.0	189.0
1999	1,773	12.4	144.3	2.7	121.8
2000	1,208	3.0	176.5	14.3	180.7
2001	2,541	19.2	153.0	33.0	154.0
2002	213	3.7	173.6	12.3	179.3
2003	986	2.5	139.1	19.5	167.4
2004	3,196	15.3	150.7	21.0	161.8
2005	8,106	5.6	106.5	13.3	143.2
2006	1,304	2.2	163.0	9.3	173.3
2007	942	7.5	131.9	3.3	183.3
2008	5,102	5.4	129.7	3.67	132.04
2009	957	1.6	154.2	1.67	144.0
2010	898	14.3	132.3	27.5	162.0
2011	251	2.5	183.0	0.0	-
2012	2,694	1.0	104.0	0.3	140
2013	530	1.7	167.0	3.0	175
2014	1457	11.8	146.0		

Table A5. Yellow perch density estimates since 1961. Data are from mark-recapture (**bold**) or based on the catch in gill nets using size specific net selectivity.

Year	Density (#/ha) at age						Total (age3+)
	2	3	4	5	6	>6	
1961	51.2	11.3	56.7	9.4	10.2	17.5	105.1
1962	18.9	38.4	27.8	40.2	12.8	6.5	125.7
1963	15.6	26.7	40.1	32.7	33.5	16.1	149.1
1964	10.5	11.3	45.0	44.4	32.8	12.4	146.0
1965	11.3	44.2	12.7	67.2	41.4	14.1	179.7
1966	34.3	19.6	28.6	20.9	39.2	12.7	120.9
1967	1.4	50.1	28.1	27.2	20.4	20.3	146.0
1968	37.0	3.5	70.2	16.0	17.1	24.6	131.4
1969	33.2	**21.7**	**7.3**	**54.3**	**18.9**	**18.9**	**121.2**
1970	6.7	48.0	23.1	7.5	61.9	37.9	178.4
1971	1.9	**7.7**	**52.6**	**17.1**	**3.0**	**30.2**	**110.7**
1972	41.5	1.8	7.6	26.9	9.0	11.9	57.1
1973	4.6	**144.4**	**3.9**	**7.2**	**17.7**	**26.2**	**199.5**
1974			No gill netting				
1975	39.0	**0.9**	**5.7**	**61.3**	**2.5**	**15.0**	**85.5**
1976	5.3	56.5	2.8	11.2	51.2	14.4	136.1
1977	2.7	**12.9**	**40.0**	**0.5**	**2.2**	**24.2**	**79.7**
1978	19.7	3.9	8.6	41.7	3.6	28.8	86.6
1979	99.1	12.5	5.4	6.1	33.9	10.3	68.1
1980	4.9	179.2	16.3	8.6	14.5	41.3	260.0
1981	16.0	16.3	134.4	23.2	3.7	24.9	202.5
1982	31.2	10.3	10.6	99.6	4.3	8.0	132.8
1983	2.8	27.7	8.2	5.2	54.4	5.8	101.4
1984	18.6	12.6	48.3	17.2	10.3	36.0	124.5
1985	29.8	7.6	5.0	22.2	3.3	12.2	50.3
1986	29.5	24.0	10.3	8.1	28.9	9.0	80.3
1987	15.4	31.7	29.0	11.1	5.0	35.7	112.5
1988	10.0	**15.5**	**24.7**	**18.9**	**4.3**	**21.9**	**85.4**
1989	27.8	7.1	18.6	31.0	23.5	24.2	104.4
1990	8.7	**33.5**	**2.9**	**5.8**	**17.2**	**18.0**	**77.4**
1991	3.4	3.7	18.5	5.9	9.0	22.3	59.4
1992	47.9	5.5	5.2	18.4	6.5	10.0	45.5
1993	29.5	28.2	7.5	4.8	13.7	10.8	65.1
1994	1.7	10.4	8.9	1.5	0.8	6.5	28.1
1995	13.9	**4.3**	**16.1**	**5.9**	**1.4**	**4.0**	**31.7**
1996	26.4	10.7	4.0	8.5	3.6	3.8	30.6
1997	21.3	**26.3**	**7.0**	**1.4**	**2.7**	**1.7**	**39.0**
1998	13.2	23.9	22.0	10.4	4.2	3.9	64.3
1999	4.3	**10.5**	**13.1**	**8.9**	**2.7**	**1.7**	**37.0**
2000	20.3	8.9	15.2	19.4	10.5	7.3	61.4
2001	3.7	**21.5**	**7.1**	**4.8**	**5.8**	**6.5**	**45.7**

2002	5.7	7.9	46.0	11.5	10.7	24.6	100.8
2003	1.7	2.3	7.1	21.7	6.1	9.8	47.0
2004	3.4	5.4	5.5	8.3	17.0	19.5	55.7
2005	2.9	13.4	12.4	4.9	9.2	32.6	72.5
2006	15.5	11.0	12.6	8.1	2.9	18.5	53.0
2007	38.2	15.0	7.1	6.5	3.5	11.7	43.8
2008	14.7	41.7	16.0	5.6	3.7	13.4	80.4
2009	8.3	14.8	12.1	3	5.8	3.4	39.1
2010	17.5	14.2	5.5	11.8	9.0	7.9	48.3
2011	33.2	8.5	12.9	6.5	13.8	7.9	49.5
2012	15.0	7.7	19.9	17.6	4.2	18.8	68.2
2013	58.1	23.4	8.1	11.4	18.0	19.7	80.6
2014	47.3	9.0	5.2	2.2	5.4	6.9	28.7

Table A6. Young-of-year and age-1 yellow perch density estimates and mean lengths. Larval yellow perch densities (at 18 mm, #/ha) are estimated from Miller sampler surveys. Age-0 yellow perch densities (#/ha), age-0 mean lengths (TL, mm) are estimates for October 15 obtained from regression analysis of weekly catches throughout the season. Age-1 yellow perch density are from trawl surveys around May 1 and from mid-July through October (#/ha). Age-1 yellow perch mean lengths are from spring trawl surveys centered on May 1 since 1961.

Year class	Larval density	October age-0		Age-1		
		density	mean length	density spring	mean length	density summer
1961		2,850	60			19.4
1962		4,260	73	486	76	186.8
1963		780	60	71		15.8
1964		3,520	71	849	73	585.9
1965	140,100	2,610	60	30		2.0
1966	40,200	170	73	25	74	39.3
1967	61,200	2,240	72			136.5
1968	141,800	6,700	67	598	75	57.2
1969	69,200	210	65	2		0.5
1970	80,000	930	77	158	85	44.5
1971	216,400	3,520	57	52	62	30.5
1972	120,700	100	67	4	77	0.8
1973	16,600	510	86	63	90	46.0
1974	32,000	320	72	33	74	9.3
1975	188,700	450	65	5	75	4.3
1976	46,600	180	72	12	77	4.8
1977	65,200	4,140	69	3385	70	241.5
1978		180	73			13.5
1979	103,200	360	75			6.4
1980	131,600	500	81	118	81	100.9
1981	208,200	2,590	57			4.6
1982	353,400	980	63	25	68	10.6
1983	45,600	710	79	95	79	26.3
1984	16,000	810	71	103	73	32.1
1985	91,100	2,700	68	174	74	29.8
1986	14,600	70	82	2	84	1.8
1987	3,700	220	68	128	70	97.9
1988	76,200	220	81	19	83	4.5
1989	3,700	20	81	17	82	13.1
1990	117,000	460	73	184	70	121.9
1991	34,000	340	82	705	84	166.5
1992	60,800	100	73	13	79	5.4
1993	32,800	320	85	70	84	56.4
1994	21,800	280	83	281	83	30.1
1995	15,100	90	90	373	89	58.5
1996	43,600	80	80	74	81	24.3

1997	4,600	30	80	23	80	17.5
1998	57,100	700	83	457	84	99.3
1999	42,100	1,080	81	18	84	17.8
2000	19,300	140	78	73	79	7.2
2001	36,200	270	84	466	86	6.3
2002	23,400	1,660	76	380	80	17.6
2003	68,500	60	85	38	84	5.3
2004	60,700	180	86	36	84	5.7
2005	36,300	410	93	280	93	13.5
2006	58,502	240	79	117	79	19.6
2007	135,990	1,842	81	243	85	6.2
2008	67,420	720	73	104	76	9.1
2009	112,712	1,454	74	1.67	88	6.9
2010	62,853	829	72	47	78	17.8
2011	4,713	21	72	16	73	2.7
2012	22,297	18	88	20	84	28.8
2013	6,654	131	84	62	84	13.6
2014	12,035	427	78			

Table A7. Relative abundance of white perch year classes at successive stages of development. Age-0 white perch abundance represented by the calculated density from area swept in trawls in August-September, Age-0 Length is from October trawls, Age-1 Spring is from the CPUE in spring trawls, and age-1 and older are catches in standard gill nets. These values are data for the year of collection. The recruitment index (RI) is the sum of the gill net catch at age 2 and 3 of fish born that year (Fitzgerald et al. 2006). For example the RI value for years 1961 is the sum of the gill net catch of age 2 in 1963 and age 3 in 1964. Bold RI numbers for 1971 and 1972 includes an extrapolation of gill net catches for 1974 when gill nets were not used (see Fitzgerald et al. 2006).

Year	Age-0	Age-0 Length	Age-1 Spring	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age7+	RI	sum GN
1961	1114	84		2	9	20	94	6	8	39	10	178
1962	287	94		0	15	2	34	66	10	13	114	140
1963	54	68		0	5	28	5	83	62	15	12	198
1964	56	79	0.4	0	55	5	36	20	62	54	54	232
1965	963	77	9.3	6	7	59	9	56	43	74	9	254
1966	1320	78	0.0	0	19	5	28	8	54	19	5	133
1967	131	85	0.0	0	3	35	9	15	26	19	16	107
1968	12	86		0	0	6	18	6	20	22	7	72
1969	81	80	0.0	0	0	5	10	21	6	23	3	65
1970	178	81	0.0	0	4	16	20	46	37	56	25	179
1971	91	78	0.0	1	0	3	7	2	9	23	**69**	45
1972	30	84	0.5	0	11	3	0	0	2	8	**9**	24
1973	2155	85	0.0	0	6	14	1	1	0	6	551	28
1974	355	72	3.0								15	
1975	207	87	0.0	0	240	5	143	14	2	11	3	415
1976	314	64	0.0	0	4	311	5	101	39	41	8	501
1977	957	77	0.0	0	1	11	128	4	52	11	517	207
1978	37	85	12.0	23	0	2	3	53	1	18	12	100
1979	1740	78		1	224	8	17	1	228	30	6	509
1980	6428	79		0	8	293	0	1	3	48	59	353
1981	278	75	2.0	0	1	4	775	28	22	132	10	962
1982	4820	75		0	21	5	10	411	8	31	29	486
1983	6588	80	0.0	0	0	38	5	6	343	28	249	420
1984	364	72	0.0	0	6	10	141	10	13	244	297	424
1985	102	70	0.5	1	31	23	12	212	15	372	38	666
1986	17	72	0.5	4	142	218	29	26	195	309	15	923
1987	5223	62	0.0	1	27	155	31	11	11	69	17	305
1988	4	81	0.0	0	1	11	7	0	3	8	3	30
1989	886	78	0.0	3	4	14	34	4	0	8	8	67
1990	74	72	0.0	2	0	13	19	56	18	17	2	125
1991	86	90	0.0	6	4	3	1	4	19	19	6	56
1992	48	70	0.0	0	0	4	1	10	4	59	0	78
1993	797	79	0.0	0	3	2	2	1	18	40	15	66
1994	66	80	0.0	1	0	3	3	0	2	31	19	40
1995	613	97	0.5	2	4	0	6	2	4	18	243	36
1996	54	87	14.7	2	2	11	3	8	0	14	13	40
1997	956	76	0.0	0	155	17	8	1	5	14	415	200
1998	125	85	0.0	87	0	88	4	10	2	6	202	197
1999	8	97	0.7	40	315	13	122	9	0	4	132	502
2000	590	78	0.7	2	50	100	4	47	2	3	211	208
2001	59	84	2.3	6	56	152	211	14	55	0	283	494
2002	1145	82	8.3	32	122	76	65	120	7	26	72	448
2003	59	84	5.3	0	106	89	46	52	36	17	5	346
2004	1413	79	0.0	0	33	177	61	38	27	40	590	376
2005	81	98	1.3	44	1	39	227	40	53	17	210	421
2006	137	76	1.7	16	261	4	32	214	50	10	115	587
2007	140	81	0.0	12	111	329	20	34	198	67	78	771
2008	335	75	1.0	5	16	99	126	11	42	74	163	373
2009	196	73	0.7	32	39	99	138	277	38	150	22	773
2010	48	89	2.5	4	79	39	45	71	184	67	93	489
2011	1181	76	0	22	10	84	32	28	84	282	5	541
2012	144	100	0	0	25	12	68	22	33	216		376
2013	44	86	0.3	44	0	68	47	97	29	261		546
2014	49	81		3	108	5	25	20	64	97		322

Table A8. Abundance and biomass of pelagic fish (emerald shiners (ES), gizzard shad, and *Alosa* spp. (blueback herring and alewife) in Oneida Lake since 1994.

	Abundance (fish/ha)					Biomass (kg/ha)				
Year	ES age-0	ES Age1+	Gizzard shad	*Alosa* spp.	Sum	ES age-0	ES Age1+	Gizzard shad	*Alosa* spp.	Sum
1994	3,589	1,352	2,515	607	7,457	2.2	4.1	15.6	6.1	28.0
1995	350	792	538	575	2,255	0.6	3.2	17.2	9.3	30.3
1996	2,909	280	22	492	3,704	2.3	1.0	1.3	5.3	10.0
1997	16,936	1,760	101	14	18,811	15.0	6.4	0.6	0.2	22.3
1998	2,254	5,668	41	3	7,966	1.0	16.1	0.4	0	17.5
1999	7,539	4,093	726	0	12,358	6.1	10.0	8.7	0	24.8
2000	3,463	1,836	1,936	0	7,235	3.4	5.2	6.3	0	14.9
2001	16,112	2,441	2,458	0	21,010	15.2	9.0	23.5	0	47.8
2002	20,529	2,516	2,924	0	25,969	9.4	7.2	5.6	0	22.2
2003	2,645	8,149	2,474	0	13,268	1.7	23.3	13.8	0	38.7
2004	9,057	1,407	2,664	0	13,128	10.1	4.9	14.6	0	29.6
2005	2,597	1,307	2,215	0	6,119	2.6	4.9	47.8	0	55.3
2006	2,651	666	1,716	0	5,033	2.6	2.3	15.5	0	20.4
2007	417	215	1,431	0	2,065	0.6	0.3	14.3	0	15.2
2008	7,900	381	2,073	0	10,354	6.6	1.3	14.6	0	22.5
2009	1,001	1,521	5,969	5	8,496	0.7	4.4	18.8	0.5	24.0
2010	8,350	2,032	7,643	26	18,051	7.0	6.3	24.7	0.2	38.2
2011	35,918	4,067	4,679	0	44,664	23.4	11.6	15.0	0	50.0
2012	2,749	1,224	2,773	0	6,746	3.2	3.8	29.9	0.0	36.9
2013	738	106	1,236	5	2,085	0.7	0.4	7.0	0.1	8.0
2014	2,031	774	4,949	0	7,754	3.0	1.1	11.4	0.0	16.0

Table A9. Catch/hour of lake sturgeon in large mesh gill nets at 12 standard sites.

Year	Month						
	May	June	July	August	September	October	November
2002	-	0.39	0.35	0.10	0.10	0.16	-
2003	0.32	0.17	0.09	0.09	0.56	-	-
2004	0.35	0.39	0.08	0.37	0.15	-	-
2005	0.18	0.11	-	-	-	-	-
2006	0.31	0.11	-	-	-	-	0.06
2007	0.30	0.11	-	-	-	0.07	-
2008	0.17	0.13	-	-	-	-	-
2009	0.20	0.14	-	-	-	-	-
2010	0.20	0.04	-	-	-	-	-
2011	0.34	0.04					
2012	0.40	0.15					
2013	0.20	0.19					
2014	0.09	0.06					

Table A10. Catches in ½" mesh fyke nets, Oneida Lake 2007-2014 (n=24 sites).

	Mean Catch/Net							
Scientific Name	2007	2008	2009	2010	2011	2012	2013	2014
Family Lepisosteidae								
Longnose gar (Adult)	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Family Amiidae								
Bowfin (Adult)	0.13	0.25	0.21	0.08	0.33	0.43	0.20	0.10
Family Clupeidae								
Gizzard shad (All)	0.16	0.38	0.33	4.13	35.30	3.42	25.1	0.50
Family Cyprinidae								
Common carp (All)	0.00	0.04	0.17	0.08	0.04	0.00	<0.1	0.00
Golden shiner (All)	0.17	0.46	0.25	0.21	0.17	0.00	0.1	0.10
Emerald shiner (All)	0.00	0.04	0.00	0.00	0.00	0.04	<0.1	0.00
Spottail shiner (All)	0.13	0.00	0.17	0.17	0.00	0.13	0.0	0.00
Bluntnose minnow (All)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00
Family Catostomidae								
Longnose sucker (All)	0.04	0.00	0.00	0.00	0.00	0.00	0.0	0.00
White sucker (All)	0.58	0.84	0.38	0.79	0.71	0.42	0.4	0.20
Creek chubsucker (All)	0.04	0.00	0.08	0.00	0.00	0.00	0.0	0.00
Greater redhorse (All)	0.04	0.04	0.00	0.00	0.00	0.00	0.0	0.00
Family Ictaluridae								
Yellow bullhead (All)	0.17	0.54	0.46	0.42	0.21	0.21	0.1	0.30
Brown bullhead (All)	0.83	0.88	0.83	0.58	0.46	0.33	1.8	0.50
Family Esocidae								
Chain pickerel (All)	0.37	0.08	0.04	0.67	0.63	0.54	1.0	0.50
Family Gadidae								
Burbot (Adult)	0.04	0.04	0.13	0.13	0.00	0.04	<0.1	0.10
Family Fundulidae								
Banded killifish (All)	0.04	0.00	0.00	0.00	0.04	0.00	0.0	0.00
Family Percichthyidae								
White perch (YOY)	1.58	0.04	5.42	0.04	4.46	0.00	0.0	0.10
White perch (Adult)	0.04	0.08	0.00	0.04	0.42	0.04	0.3	0.10
Family Centrarchidae								
Rock bass (Adult)	3.08	2.91	2.46	3.29	1.96	2.50	3.7	3.30
Green sunfish (Adult)	0.21	0.13	0.21	0.33	0.38	0.38	0.4	0.10
Pumpkinseed (Adult)	9.54	12.75	16.83	7.04	7.46	4.50	10.1	7.00
Bluegill (Adult)	2.58	3.58	9.30	3.54	4.29	4.42	19.5	5.20
(YOY - <75mm)	3.29	3.38	2.08	3.21	10.67	2.88	3.0	1.00
Smallmouth bass (YOY)	11.58	4.75	2.38	1.33	0.96	0.96	0.4	1.90
Smallmouth bass (Adult)	0.00	0.08	0.00	0.17	0.08	0.13	0.0	0.10
Largemouth bass (YOY)	1.25	1.96	0.71	0.75	0.75	0.96	1.3	2.90
Largemouth bass (Adult)	0.08	0.38	0.13	0.04	0.04	0.08	0.2	0.10

Black crappie (All)	2.37	3.03	0.88	0.83	3.33	0.88	6.2	2.20
Family Percidae								
Yellow perch (YOY)	18.21	1.50	0.46	0.29	1.04	6.17	0.3	0.80
Yellow perch (Adult)	16.04	26.08	24.46	19.46	19.63	16.29	24.5	14.90
Logperch (All)	0.08	0.08	0.00	0.00	0.00	0.04	0.0	0.00
Tesselated darter (All)	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00
Walleye (YOY)	0.17	0.38	0.13	0.17	0.08	0.08	<0.1	0.10
Walleye (Adult)	0.54	0.50	0.63	0.50	1.63	1.08	1.0	1.40
Family Sciaenidae								
Freshwater drum (Adult)	0.04	0.00	0.13	0.25	0.38	0.42	0.4	0.20

Table A11. Catches in 1/4" mesh fyke nets, Oneida Lake 2008-2012 (2008: n=14 sites; 2009-2014: n=24 sites).

Scientific Name	Mean Catch/Net						
	2008	2009	2010	2011	2012	2013	2014
Family Lepisosteidae							
Longnose gar (Adult)	0.00	0.00	0.00	0.00	0.00	0.0	0.00
Family Amiidae							
Bowfin (Adult)	0.14	0.25	0.00	0.04	0.04	0.0	0.00
Family Clupeidae							
Gizzard shad (All)	0.07	0.37	0.13	465.13	5.13	168.9	0.30
Family Cyprinidae							
Common carp (All)	0.00	0.04	0.00	0.00	0.00	0.0	0.00
Golden shiner (All)	0.07	0.04	0.08	0.42	0.08	0.2	0.10
Emerald shiner (All)	0.07	0.04	0.04	0.21	0.08	5.2	0.10
Spottail shiner (All)	0.00	0.75	0.13	2.75	0.17	0.7	0.00
Bluntnose minnow (All)	0.21	7.13	0.21	0.29	0.08	0.7	0.10
Family Catostomidae							
Longnose sucker (All)	0.00	0.00	0.00	0.00	0.00	0.0	0.00
White sucker (All)	0.00	0.13	0.04	0.08	0.04	<0.1	0.00
Creek chubsucker (All)	0.00	0.04	0.00	0.00	0.00	0.0	0.00
Greater redhorse (All)	0.00	0.00	0.00	0.00	0.00	0.0	0.00
Family Ictaluridae							
Yellow bullhead (All)	0.57	0.25	0.00	0.13	0.21	0.6	0.40
Brown bullhead (All)	0.50	0.17	0.17	0.46	0.33	0.4	0.30
Family Esocidae							
Chain pickerel (All)	0.00	0.04	0.08	0.13	0.08	<0.1	0.10
Family Gadidae							
Burbot (Adult)	0.21	0.00	0.00	0.00	0.17	0.0	0.20
Family Fundulidae							
Banded killifish (All)	0.36	1.21	5.13	0.04	1.83	3.5	0.10
Family Percichthyidae							
White perch (YOY)	0.00	0.08	0.00	6.00	0.00	0.0	0.10
White perch (Adult)	0.00	0.00	0.00	0.00	0.00	0.1	0.00
Family Centrarchidae							
Rock bass (Adult)	3.57	2.63	3.33	2.96	3.63	2.9	4.20
Green sunfish (Adult)	0.29	0.29	0.04	0.38	0.46	0.4	0.20
Pumpkinseed (Adult)	2.00	1.67	4.33	3.08	1.42	2.3	5.80
Bluegill (Adult)	2.43	4.50	5.33	3.46	3.54	10.0	4.70
(YOY - <75mm)	43.29	237.46	21.13	138.96	38.08	1009.7	89.3
Smallmouth bass (YOY)	12.00	2.33	2.46	5.04	6.21	0.8	9.10
Smallmouth bass (Adult)	0.07	0.00	0.13	0.04	0.04	<0.1	0.00

Largemouth bass (YOY)	2.57	0.42	1.54	2.33	1.75	1.0	2.90
Largemouth bass (Adult)	0.07	0.00	0.00	0.08	0.04	0.0	0.00
Black crappie (All)	0.38	0.13	0.46	0.88	0.17	0.90	0.70
Family Percidae							
Yellow perch (YOY)	18.14	22.42	25.71	11.83	16.54	9.2	18.00
Yellow perch (Adult)	2.00	9.42	1.88	3.75	2.00	7.0	6.90
Logperch (All)	0.07	0.41	0.04	0.29	0.54	1.0	0.50
Tesselated darter (All)	0.07	0.67	0.08	0.08	0.08	0.5	0.30
Walleye (YOY)	0.00	0.00	0.17	0.04	0.29	0.0	0.00
Walleye (Adult)	0.00	0.00	0.13	0.21	0.00	0.1	0.10
Family Sciaenidae							
Freshwater drum (Adult)	0.00	0.00	0.04	0.04	0.00	0.0	0.00

Table A12. Catches (#/hr) from spring shoreline electrofishing, Oneida Lake 2011-2014. Catches are means from 8 sites, with each site comprised of a 1 hour predator run and 2 15 minute all fish runs (total predator effort = 12 hours, effort for non-predators = 4 hours).

		Catch/Hour		
Scientific Name	Common Name	2011	2012	2014
PREDATORS				
Family Lepisosteidae				
Lepisosteus osseus	Longnose gar (Adult)	1.8	2.0	2.2
Family Amiidae				
Amia calva	Bowfin (Adult)	2.6	1.6	2.6
Family Ictaluride				
Ictalurus punctatus	Channel catfish (All)	0.1	0.2	0.2
Family Esocidae				
Esox niger	Chain pickerel (Age-1)	0.5	0.0	0.6
	Chain pickerel (Adult)	4.0	3.7	6.6
Family Gadidae				
Lota lota	Burbot (Adult)	3.8	1.0	0.6
Family Centrarchidae				
Micropterus dolomieu	Smallmouth bass (Age-1)	0.9	1.0	0.2
	Smallmouth bass (Adult)	2.3	3.7	3.7
Micropterus salmoides	Largemouth bass (Age-1)	0.9	2.1	0.2
	Largemouth bass (Adult)	9.6	8.2	12.0
Family Percidae				
Sander vitreus	Walleye (Age-1)	4.0	1.5	3.3
	Walleye (Adult)	4.7	8.0	4.8
Family Sciaenidae				
Aplodinotus grunniens	Freshwater drum (Adult)	1.8	5.4	1.8

OTHER SPECIES

Family Clupeidae				
Dorosoma cepedianum	Gizzard shad (All)	9.5	10.0	3.0
Family Cyprinidae				
Notemigonus crysoleucas	Golden shiner (All)	4.0	4.5	3.0
Notropis atherinoides	Emerald shiner (All)	15.0	30.3	3.0
Notropis hudsonius	Spottail shiner (All)	4.0	2.0	0.0
Pimephales notatus	Bluntnose minnow (All)	1.8	0.8	0.8
Family Catostomidae				
Catostomus commersoni	White sucker (All)	4.0	1.3	0.5
Erimyzon oblongus	Creek chubsucker (All)	0.3	0.0	0.3
Family Ictaluridae				
Ameiurus natalis	Yellow bullhead (All)	0.5	1.0	2.0
Ameiurus nubulosus	Brown bullhead (All)	28.0	37.0	44.0
Family Atherinopsidea				
Labidesthes sicculus	Brook silverside (All)	0.3	0.3	0.3
Family Fundulidae				
Fundulus diaphanus	Banded killifish (All)	20.3	3.0	2.3
Family Percichthyidae				
Morone americana	White perch (All)	0.8	0.3	0.8
Family Centrarchidae				
Ambloplites rupestris	Rock bass (Age-1)	3.8	0.3	0.0
	Rock bass (Adult)	6.5	5.5	15.0
Lepomis cyanellus	Green sunfish (Adult)	0.8	1.3	1.8
Lepomis gibbosus	Pumpkinseed (Age-1)	4.3	7.8	0.5
	Pumpkinseed (adult)	62.8	22.8	42.0
Lepomis macrochirus	Bluegill (Age-1)	2.8	5.5	0.3
	Bluegill (Adult)	24.5	6.5	12.8
Pomoxis nigromaculatus	Black crappie (Age-1)	0.3	0.0	0.0
	Black crappie (Adult)	0.8	0.5	0.5
Family Percidae				
Perca flavescens	Yellow perch (Age-1)	129.0	24.5	51.5
	Yellow perch (Adult)	90.5	19.3	98.0
Percina caprodes	Logperch (All)	25.0	26.8	8.0
Etheostoma olmstedi	Tesselated darter (All)	1.8	1.0	0.0

Table A13. Open water angling effort (boat hours) as determined by tower counts, Oneida Lake 2002-2007, 2010-2014

Year	Month					
	May	June	July	August	September	**TOTAL**
2002	12,773	21,132	24,983	19,156	15,465	**93,509**
2003	15,675	24,041	33,281	28,375	20,859	**122,231**
2004	22,230	37,240	34,681	32,012	17,925	**144,088**
2005	30,738	35,344	38,622	29,799	21,564	**156,069**
2006	25,004	41,381	63,308	30,230	19,807	**179,730**
2007	30,942	40,203	41,183	35,748	26,844	**174,921**
2010	49,180	40,749	43,819	48,552	26,179	**208,479**
2011	58,774	41,997	52,025	38,090	23,774	**214,660**
2012	53,554	49,933	56,295	35,629	18,159	**213,570**
2013	42,479	59,037	62,224	35,169	19,480	**218,389**
2014	43,253	57,078	55,955	40,951	20,312	**217,548**