

# The fisheries and limnology of Oneida Lake, 2022

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## EXECUTIVE SUMMARY

This report provides the results of studies conducted by the Cornell Biological Field Station on Oneida Lake in 2022 and compares these results to previous data collected as part of the long-term monitoring program. Oneida Lake is New York State's 3<sup>rd</sup> most heavily-fished lake. Walleye *Sander vitreus* has historically received the majority of angler effort followed by black bass *Micropterus* spp. Long-term monitoring of the fisheries and limnology of Oneida Lake has captured a series of changes in recent decades that have resulted in pronounced changes in the lake's physical and biological characteristics including reductions in nutrient inputs resulting from the Great Lakes water quality agreements, establishment of invasive dreissenid mussels resulting in increases in water clarity, increases in summer water temperatures and decreases in duration of ice cover, and establishment of a breeding population of double-crested cormorants *Phalacrocorax auritus*. New arrivals include round goby *Neogobius melanostomus*, first reported by anglers in 2013 and in standard fisheries surveys in 2014, and spiny water flea *Bythotrephes longimanus* in 2019. In addition, the burrowing mayfly *Hexagenia rigida* and *H. limbata* has returned to the lake. Assessments of the impacts of these additions are ongoing.

Long-term analyses show significant changes in abundance of many important sport and prey fish species. To differentiate long-term from recent changes with more immediate management implications, analyses of fisheries data are focused on the period beginning in 2007. This year was chosen because quagga mussels *Dreissena rostriformis bugensis* started to increase in the lake at that time. Quagga mussels further increased water clarity and decreased *Daphnia* spp. abundance, an important food item for age-0 fish. Establishment of a double-crested cormorant population contributed to declines in yellow perch *Perca flavescens* and walleye populations in the 1990s, but an aggressive management program combined with a period of more restrictive walleye harvest regulations has aided the recovery of these two important fish species.

Walleye adult abundance is currently near average, and the yellow perch adult abundance remains near a record high. Adult walleye growth and condition improved in 2022 after 3 subpar years due to low age-0 yellow perch and gizzard shad *Dorosoma cepedianum* abundances relative to the size of the walleye population, while adult yellow perch length at age has increased with increases in round goby and burrowing mayfly. The smallmouth bass *Micropterus dolomieu* population has generated concern in recent years. Lower catches of age-0 fish in several gears and older fish in gill nets are fueling these concerns. Recent smaller year-classes are consistent with the arrival of round goby, which is a known egg and larvae predator. However, age-0 catches of other nesting *Centrarchid* spp. do not appear to be decreasing. Angler catch rates continue to be characteristic of a very good walleye fishery, as defined by the Walleye Management in New York State plan, as well as a good black bass fishery. The walleye harvest regulation change from 3 fish/day to 5 fish/day instituted on May 1, 2022 contributed to the harvest of over 100,000 walleye.

Oneida Lake continues to support quality sustainable fisheries for walleye, yellow perch and black bass. Continued monitoring of the lake's limnology and fish populations will track the impacts of ongoing ecological changes and guide management directed at sustaining or improving quality recreational fisheries.

## INTRODUCTION

Oneida Lake is the largest lake by area entirely within the borders of New York State (51,000 acres, 20,700 hectares) and is third only to lakes Ontario and Erie in total angling effort in New York State. Duda et al. (2019) estimated 649,000 angler-days/year on Oneida Lake in 2017, compared to 1.5 million angler-days/year on Lake Ontario and 659,000 angler-days/year on Lake Erie. Effort estimates conducted by the Cornell Biological Field Station (CBFS) have produced annual levels of open water effort in excess of 165,000 boat-hours in every year since 2010 (see below). Angling on Oneida Lake generates revenues of over 21 million dollars annually (Duda et al. 2019), and as such represents an important resource both locally and across the state. 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.

The Oneida Lake walleye population is intensively managed through annual stockings of walleye fry, management of double-crested cormorants *Phalacrocorax auritus*, 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 other sport fish (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 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 the Environment and the New York State Department of Environmental Conservation's Bureau of Fisheries (NYSDEC). Research and monitoring on Oneida Lake are 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. During the time span that data have been collected, a series of perturbations has resulted in fundamental changes in the lake and how it functions. Events that have resulted in demonstrable impacts on Oneida Lake's dynamics include the Great Lakes Water Quality Agreement of 1972 (with amendments in 1983 and 1987), establishment of a nesting colony of double-crested cormorants in the 1980s, and invasion by zebra mussels *Dreissena polymorpha* in the early 1990s (followed by the invasion by quagga mussels *Dreissena rostriformis bugensis* in the mid-2000s). More recent additions to the biotic community include the return of burrowing mayfly *Hexagenia* spp. in the early 2010s, and the arrival of round goby *Neogobius melanostomus* in the mid-2010s and spiny water flea *Bythotrephes longimanus* in 2019. Impacts of these additions are still being assessed.

In this report, we provide analyses that incorporate data during two time periods. We use data from the beginning of the data set to 2022 to assess long-term trends, and data from 2007 to 2022 to assess more recent trends that may have more immediate management implications. The more recent time period spans the years during which zebra mussels were replaced by quagga mussels (Hetherington et al. 2019), with concomitant declines in chlorophyll *a* and *Daphnia* spp. biomass (identified with change-point analyses, Jackson et al. 2019), and is characterized by ongoing double-crested cormorant management efforts and consistent walleye harvest regulations until 2022 when the daily bag limit was increased from 3 to 5 fish. This shorter time frame for trend analyses was explored with the intention of allowing detection of responses to recent perturbations free from the influence of more well-established shifts in lake dynamics associated with water quality improvements, increases in the double-crested cormorant population, and the initial colonization of the lake by zebra mussels. With this

approach we hope 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, burrowing mayfly).

Collection of data to maintain the long-term database and directed studies aimed at understanding the effects of ecosystem change on fish populations were continued in 2022 by the DNRE 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. Appendices that appear at the end of the report describe standardized methods for data collection (Appendix 1) and provide standard data arranged in tables (Appendix 2). Many of our data sets are available for download from the Knowledge Network for Biocomplexity (<http://knb.ecoinformatics.org/index.jsp>), a data repository that is a member node of the National Science Foundation DataONE portal ([www.dataone.org](http://www.dataone.org)). These data-packages include method descriptions and metadata for limnology, ice data, phytoplankton, zooplankton, benthic invertebrates, mussels, gill-net data, trawl data, walleye, and yellow perch and are described in Rudstam et al. (2016a). They are updated annually and are associated with this report.

## METHODS

Much of the data presented in this report result from continuation of long-term sampling protocols established at the outset of the CBFS studies on Oneida Lake. Detailed methods for both limnological and fisheries surveys can be found in Appendix 1 and in the metadata on the Knowledge Network for Biocomplexity website. Many of the equations that appeared in the text of recent annual reports are now provided in Appendix 1.

## RESULTS

### Limnology

Oneida Lake has a wealth of long-term limnological data including benthic invertebrates (1956-present), zooplankton (1964-present) and phytoplankton and nutrients (1975-present). Annual measurements of these lower trophic level parameters (Appendix 2 Table A1) allow for an ecosystem-based approach to understanding fish population dynamics in the lake. Here we report on year 2022 and discuss implications for Oneida Lake. This section also provides analyses of limnological time trends from 1975 to 2022 using standard linear regression (Table 1) and ANOVA (Table 2). New for this section is the addition of mussel biomass to these analyses and inclusion of more information on benthic invertebrates.

**Table 1. Analyses of the 1975-2022 long-term trends in limnological indicators using simple linear regression. Trend is the rate of change per year in the units given, SE is the standard error of these trend values, adjusted  $r^2$  indicates the proportion of the variance explained, N is the number of years included, and the  $p$ -values represent the statistical significance. Values  $\leq 0.05$  are considered significant and in bold. Variables are explained in Table 2. Mussel biomass was analyzed from 1992 to 2022. Analyses were conducted using the statistical package Jmp v16.0.**

Indicator	Trend	SE	adj $r^2$	N	$p$
Summer temp at 6 ft (°F)	<b>0.10</b>	<b>0.014</b>	<b>0.49</b>	<b>48</b>	<b>&lt;0.001</b>
Ice duration (days)	<b>-0.65</b>	<b>0.25</b>	<b>0.13</b>	<b>47</b>	<b>0.008</b>
Summer BDO <3ppm (%)	<b>0.53</b>	<b>0.14</b>	<b>0.23</b>	<b>48</b>	<b>0.0004</b>
TP (µg/L)	<b>-0.41</b>	<b>0.097</b>	<b>0.28</b>	<b>48</b>	<b>&lt;0.0001</b>
SRP (µg/L)	<b>-0.13</b>	<b>0.060</b>	<b>0.07</b>	<b>47</b>	<b>0.037</b>
Chlorophyll (µg/L)	<b>-0.15</b>	<b>0.018</b>	<b>0.60</b>	<b>48</b>	<b>&lt;0.0001</b>
Secchi (ft)	<b>0.086</b>	<b>0.019</b>	<b>0.30</b>	<b>48</b>	<b>&lt;0.0001</b>

Mussel biomass (g/m <sup>2</sup> )	2.24	2.46	0.0	31	0.37
<b>Daphnia (µg/L)</b>	<b>-1.65</b>	<b>0.34</b>	<b>0.33</b>	<b>48</b>	<b>&lt;0.0001</b>
Other zooplankton (µg/L)	-0.06	0.34	0.00	48	0.86

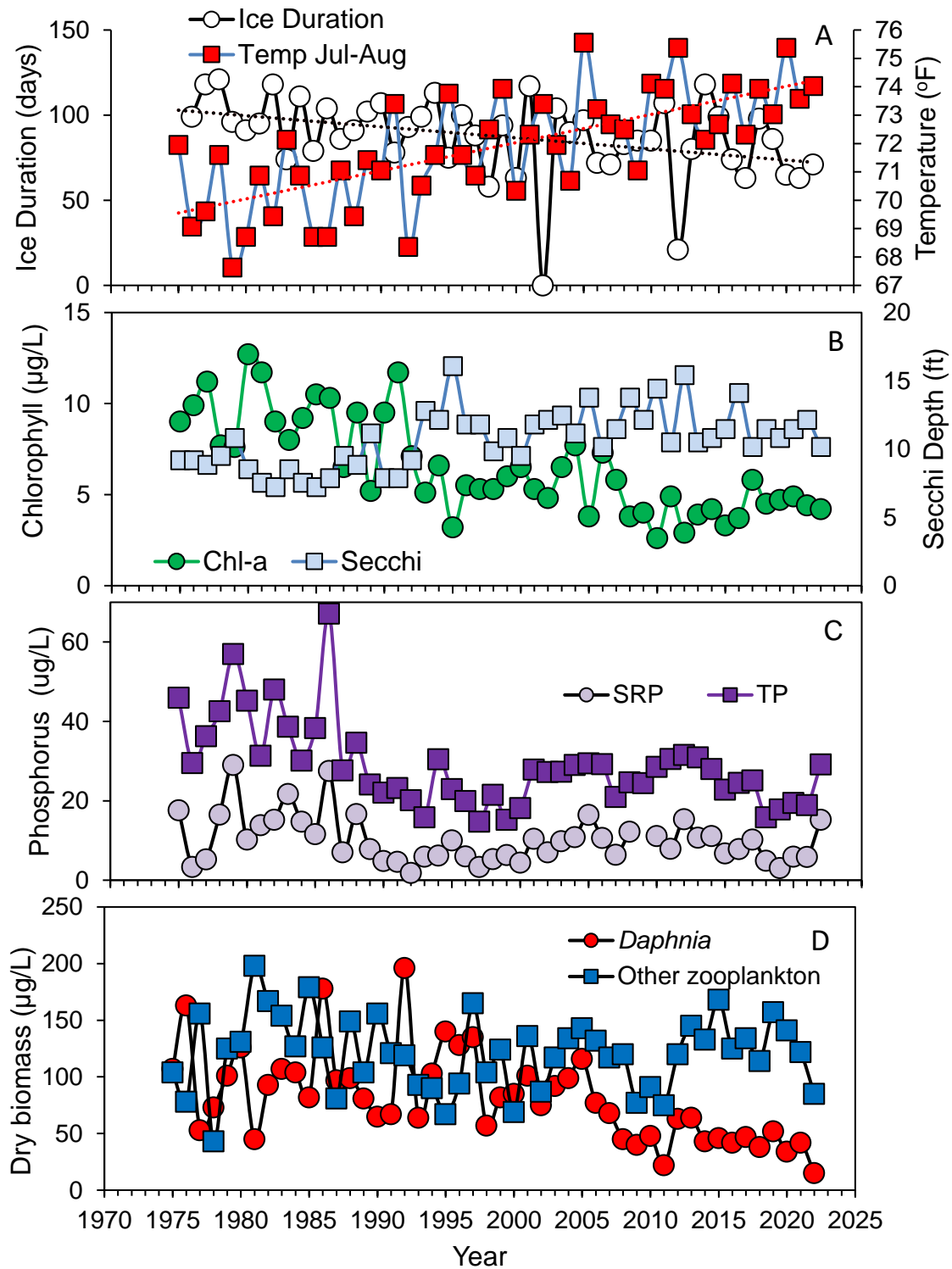
In last year's report (VanDeValk et al. 2022), changes in limnological data were analyzed by comparing four time periods that correspond to major changes in Oneida Lake (Table 2): Eutrophic Period (1975-1986), Pre-Mussel Period (1987-1991), Zebra Mussel Period (1993-2007) and Quagga Mussel Period (2009-2022). Note that the 2022 values are included in the QM period. Table 2 also provides data for 2022 separately. Although adding one more year to these analyses was not expected to change the conclusions made last year, it is still informative to see how 2022 compares with the observed time trends. The years 1992 and 2008 were excluded from these analyses as those years were considered transition years. Periods were compared using ANOVA followed by Tukey's HSD to test for differences among time periods.

**Table 2. Analyses of limnological data divided in four time periods: 1) Eutrophic (1975-1986), 2) Pre-Mussel (1987-1991), 3) Zebra Mussel (ZM, 1993-2007), and 4) Quagga Mussel (QM, 2009-2022). The ANOVA column shows the adjusted  $r^2$  and in parentheses the number of years and the overall model  $p$ -value; significant models ( $P<0.05$ ) are in bold. Other columns provide the average annual values for each time period. Annual values are in Appendix 2 Table A1. Letters indicate significant differences between time periods. Summer temp is the average temperature for June through August at 6.6 ft depth, Ice is number of days with complete ice cover, BDO is the percent of sites sampled in June-August with bottom dissolved oxygen values below 3 ppm, TP (total phosphorus), SRP (soluble reactive phosphorus), Chl (chlorophyll), Secchi (a measure of water clarity), *Daphnia* spp. (dry mass) and Other zoop (dry mass) are calculated as averages of weekly values from May through October. Mussels refers to both zebra and quagga mussel shell-on dry weight collected in the annual fall survey (September through November). Analyses conducted using the statistical package Jmp v16.0.**

Indicator	ANOVA	Eutrophic	Pre-Mussel	ZM	QM	2022
Summer temp (°F)	<b>0.47 (46, &lt;0.0001)</b>	<b>70.0 [A]</b>	<b>71.2 [A,B]</b>	<b>72.3 [B,C]</b>	<b>73.4 [C]</b>	<b>73.9</b>
Ice (days)	0.06 (45, 0.13)	100.5 [A]	92.8 [A]	82.7 [A]	79.6[A]	71
BDO <3ppm (%)	<b>0.14 (46, 0.026)</b>	<b>9.2 [A]</b>	<b>13.0 [A,B]</b>	<b>20.0 [A,B]</b>	<b>25.8 [B]</b>	<b>16</b>
TP (µg/L)	<b>0.56 (46, &lt;0.0001)</b>	<b>42.5 [A]</b>	<b>26.3 [B]</b>	<b>23.3 [B]</b>	<b>24.8 [B]</b>	<b>29.1</b>
SRP (µg/L)	<b>0.30 (45, 0.002)</b>	<b>15.5 [A]</b>	<b>8.2 [A,B]</b>	<b>7.9 [B]</b>	<b>8.9 [B]</b>	<b>15.2</b>
Chl (µg/L)	<b>0.71 (46, &lt;0.0001)</b>	<b>9.7 [A]</b>	<b>8.5 [A]</b>	<b>5.6 [B]</b>	<b>4.1 [C]</b>	<b>4.2</b>
Secchi (ft)	<b>0.51 (46, &lt;0.0001)</b>	<b>8.5 [A]</b>	<b>9.2 [A]</b>	<b>11.8 [B]</b>	<b>11.8 [B]</b>	<b>10.2</b>
Mussels (g/m <sup>2</sup> )	0.10 (29, 0.053)			289 [A]	378 [A]	363
<b>Daphnia (µg/L)</b>	<b>0.46 (46, &lt;0.0001)</b>	<b>103 [A]</b>	<b>82 [A]</b>	<b>95 [A]</b>	<b>43 [B]</b>	<b>15</b>
Other zoop. (µg/L)	0.0 (46, 0.457)	132 [A]	122 [A]	111 [A]	120 [A]	85

Several limnological parameters in 2022 mirrored trends identified in last year's report (VanDeValk et al. 2022). **Water temperature** was again high. The year 2022 had the 6th highest June-August temperature in the data set which was consistent with a trend of ~1° F increase per decade observed since 1975 (Figure 1A, Table 1). All five warmer summers have occurred since 2005. For a global perspective that includes Oneida Lake see O'Reilly et al. (2015). Although not yet detrimental to walleye growth, average lake temperature during the warmest months (July-August, 75.9 °F) was higher than the optimum temperature for walleye growth (73.4 °F, Kitchell et al. 1977, Lantry et al. 2008). **Ice duration** was relatively short in 2021-22 (Table 1, two weeks shorter than the average since 1975), consistent with the trend since 1975 of shorter ice duration on the lake (Figure 1A). Loss of ice cover is accelerating in lakes worldwide (see Sharma et al. 2021 for an analysis of worldwide trends that includes Oneida Lake). Average May-October **water clarity** remained high and **chlorophyll** levels low

(Figure 1B), consistent with the impact of zebra and quagga mussels on the lake (Karatayev et al. 2023). Major algae blooms were not observed in 2022.

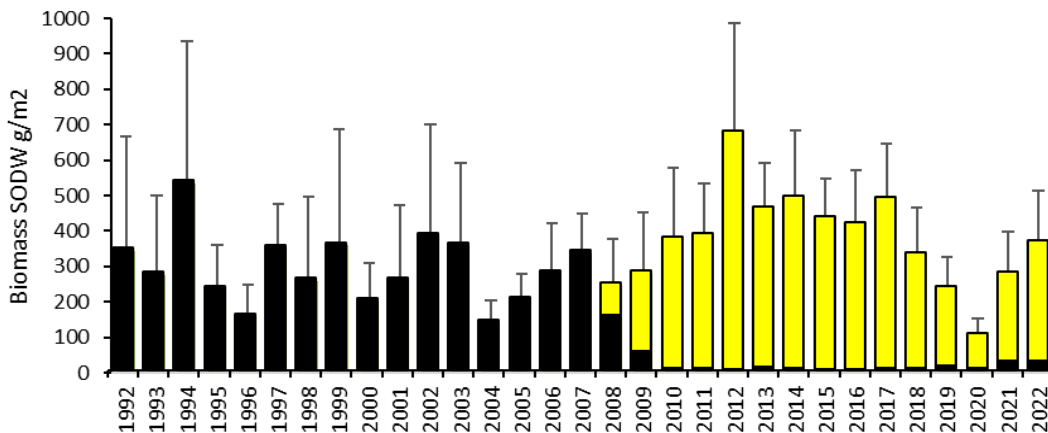


**Figure 1. Time trends of major limnological measures for Oneida Lake 1975-2022. Data available in Rudstam (2023a,b), Rudstam and Jackson (2022) and in Appendix 2 Table A1.**

**Phosphorus** levels increased in 2022 compared to the last four years although values were similar to measurements in 2000-2014 (Figure 1C). Higher phosphorus levels occurred particularly in the late summer and fall periods and coincided with low nitrate levels. Although phosphorus limits Oneida Lake algae production in early summer (Volponi et al. 2022), these results suggest that algae were limited by nitrogen and not phosphorus in late summer and fall of 2022. *Daphnia spp.*, a preferred zooplankton prey for young fish, declined to the lowest levels recorded to date in 2022 (Figure 1D). This was likely related to the spiny water flea and to a moderate population of age-0 fish in 2022. Our preliminary analysis suggests the low *Daphnia* did not negatively impact age-0 yellow perch in 2022, and effects were likely offset by consumption of spiny water fleas (as observed for 2020 and 2021, Jordan et al. 2023). The **spiny water flea** *Bythotrephes longimanus* was still abundant in 2022 but less so than in 2020 and 2021. In 2021 this species contributed about half of age-0 yellow perch diets by mass and, contrary to expectations, did not negatively affect age-0 yellow perch growth (Jordan et al. 2023).

**Oxygen levels** in bottom waters (33 ft [10 m] depth) were below 3 ppm (limiting to fish) on 8 of the 50 (16%) sampling occasions in June through August 2022. This was a lower percentage of days of oxygen depletion than average in the zebra and quagga mussel periods although the overall trend of increasing occurrence of low oxygen in the bottom waters continues (Tables 1 and 2). Hetherington et al. (2015) showed that this trend is expected given increasing temperatures; however, the time between strong wind events may also be important.

The lake-wide decline in **zebra and quagga mussel** biomass coincident with the arrival of round goby did not continue. The mussel biomass increased in 2021 and 2022 compared to low values in 2020 (Figure 2) due to recruitment of age-0 mussels in both 2021 and 2022. The decrease in quagga mussels from 2017 to 2020 may be attributed to round goby predation (Brooking et al. 2022), but the round goby population remained high in both 2021 and 2022. The increase in mussel biomass occurred primarily on soft substrates while gobies are more abundant on rocky and sandy substrates where mussel biomass remained low.



**Figure 2. Dreissenid biomass (SODW is shell on dry weight) in Oneida Lake 1992-2022. Zebra mussel biomass indicated in black, quagga mussel biomass in yellow. Error bars represent 1 SE. Data available online in Rudstam (2023c).**



Several **benthic invertebrate groups** (amphipods, snails, caddisflies, worms), major food resources for yellow perch and white perch *Morone americana*, have declined with the invasion of the round goby (Brooking et al. 2022), and low densities of these groups continued in 2021 and 2022. However, there was some increase in snails in 2022 compared to 2020 and 2021 (Figure 3).

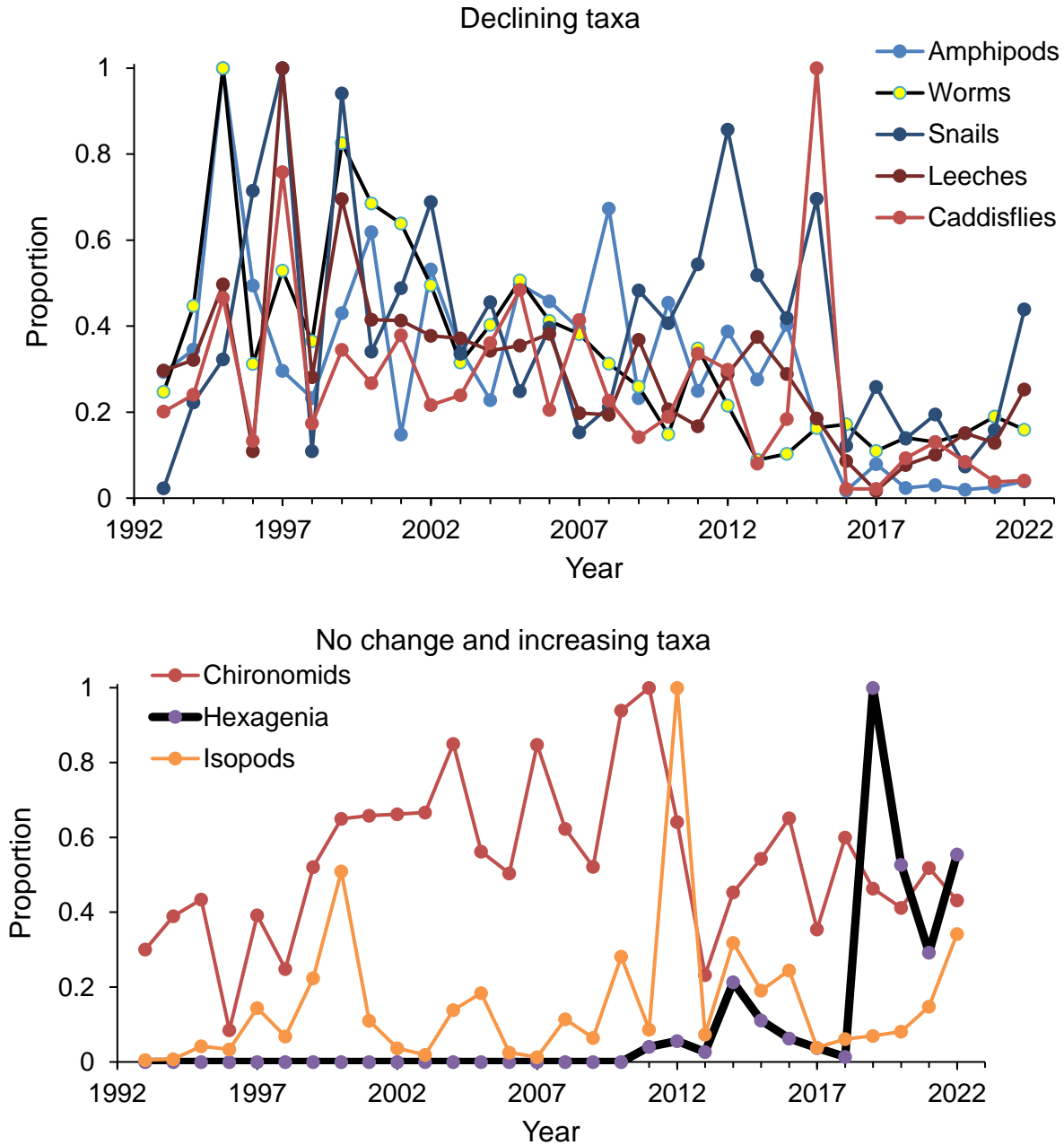
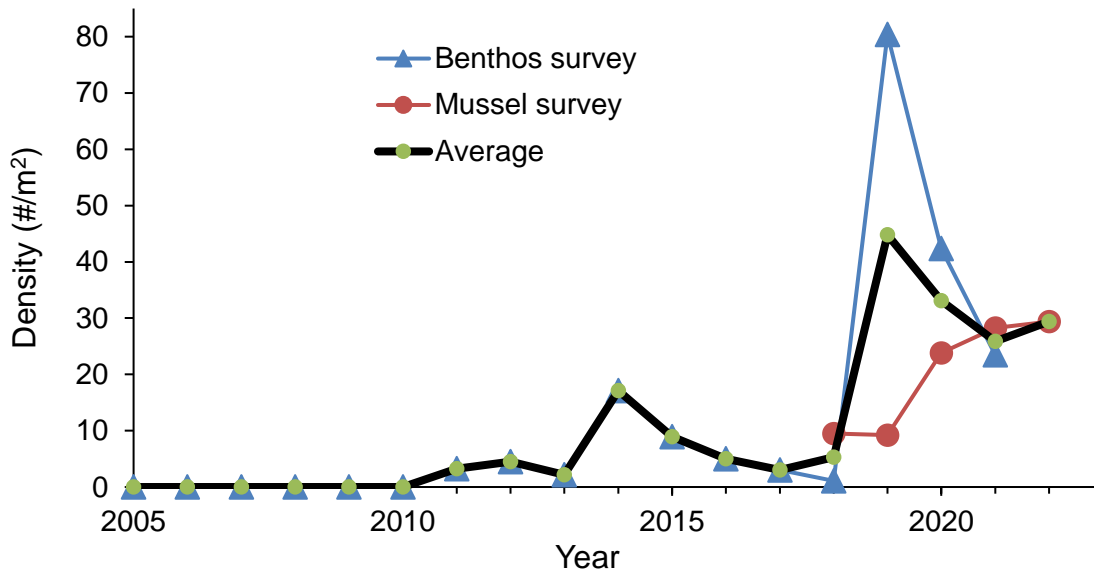


Figure 3. Trends in benthic invertebrates that have decreased (top panel) and remained the same or increased (bottom panel) since the arrival of zebra mussels, 1993 to 2022. The scale on the Y-axis refers to the proportion of the maximum value recorded in 1993-2022 for each group. Values are averages of spring, summer and fall densities found in two deep and one shallow benthic grab sites. Total numbers of grabs included in each value range from 19 to 42. Data available online in Rudstam (2023d).

In contrast to these benthic invertebrates, **the burrowing mayfly** *Hexagenia* spp., was again abundant in the lake in 2022 (Figure 4) and was a major part of yellow perch and white perch diets, as it has been since about 2012 (Brooking et al. 2022). The burrowing mayfly is likely to affect predator-prey interactions between yellow perch and walleye by buffering predation on age-0 fish by the adults of these species. The presence of abundant mayfly in June may lead to better survival of age-0 year classes of both species.



**Figure 4. Changes in *Hexagenia* spp. abundance in Oneida Lake from the benthos survey (since 2005) and the mussel survey (since 2018). See Hetherington et al. (2019) and Brooking et al. (2022) for details on methods.**

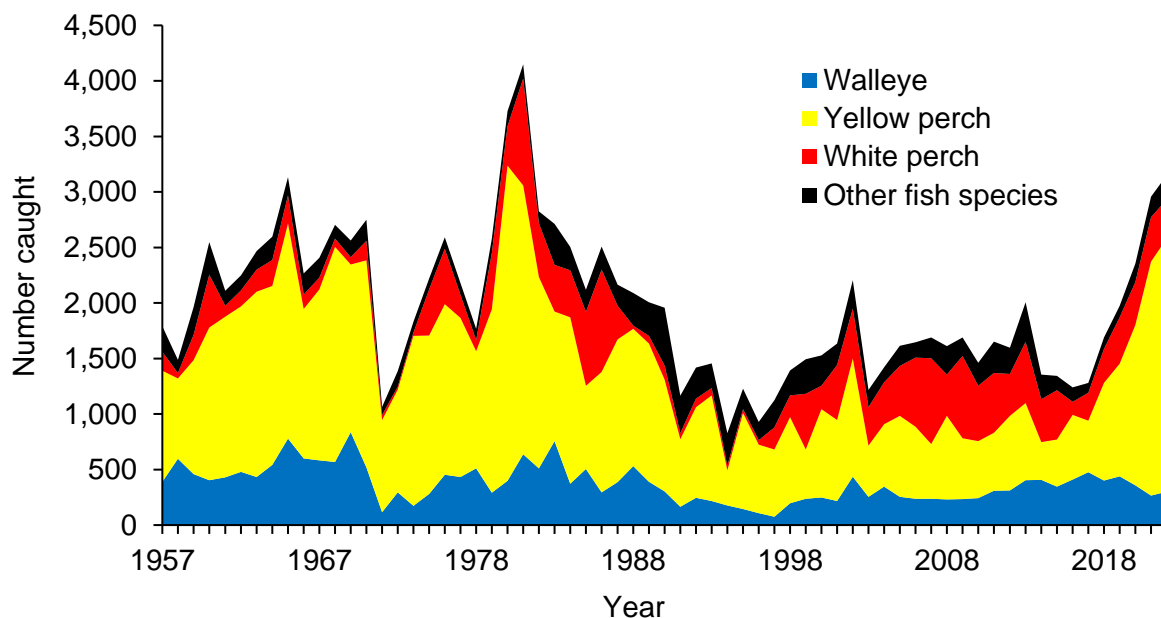
Increased consumption of round goby and of burrowing mayfly by yellow perch and white perch compensated for declines in consumption of other benthic invertebrates, and a decline in **growth rates** of these fish species through 2020 was not detected (Brooking et al. 2022).

Oneida Lake continues to change both physically and biologically. Climate change has resulted in warmer summer water temperatures and shorter duration of ice cover. Warm summer water temperatures may make the lake a better place for warmwater species such as sunfish and bass, but a worse place for walleye and yellow perch. Invasive species that are affecting food web interactions and ecosystem function are zebra mussels (arrived in 1991) quagga mussels (in 2005), round goby (in 2013), and the spiny waterflea (in 2019). Other important changes are the return of the native burrowing mayfly in high numbers since 2019 and declines in other bottom fauna and *Daphnia*. These physical and biological changes will affect the lake’s fish community and its fishery, but note that these changes can be both positive and negative for the fishery.

## Fish Community

The Oneida Lake fish community is sampled using gill-net surveys (since 1957, except 1974) to assess subadult and adult percid abundances, trawl surveys (since 1961) to assess offshore prey fish abundances, seine surveys (intermittently since 1959) and fyke-net surveys (since 2007) to assess inshore prey fish abundances, hydroacoustic surveys (since 1993) to assess pelagic prey fish abundances, spring electrofishing surveys (since 2011) to assess the centrarchid community, and spring (since 1992) and fall (since 1957) trap-net surveys to assess seasonal inshore adult fish abundances. Fish community survey results by gear are provided below.

Gill-net survey – Gill-net catches in Oneida Lake are typically dominated by yellow perch, white perch and walleye. These three species have represented over 70% of the total gill-net catch in every year since sampling started in 1957. In 2022, the gill-net catch of walleye was 301 fish (Appendix 2 Table A2); below the long-term average of 372 fish but similar to the average catch since 2007 of 336 fish (Figure 5). The gill-net catch of white perch was 351, above the long-term average of 308 fish but lower than the average of 437 fish since 2007. The gill-net catch of yellow perch was 2,279, continuing an increase that started in 2018 and exceeded all other annual catches since the early 1980s. The smallmouth bass catch matched 2019 with a catch of 17; the lowest observed since the mid 1980s. Other common species such as freshwater drum *Aplodinotus grunniens*, gizzard shad *Dorosoma cepedianum* and white sucker *Catostomus commersonii* were captured in numbers within the range of recent years. Notable catches of less common species in the gill net include 15 rock bass *Ambloplites rupestris* which was the third year in a row with a double digit catch (highest observed since 1989). The pumpkinseed *Lepomis gibbosus* catch was also relatively high. Burbot *Lota lota* catches in gill nets since 1957 indicate significant population declines; no burbot were caught in gill-net surveys since 2013. Fall trap-net surveys also indicate a significant decline; the mean catch per net-night in fall trap nets since 2000 was 1.35 burbot, well below the average from previous years (Appendix 2 Table A20, 5.22 fish/net-night, data on file, CBFS).



**Figure 5.** Total annual catch of three major fish species in standard gill-net surveys in Oneida Lake since 1957. There was no gill-net survey conducted in 1974.

Trawl survey – Seven species of prey fish were caught in standard 18-foot trawl surveys in 2022 (Appendix 2 Table A3). Age-0 yellow perch (106.5/haul) was the most abundant prey fish species, followed by round goby (16.6/haul) and white perch (4.2/haul). Round goby and age-0 walleye, yellow perch, white perch and smallmouth bass trawl catches are discussed further in the Species of Interest section below. For the third year in a row the catch of trout-perch *Percopsis omiscomaycus* (1.8/haul) was lower than all other years between 1977 and 2019 while the 2022 catch of age-1 and older pumpkinseed (1.3/haul) was the third highest on record (the catch in 2021 being the highest, data on file, CBFS). Otoliths removed from a sample of 27 pumpkinseed indicated a strong 2019 year class (74% of the trawl catch) which was consistent with 32 fish aged from gill nets (66%). No tessellated darters *Etheostoma olmstedi* were caught in trawl surveys for the fifth year in a row and only six have been caught in 980 trawl hauls after 2014 when round goby arrived. The mean CPUE prior to 2014 was 8.40/haul. The loss of *Etheostoma* spp. after round goby arrival has been documented elsewhere (Lauer et al. 2004).

Fyke-net survey –Catches in the large (½ in) mesh nets in 2022 were dominated by age-1 and older yellow perch (19.4/net-night) followed by age-1 and older pumpkinseed (6.2/net-night, Appendix 2 Table A4). The age-0 largemouth bass catch fell below 1.0/net-night and the age-0 smallmouth bass catch remained below 1.0/net-night for the third year in a row.

Catches in the 3/16 in mesh nets in 2022 were dominated by age-0 *Lepomis* spp. (325.4/net-night) followed by age-0 yellow perch (131.6/net-night) and round goby (33.2/net-night, Appendix 2 Table A4). Catch rates of other species were all below 5.0/net-night. The age-0 largemouth bass catch rate fell below 1.0/net-night for the first time since 2017 while the age-0 smallmouth bass catch rate increased from last year to 1.3/net-night (but still below the data set average of 3.3/net-night, Appendix 2 Table A4).

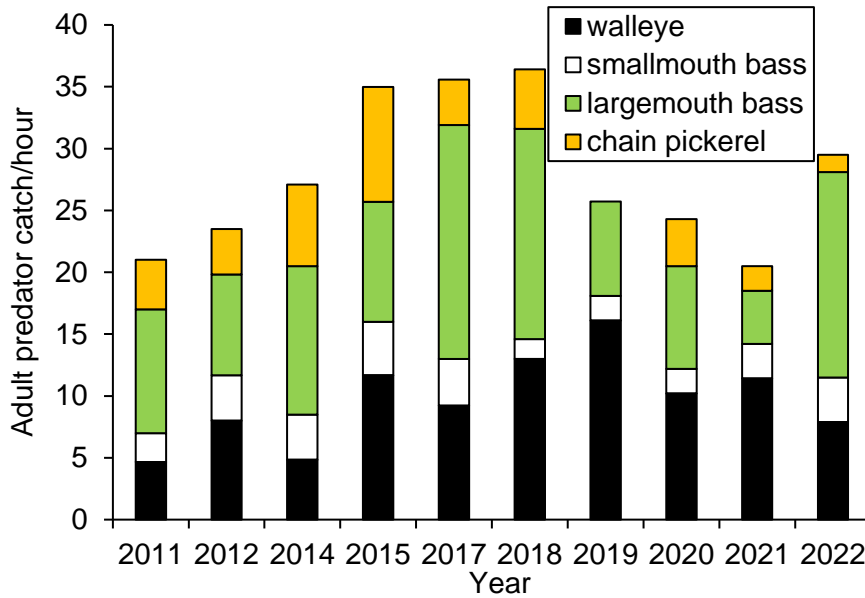
Fyke nets provide the only index of young of year largemouth bass abundance prior to the initiation of regular shoreline seining in 2015, and also show potential as an index for sunfish and esocids. Fyke nets do not show potential as an index of adult black bass, and an index of largemouth bass requires shoreline electrofishing. Fyke nets are one of our primary gear for indexing age-0 smallmouth bass abundance over the long term (beach seining serves as a more traditional index but has not been conducted as consistently since the mid-2000s as fyke-net sampling). The use of fyke nets as an index of age-0 black bass abundance is discussed in more detail in the Black bass section of the Species of Interest.

Shoreline seine survey – A shoreline seine survey was implemented in 2015 to address potential shifts in habitat use by age-0 yellow perch from offshore areas (where they are indexed by our trawl samples) to inshore areas (Fetzer 2013, Fetzer et al. 2015). Daytime seining with a 75 ft (22.9 m) beach seine with ¼ in mesh is conducted at nine sites with available long-term data once every month from July through September.

Seine samples in 2022 were dominated by age-0 yellow perch (138.3/haul) and round goby 123.7/haul for the three surveys conducted. Banded killifish *Fundulus diaphanous* (33.4/haul) and emerald shiner *Notropis atherinoides* (21.2/haul) were the other two most common species caught (Appendix 2 Table A5). Catch rates for all other species were less than 20/haul. The catch/haul of round goby in 2021 and 2022 were the two highest on record.

Centrarchid survey - In spring 2011, a shoreline electrofishing survey directed at centrarchids was initiated. In 2022, age-1 and older largemouth bass were captured at the highest rate among predators, followed by walleye (Figure 6, Appendix 2 Table A6). The smallmouth bass

catch rate remained stable at 2.6/hr but the chain pickerel catch rate was the lowest on record, continuing the decreasing trend that started in 2017.



**Figure 6. Catch rate (#/hr) of predators in spring electrofishing surveys for Oneida Lake since 2011. Chain pickerel was not included as a target species in 2019.**

Hydroacoustic survey - Pelagic prey fish (gizzard shad, emerald shiner and alewife/blueback herring *Alosa* spp.) abundance and biomass are estimated in the fall using hydroacoustics with supporting small-mesh gill nets and midwater trawling. Total pelagic prey fish density in 2022 was estimated at 531 fish/acre (1,312 fish/hectare, long-term average was 4,162 fish/acre, Appendix 2 Table A8). Biomass of pelagic prey fish was estimated at 10.5 lb/acre (9.4 kg/hectare, long-term average 28.5 lb/acre, Appendix 2 Table A8). Age-0 gizzard shad densities were higher than observed the previous 3 years but still only about half the long-term average of 989/acre, and age-0 and adult emerald shiner densities were the lowest since assessments began in 1993 (Figure 7). Biomass of pelagic prey fish was the third lowest on record. The pelagic prey fish survey did not catch any alewife *Alosa pseudoharengus* or blueback herring *A. aestivalis*. These clupeids were common in early surveys (1993-1996) but have been caught in low numbers in only seven surveys since.

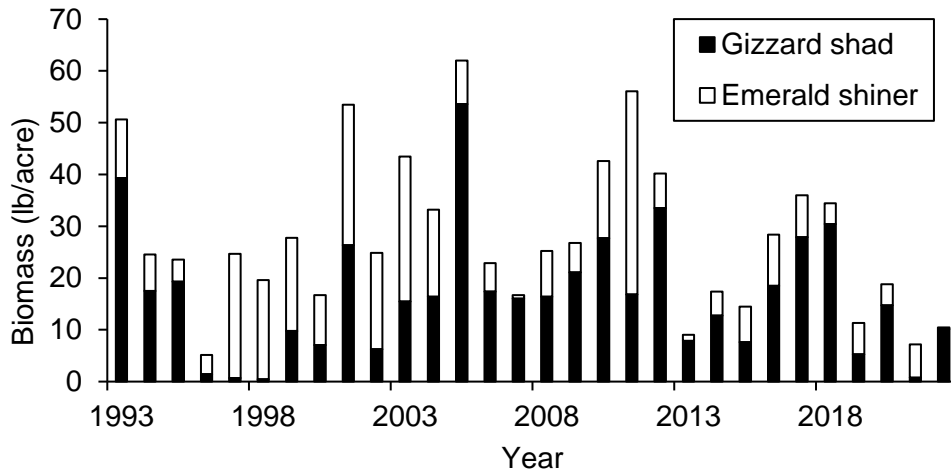


Figure 7. Time trends in biomass (lb/acre) of emerald shiner and age-0 gizzard shad from hydroacoustic estimates for Oneida Lake since 1993.

### Species of Interest

More detailed population assessments of species of particular interest are provided below. These species are walleye, yellow perch, white perch, black bass (smallmouth bass and largemouth bass), lake sturgeon *Acipenser fulvescens*, round goby and double-crested cormorants.

Walleye - The walleye population in Oneida Lake is assessed at several life stages: as larvae (lengths of 9-13 mm) with Miller high-speed samplers; as juveniles in the spring, summer and fall with bottom trawls; and as juveniles and adults with gill nets in the summer. Adult (age-4 and older) abundance estimates are supported with mark-recapture estimates at regular intervals (currently every 3 years).

The 2022 adult walleye population was estimated using mark-recapture. A total of 21,560 age-4 and older walleye (10,805 males and 10,755 females) were marked with a left ventral (LV, also called pelvic fin) fin clip from late March through mid-April. Recapture efforts from June into November provided 1,660 adults for examination for clips of which 56 were clipped. The resulting adult walleye abundance was estimated at 628,000 ( $\pm 23\%$ , Figure 8; Appendix 2 Table A9). The 2016 year-class remained strong accounting for almost half of the adult population. The adult walleye population has shown a significant increasing trend since 2007 (Table 3).

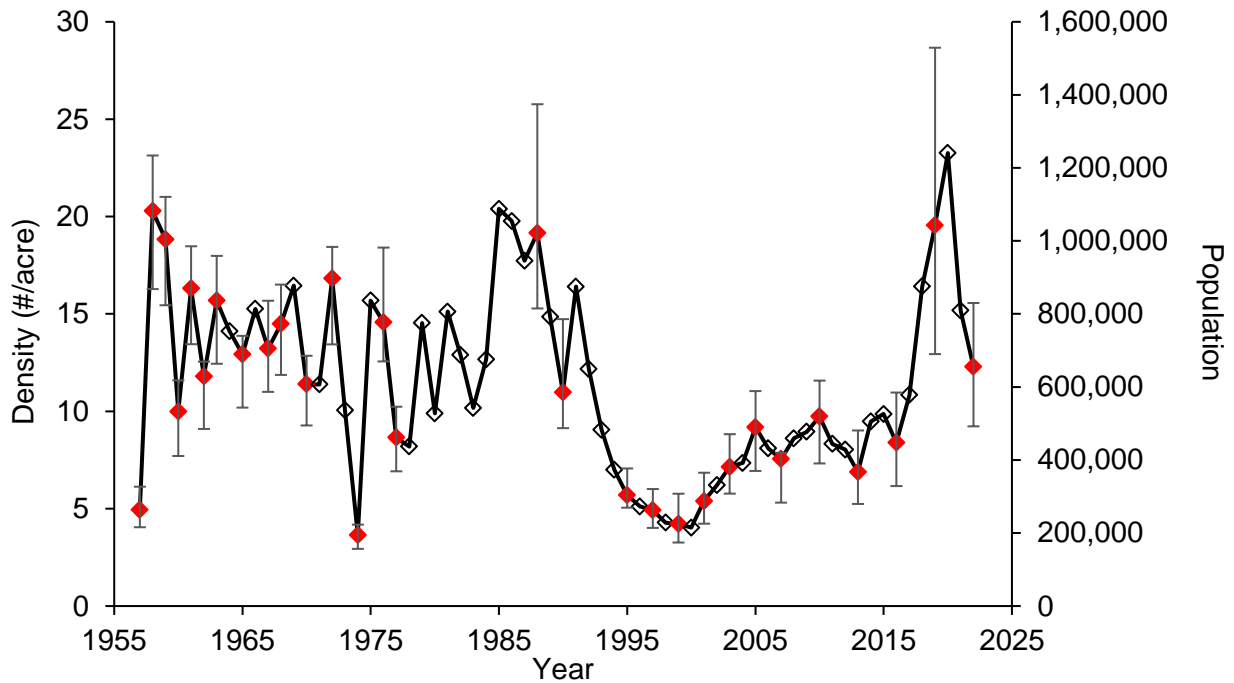


Figure 8. Density of adult (age-4 and older) walleye in Oneida Lake since 1957. Red markers indicate mark-recapture years with associated 95% confidence limits. Secondary y-axis provides population scale.

Table 3. Recent trends (2007-2022) in walleye abundances at various life stages in Oneida Lake. Significance levels are based on simple linear regression. Data are presented in Appendix 2 Table A9. Trend indicates direction (+ or -) over time, with  $r^2$  and  $p$  reported for regressions. Significant trends indicated by bold type.

Variable	Trend	$r^2$	$p$
Adult population size	<b>+</b>	<b>0.47</b>	<b>&lt;0.01</b>
Larval density	-	0.06	0.77
Age-0 density	+	0.05	0.42
Spring age-1 density	-	0.03	0.56

The catch for the recapture portion of the mark-recapture was obtained by pooling catches from multiple offshore and inshore sampling methods. Offshore areas were surveyed using gill nets and bottom trawls (18' trawl prey fish surveys and 30/40' trawl surveys conducted specifically for mark-recapture). Inshore areas were surveyed using fyke nets and electrofishing (spring Centrarchid survey in June and fall electrofishing surveys conducted specifically for mark-recapture). Most (70%) of the catch examined for clips came from fall targeted electrofishing surveys, followed by targeted 30/40' trawl surveys (15%) and gill net surveys (9%) with the remaining 3 surveys accounting for 5% of the fish examined combined. Estimates of the lake-wide adult walleye population derived using offshore catches only can be substantially different than estimates using inshore catches only. Of the 29 walleye mark-recapture estimates generated since 1957, only 12 comparisons between estimates based on offshore catches and estimates based on inshore catches from the same year differed by 30% or less, with estimates based on offshore catches being higher 83% of the time. In 2022, the estimate based on offshore catches was 32% higher than the inshore estimate and CLs did overlap.

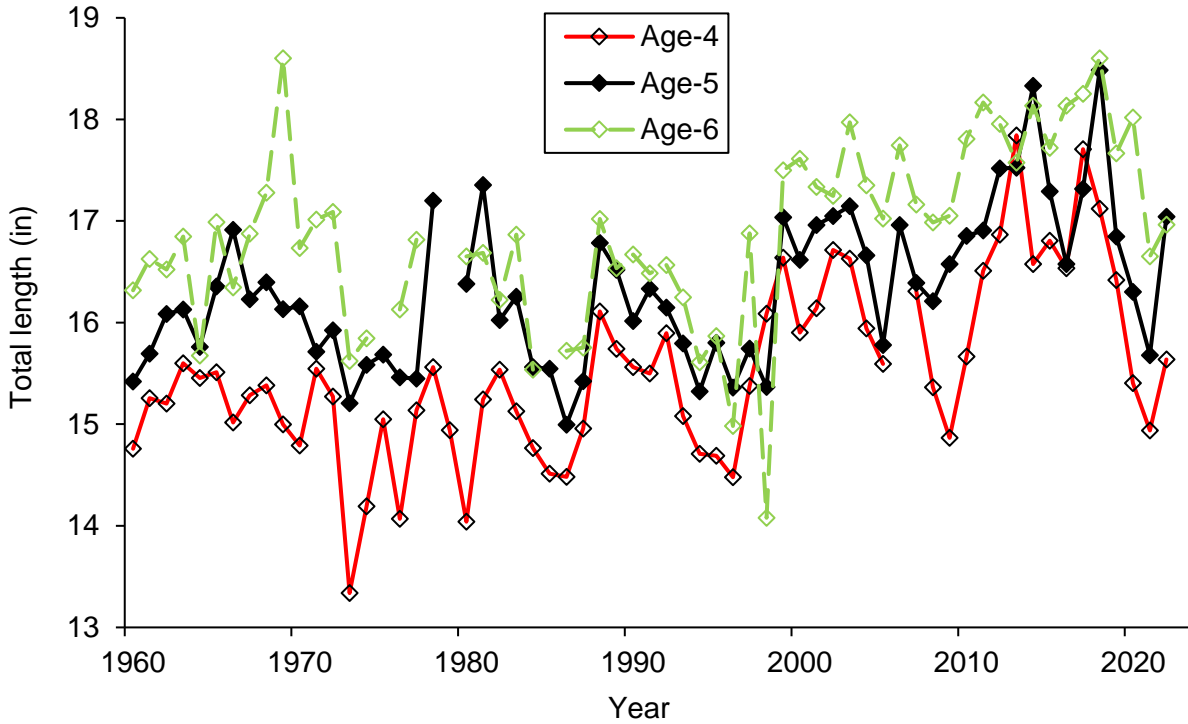
The discrepancy between estimates based on offshore and inshore catches could be due to the distribution of sampling effort. One of the assumptions of mark-recapture is that marked fish randomly mix with unmarked fish OR that recapture effort is distributed in proportion to the number of fish in different parts of the population area (Van Den Avyle 1993). Walleye marked at the hatchery do not randomly mix with the unmarked population (Forney 1963); therefore, offshore and inshore recapture effort is distributed in proportion to fish density. However, because recapture effort of gears used offshore is not comparable to effort of gears used inshore, it is unclear whether fish are sampled in proportion to their offshore and inshore abundances. In 2005, walleye caught by electrofishing during the fall recapture period were marked with a unique fin clip. Walleye were subsequently examined the following spring (2006) for fall 2005 clips. The resulting fall estimate from fall tagging was in close agreement with the previous spring's estimate. However, the 1,276 walleye marked in the fall provided only 14 recaptures the following spring resulting in wide 95% CLs. While this exercise did provide some reassurance that our recapture methodology was valid, continued discrepancy between estimates from offshore and inshore catches is concerning. Year 2 of the scheduled telemetry project should provide valuable insight into the post-spawn distribution of walleye clipped at the hatchery for mark-recapture population estimation.

The adult population estimated by age provided an observed mortality of 84% over the 3-year period (2019-2022). The resulting annual mortality rate for that period was 0.46, more than triple what was estimated from 2016-2019 (0.14). Two possible explanations for the dramatic increase in mortality are: 1) angler harvest increased substantially during the period from 2019-2022, or 2) the 2019 adult population was over-estimated, or a combination of the two. While angler harvest can result in high annual mortality (for example anglers removed 50% of the adult population in 1959, Grosslein 1961) estimates of harvest in 2019 and 2021 were approximately 10% annually. Angler harvest in 2020 was not estimated due to covid but the harvest rate required to account for the observed 3-year mortality rate of 84% would have had to have been around 70% which is unlikely. The 2019 adult walleye population estimate was based on only 24 recaptures and resulted in a 95% CL of 33%. If we assume the 2019 population was actually at the lower end of the 95% CL (700,000, still within the 95% CL) the resulting 2016-2019 mortality rate increases to 0.24 and the 2019-2022 mortality rate decreases to 0.38. At this lower 2019 population level a harvest rate of 0.40 in 2020 would account for the remainder of the mortality from 2019 to 2022.

Average catches of age-1 and age-2 walleye in trawls and gill nets combined with gear-specific catchabilities derived by Irwin et al. (2008) are used to predict future recruitment at age-4 (Jackson et al. 2020). Based on these relationships, we predict the 2019 year-class will add 90,000 age-4 fish to the adult stock in 2023 and the 2020 year class to add 133,000 age-4 fish in 2024. These additions combined with the 2022 mark-recapture estimate of adults (adjusted for annual mortality-25%, Irwin et al. 2008) suggest the adult population should remain at about 600,000 fish through 2024.

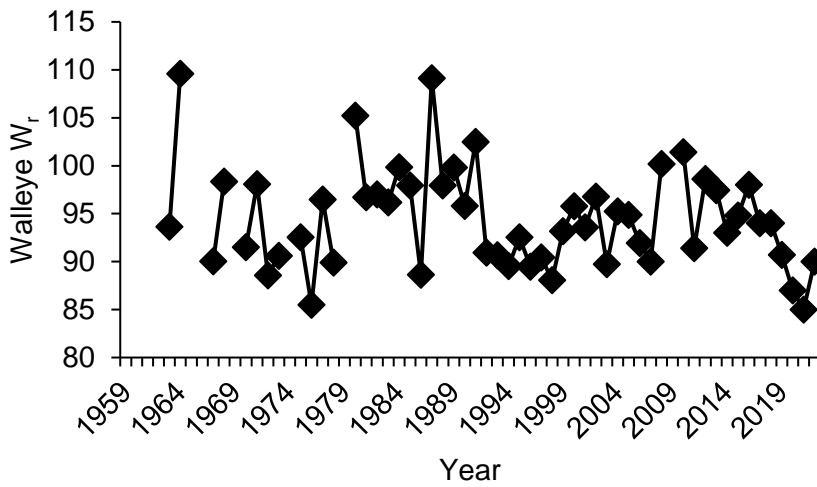
Adult walleye length at age is determined from fish collected in fall (typically October) using 40-ft bottom trawls and electrofishing. Despite significant increases in growth from 2007 through 2019 (Jackson et al. 2020), recent poor growth (Figure 9) has resulted in no change in length at age over the period of 2007-2022 (linear regression: age-4: N=16;  $r^2=0.07$ ;  $p=0.93$ ; age-5: N=16;  $r^2=0.07$ ;  $p=0.82$ ; age-6: N=16;  $r^2=0.01$ ;  $p=0.70$ ).





**Figure 9. Observed length at age for ages 4-6 walleye from fall trawls and electrofishing for Oneida Lake since 1960.**

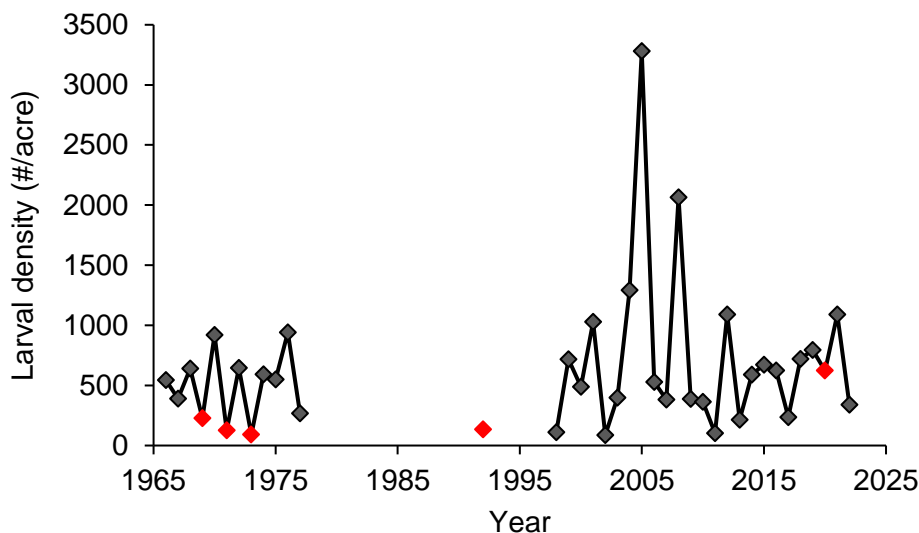
Because observed length at age is a culmination of growth conditions of every year the fish is alive, relative weight is likely a better indicator of growth conditions for a particular year. Fall relative weight is used to monitor condition of age-1 and older walleye caught in 40-ft trawl and electrofishing surveys each year (Figure 10). Relative weights for 2020 and 2021 were among the lowest in the data set. However, relative weight in 2022 exhibited a modest recovery (2022  $W_r=90$ ) approaching the long-term mean (mean  $W_r=94$ , since 1963).



**Figure 10. Relative weight ( $W_r$ ) of age-1 and older walleye caught in fall trawl and electrofishing surveys for Oneida Lake since 1963.**

Recent decreases in length at age and condition are indicative of a changing predator-prey community. Walleye growth has historically been dependent on availability of young yellow perch, with gizzard shad and white perch providing additional forage in recent decades (VanDeValk et al. 2008). Round goby was added to the forage base in 2014. Decreases in growth and condition observed in 2020 and 2021 are likely due to lower prey fish densities per walleye (Appendix 2 Tables A3 and A8). Fall diet assessments are consistent with these observations. The number of fish per pound of walleye examined in those years were below the long-term (since 1971) average, and gizzard shad, which typically are the most abundant diet item in the fall, appeared in fall diets at a lower rate than any year since 2003 (Appendix 2 Table A10). The modest recovery in length at age and condition observed in 2022 was likely due to a combination of fewer adult walleye and an increase in prey fish abundance. The recent addition of round goby to the Oneida Lake prey fish community has not resulted in improved growth of adult walleye to date despite being numerically the first or second most common fall diet item in recent years.

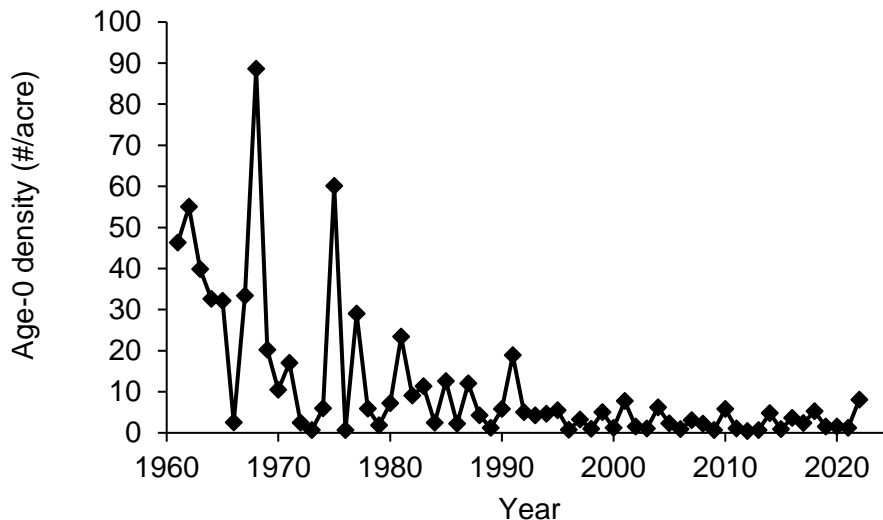
The Oneida Fish Cultural Station (OFCS) stocked 168 million walleye fry in Oneida Lake from late April to May 2 in 2022. The estimated larval abundance approximately 2.5 weeks after stocking was 339 fish/acre (838 fish/hectare, Figure 11) about half the long-term mean (648 fish/acre). To date no relationship between larval density and density at any later life stage has been demonstrated (Rudstam et al. 2016b).



**Figure 11. Time trends in larval walleye density (#/acre) for Oneida Lake for various years since 1966. Red markers indicate larval density estimates for years no walleye fry were stocked.**

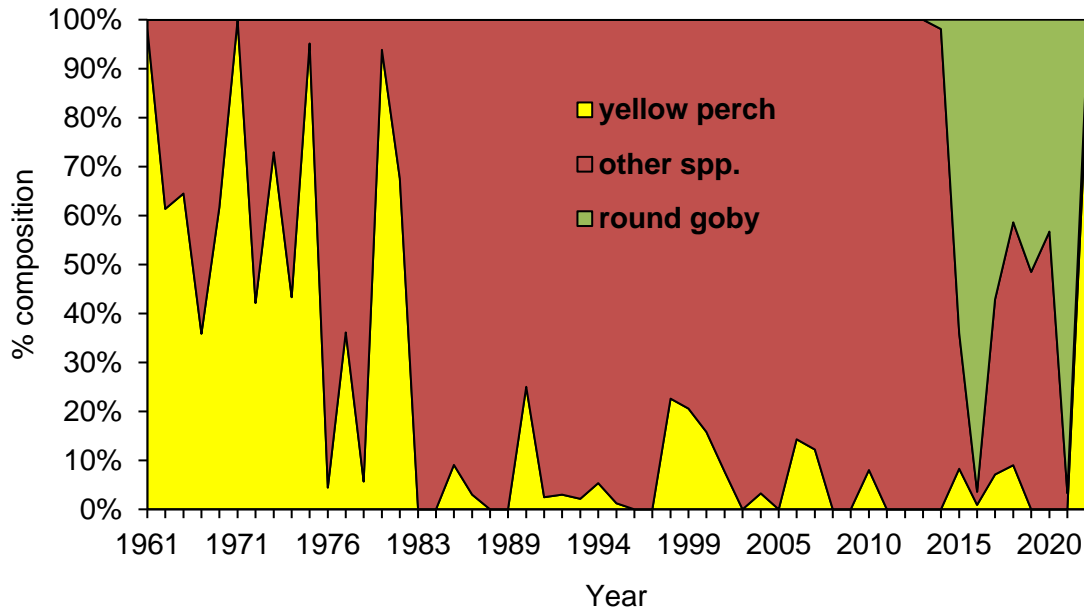
Data sets of fall age-0 and age-4 abundances indicate that the 2022 walleye year class may contribute substantially to the adult stock in 2026 despite low abundance at the larval stage. Age-0 walleye are monitored with 18-ft bottom trawl surveys beginning in mid to late July and catch per unit effort (CPUE) is converted to density assuming that each trawl samples an area of 0.25 acre (0.1 hectare) and there is no avoidance by young fish. Age-0 walleye densities and mean lengths on October 1 are from trawl surveys surrounding October 1 (approx. 9/15 to 10/15). This year the October 1 age-0 walleye density estimate was 8.1 fish/acre (20.0 fish/hectare, Appendix 2 Table A11). This fall age-0 density was the highest observed since 1991 (Figure 12, Appendix 2 Table A11). Fall age-0 density is positively correlated with

abundance at age-4 (Rudstam et al. 2016b). Additionally, the mean length on October 1 was 7.4 in (189 mm), the highest observed since 1998 (Appendix 2, Table A11). Forney (1976) found that the relative survival of walleye between the first and second year of life was 0.84 and 0.82 for the 1971 and 1973 year classes (mean length in October was 6.8 in and 6.7 in) compared to 0.006 to 0.19 for other year classes from 1966-1973 (mean lengths averaged 5.0-5.7 in). The combination of a relatively high fall age-0 density and large size going into the winter suggests we can expect a significant contribution from the 2022 walleye year class to the adult stock in 2026.

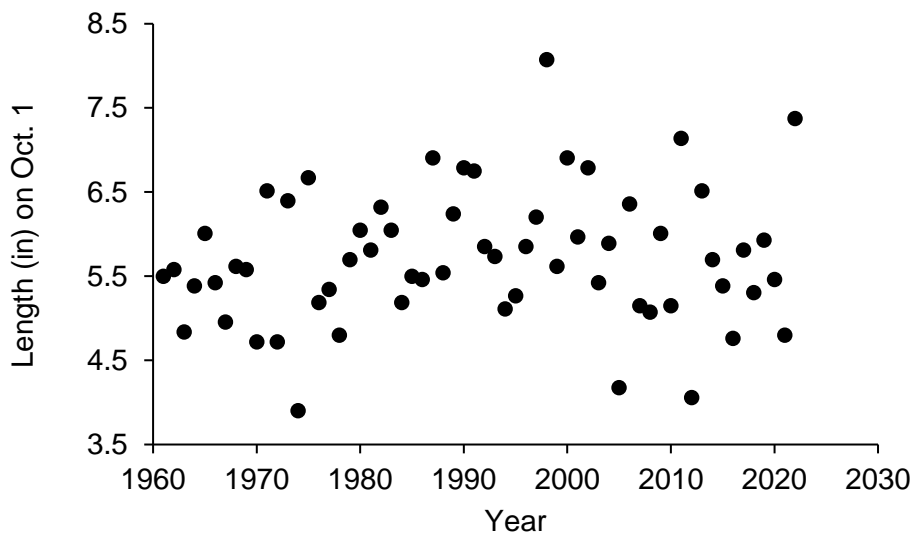


**Figure 12. Time trends in density (#/acre) of age-0 walleye on October 1 based on bottom trawls for Oneida Lake since 1961.**

As early as 2014 we hypothesized the addition of round goby to the Oneida Lake prey base may increase growth and decrease mortality of young walleyes (Jackson et al. 2015). Age-0 walleye mortality in Oneida Lake is attributed to predation by older walleyes, and predation is influenced by abundance of alternate prey as well as growth of young walleyes as it affects cannibalism (Forney 1976). Young walleye growth is determined by temperature and the abundance of appropriate-size prey fish (Forney 1966). The round goby spawns multiple times in a season so their addition to the fish community should provide appropriate-size prey for age-0 walleye throughout the season. Diets of age-0 walleye caught in 12-15 trawl surveys from July-October have been examined each year since 1961 (Figure 13). Diets over this 61-year period reflect the transition from a prey fish community dominated by age-0 yellow perch during the 1960s into the early 1980s to later-spawning species (including darter sp., white perch, sunfish, and gizzard shad, Hall and Rudstam 1999) during the mid-1980s through the early 2010s to round goby since 2014. While variable, length attained by October has not exhibited a trend despite the changes in the prey fish community (Figure 14). While it would have been convenient to attribute the large size of this year's age-0 walleye to round goby availability as we had hypothesized, age-0 yellow perch clearly were responsible for providing the energy to young walleye for growth as they accounted for 79% of all species identified in young walleye stomachs with round goby (14%), age-0 gizzard shad (4%), *Lepomis* spp. (2%) and logperch *Percina caprodes* (1%) accounting for the remaining 21%. Eleven mayflies (*Hexagenia* spp.) were recorded from the 179 stomachs examined.



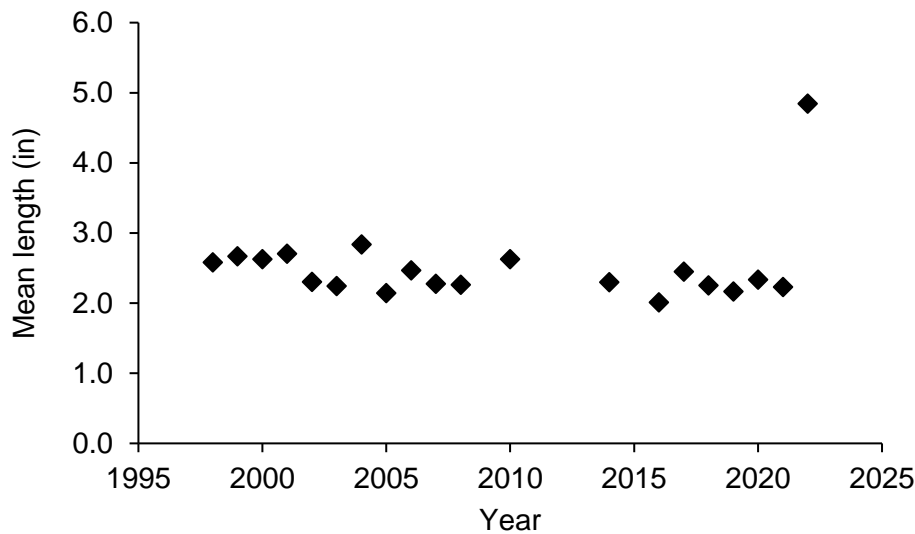
**Figure 13. Species composition of fish identified in diets of age-0 walleye caught in trawls since 1961.**



**Figure 14. Mean length of age-0 walleye caught in trawls in October since 1961.**

The shift in 2022 to yellow perch dominating young walleye diets is not easily explained. Age-0 yellow perch were sampled at the 18-mm stage (see below) from June 13-15 (mean date June 14, 3 days later than the long-term mean date) and were found to be relatively abundant (nearly twice the mean since 2007, see Figure 18 below). Age-0 yellow perch abundance was again sampled using trawls when they averaged 1.0 g in weight. In 2022, the date yellow perch averaged 1.0 g was July 25, the latest since 1994 (9 days later than the mean) so early-life growth was relatively slow. By August 1 age-0 yellow perch density was half the average observed since 2007. Age-0 walleye averaged 4.8 in (123 mm) by the time trawl surveys commenced in late July, by far the largest for recent years examined (since 1998, Figure 15). It appears age-0 walleye established a growth advantage over age-0 yellow perch shortly after the

yellow perch larval survey that allowed utilization of age-0 yellow perch as prey throughout the summer, an advantage not observed since the early 1980s. Analyses of factors affecting first-year walleye growth and survival are ongoing.



**Figure 15. Mean length of age-0 walleye at first trawl survey (late July) since 1998.**

The adult walleye population in Oneida Lake declined through the 1990s presumably due to double-crested cormorant predation on subadult fish (Rudstam et al. 2004). Aggressive double-crested cormorant management combined with a more restrictive daily harvest limit of three fish and 18 in minimum length contributed to a steady recovery through the 2000s and 2010s (Figure 8, Appendix 2 Table A9). After record high adult populations of around 1 million fish in 2019 and 2020, increased adult mortality and relatively low recruitment have resulted in a return of the adult population to slightly above the long-term average of 600,000 fish. Observed adult mortality combined with expected recruitment suggest the adult population will remain near the current level for the next 2 years.

Yellow perch - The yellow perch population in Oneida Lake is assessed at several life stages: as larvae with Miller high-speed samplers; as juveniles in the spring, summer and fall with bottom trawls and seines (summer and fall age-0 only); and as adults (age-3 and older) with gill nets in the summer.

In 2022, the method used to estimate the adult yellow perch population was modified in order to be more consistent with estimates provided on-line and used in recent publications. The new method still bases population estimates on gill-net catches but the catches are corrected for gill net selectivity by age rather than mean length (for a more detailed description of yellow perch abundance estimation see Appendix 1 Gill-net surveys). Estimates derived from the two methods are closely related ( $N=62$ ,  $r^2=0.97$ ,  $p<0.001$ ). The population estimate of adult yellow perch in 2022 was 3.0 million (58.2/acre, 144/hectare) and was the highest since 1981 (Figure 16, Appendix 2 Table A12). Catches over the last five summers reflect a recovery from a population low observed in 2014. The adult yellow perch population has increased significantly since 2007 (Table 4).

**Table 4. Recent trends (2007-2022) in adult and first-year yellow perch populations for Oneida Lake. Significance levels are based on simple linear regression. Data are presented in Appendix**

2 Tables A12 and A13. Trend indicates direction (=, + or -) over time, with  $r^2$  and  $p$  reported for regressions. Significant trends indicated by bold type.

Variable	Trend	$r^2$	$p$
Adult population size	<b>+</b>	<b>0.49</b>	<b>&lt;0.01</b>
Larval density	-	0.03	0.53
Age-0 density	-	0.16	0.13
Age-0 mean length	+	0.08	0.30
Spring age-1 density	-	0.01	0.83
Summer age-1 density	+	0.11	0.23

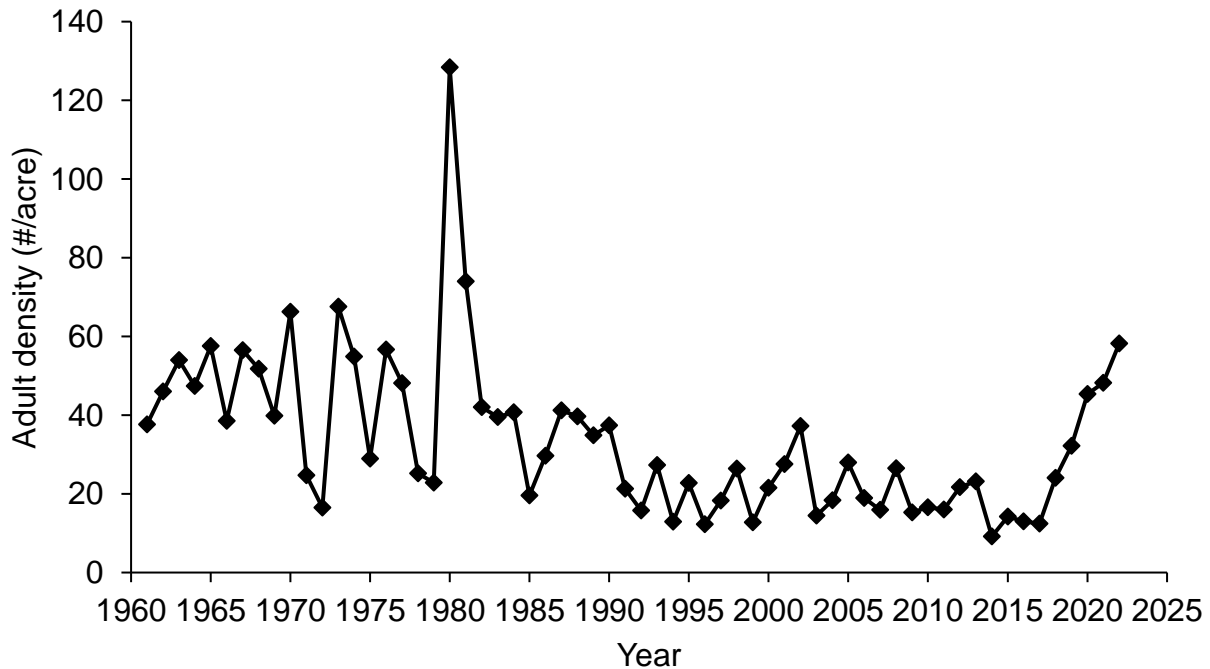
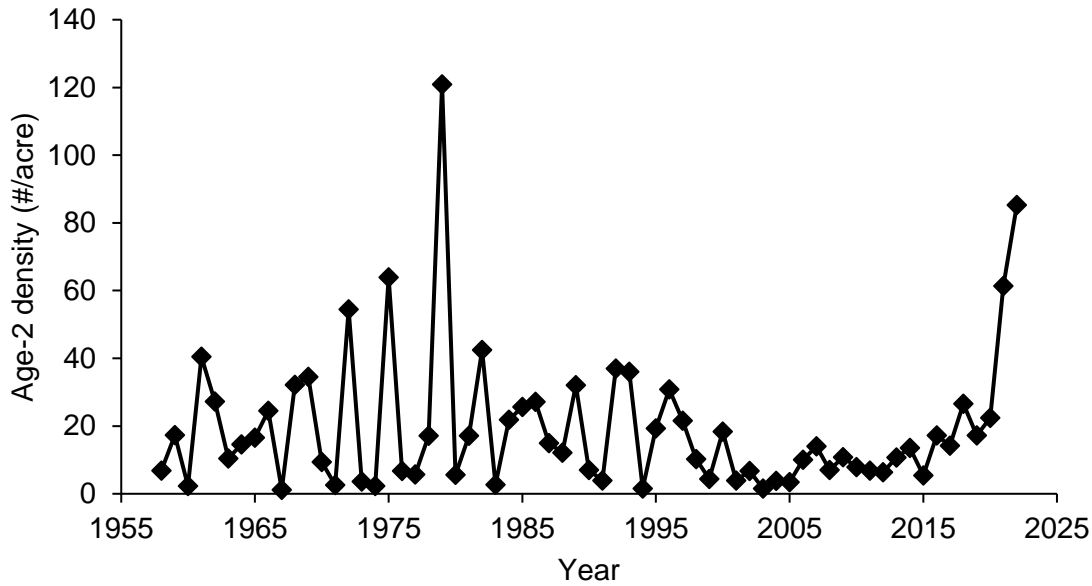


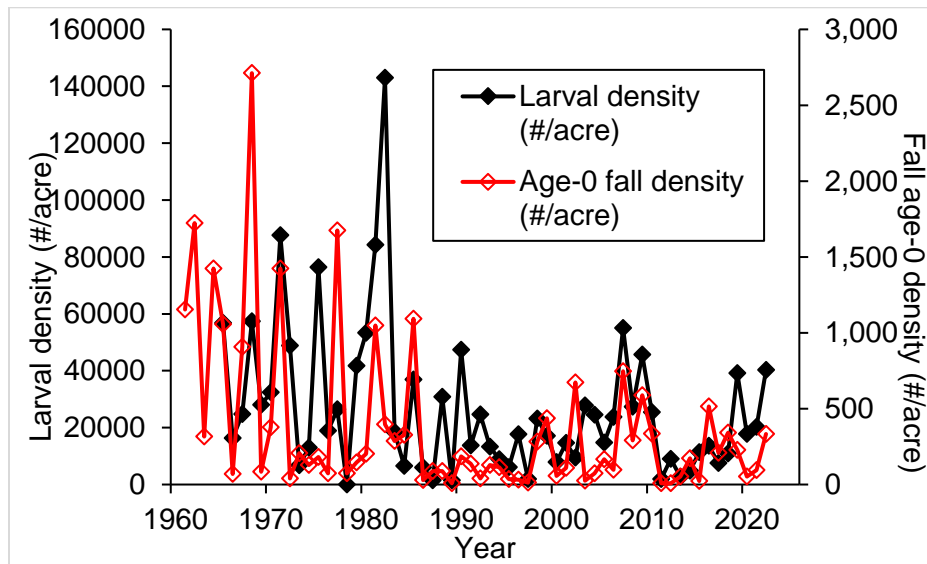
Figure 16. Time trends in age-3 and older yellow perch densities (#/acre) for Oneida Lake since 1961.

The catch in gill nets is also used to estimate age-2 yellow perch abundance (Figure 17, Appendix 2 Table A12) and year class abundance at age-2 is closely related to abundance the following year when they recruit to the adult population at age-3 ( $N=64$ ;  $r^2=0.79$ ;  $p<0.001$ ). The age-2 gill-net catch in 2022 was higher than any year except 1979 suggesting this year class (2020) could contribute substantially to an already high adult population in 2023. The 1977 year class of yellow perch was by far the strongest year class of yellow perch observed since monitoring began in the late 1950's and nearly quadrupled the adult population in 1980 by adding almost 4 million age-3 fish. Unlike the 1977 year class, the strength of the 2020 year class was not evident in trawl catches at age-0 or age-1 (see below). Reasons for this remain unclear. Catches of age-0 yellow perch in fyke-net surveys did indicate a strong 2020 year class but seine surveys did not.

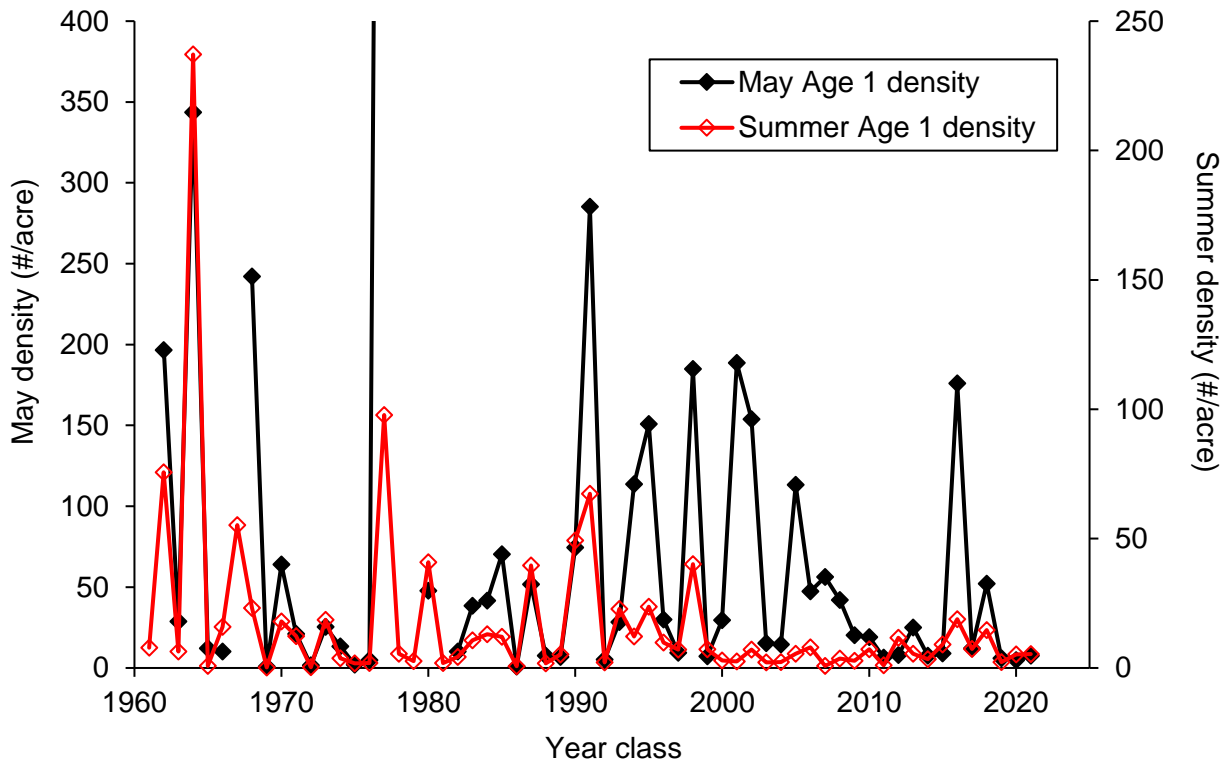


**Figure 17. Time trends in age-2 yellow perch densities (#/acre) for Oneida Lake since 1961.**

Abundance of age-0 yellow perch is measured at the larval stage (two surveys: 8 mm and 18 mm), and in 18-ft bottom trawls through the summer, and again as yearlings in trawls centered on May 1 (Appendix 2 Table A13). The larval yellow perch density at the 18 mm stage in 2022 was 40,200/acre (99,400/hectare) which was higher than the long-term average of 27,200/acre (67,000/hectare), and the highest since 2010 (Figure 18). Fall density of age-0 yellow perch was 334/acre (825/hectare, average of October trawl surveys) in 2022, below the long-term average of 385/acre (950/hectare, Figure 18). Spring yearling catches of yellow perch from the 2021 year-class indicated a density of 7.7/acre (19/hectare, Figure 19).



**Figure 18. Time trends in larval and fall age-0 yellow perch densities (#/acre) for Oneida Lake since 1961.**

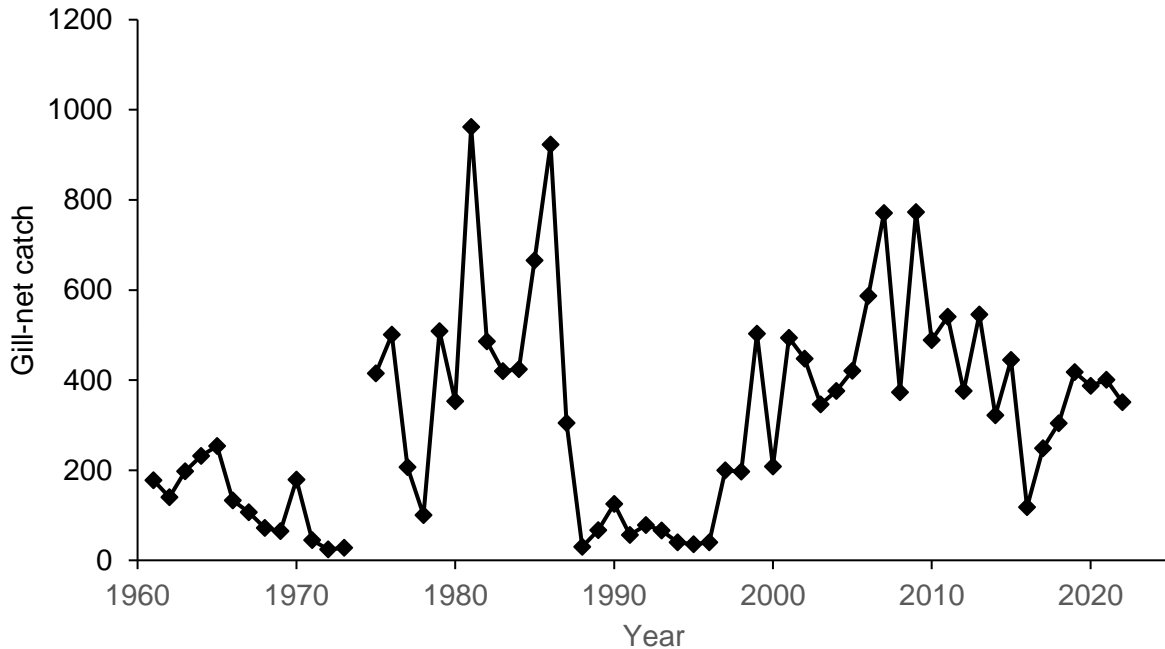


**Figure 19. Time trends in spring and summer age-1 yellow perch densities (#/acre) for Oneida Lake since 1962. The 1977 year-class spring yearling density was 1,370/acre.**

While recent abundances of adult yellow perch have reached 30-year highs, larval densities, fall age-0 densities and summer catches of age-1 fish all exhibited significant declines over the long term (Irwin et al. 2009; Rudstam et al. 2016b). The last decade has shown some moderation of the declining trends in subadult abundances observed over the long term, with no significant trends in abundance for first-year life stages since 2007 (Table 4). Yellow perch still represent the primary forage for adult walleye prior to gizzard shad recruiting to their diets in late summer and fall. As a result, mortality of age-0 yellow perch remains high, but survival of subadults after their first year must be high to allow for the observed increase in the adult population. Reduced predation by double-crested cormorants, which was once the bottleneck for young percid recruitment, is likely contributing to increased subadult survival.

White perch - Based on gill-net catches, the white perch population in Oneida Lake increased sharply through the late 1990s and 2000s (Figure 20) exceeding gill-net catches of yellow perch in 2007, 2009-2011, and 2015 (Appendix 2 Table A2). Recruitment is variable, but the white perch recruitment index was suggestive of successful ( $RI > 200$ ) year-classes at least once every 3 years from the mid-1990s through 2004. However, only two relatively large year-classes have been observed since 2005 (Appendix 2 Table A14). Infrequent strong year classes in recent years have resulted in a significant decline in adult catches in gill nets since 2007 (linear regression:  $N=16$ ;  $r^2=0.36$ ;  $p=0.01$ ). White perch diets are similar to yellow perch, although they appear to feed more on larval and juvenile fish. The decline in adult numbers likely contributed to recent increases in survival of larval percid (Jackson et al. 2020). For a more thorough assessment of white perch recruitment in Oneida Lake see VanDeValk et al. 2016.





**Figure 20. Time trends in annual gill-net catches of white perch for Oneida Lake since 1961. No gill-net surveys were conducted in 1974.**

**Black bass** - Black bass are an important sport fish in Oneida Lake. 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 early studies of potential impacts of spring fishing showed catches of age-0 smallmouth bass over the first 6 years following the opening of spring fishing were significantly higher than those from the 6 years preceding the regulation change (Jackson et al. 2015). However, age-0 smallmouth bass abundance now appears to be decreasing, while age-0 largemouth bass abundance has not changed significantly. All four age-0 smallmouth bass indices we currently incorporate into our annual sampling (18-ft trawl, shoreline seine, small mesh fyke nets and large mesh fyke nets) indicate significant decreasing trends in age-0 abundance since 2007 (Table 5). Catches of age-0 smallmouth bass in seines, 18-ft trawls, and small-mesh fyke nets were correlated (Table 6). Jackson et al. (2015) reported trawl catches of young of year smallmouth bass year-classes were significantly correlated with later gill-net catches at age-4 and age-5 (1984–2007 year-classes). A similar analysis using data for the 2007-2016 year-classes and all four age-0 indices indicated none of the age-0 indices were correlated with adult abundance (VanDeValk et al. 2022). Age-0 largemouth bass abundances showed no significant trends in any of the three indices (shoreline seine, small mesh fyke nets and large mesh fyke nets) since 2007 (Table 5). For age-0 largemouth bass, only catches in the two fyke nets were correlated [Corr. Coefficient=0.68 ( $p=0.008$ )].

**Table 5. Recent trends (2007-2022) in measurements of age-0 smallmouth bass and largemouth bass abundances from various gear for Oneida Lake. Smallmouth bass data were log transformed [ $\log_{10}(\text{CPUE}+0.1)$ ], largemouth bass data were normally distributed. Significance levels are based on simple linear regression. Data are presented in Appendix 2 Tables A3-5. Trend indicates direction (+ or -) over time, with  $r^2$  and  $p$  reported for regressions. Significant trends indicated by bold type.**

Species	Variable	Trend	$r^2$	$p$
Smallmouth	18-foot trawl	-	<b>0.51</b>	<b>0.002</b>

bass	Shoreline seine	-	<b>0.53</b>	<b>0.005</b>
	Fyke net (small mesh)	-	<b>0.45</b>	<b>0.007</b>
	Fyke net (large mesh)	-	<b>0.25</b>	<b>0.05</b>
Largemouth bass	Shoreline seine	-	0.21	0.11
	Fyke net (small mesh)	+	0.03	0.57
	Fyke net (large mesh)	+	0.01	0.97

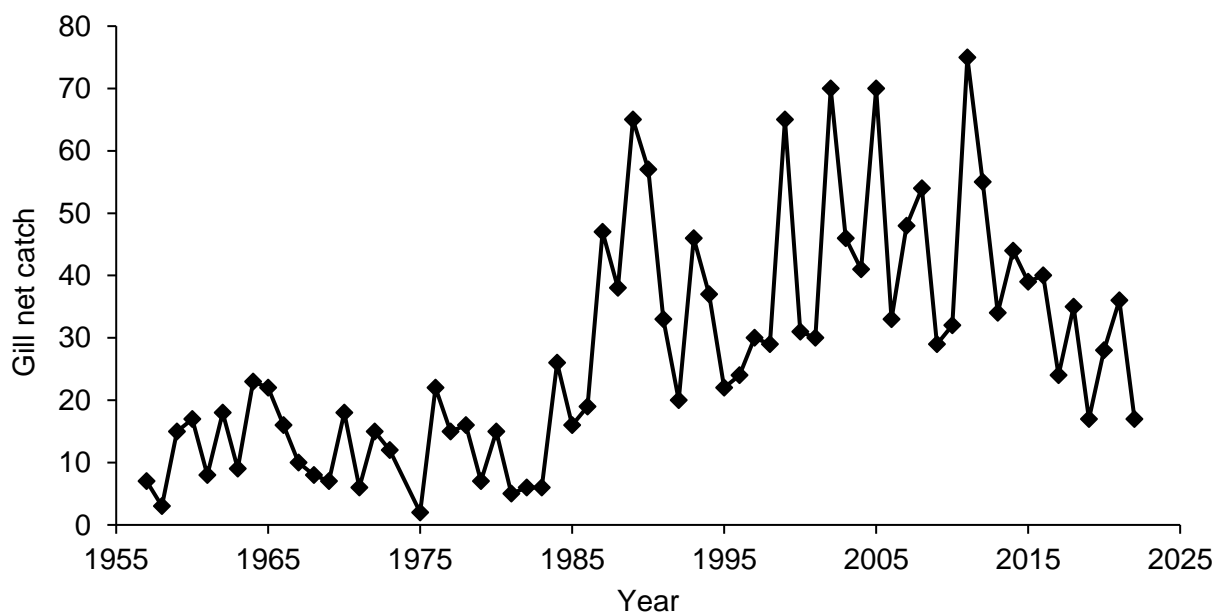
**Table 6. Spearman rank correlation analysis comparing age-0 smallmouth bass catches from four gear from 2007-2022. Table provides correlation coefficient ( $\rho$ -value). Values in bold indicate significant correlation.**

	18-ft trawl	Seine	Small-mesh fyke
Seine	<b>0.85(0.0003)</b>		
Small-mesh fyke	<b>0.81(0.0002)</b>	<b>0.78(0.003)</b>	
Large-mesh fyke	0.35(0.19)	0.50(0.09)	0.46(0.08)

Catches of age-1 and older smallmouth bass in standard gill nets have decreased significantly since 2007 (Table 7) and are now in the range observed during the 1970s and early 1980s (Figure 21). Electrofishing CPUE since 2011 did not reveal any significant trends for smallmouth bass or largemouth bass (Table 7).

**Table 7. Recent trends in catches of age-1 and older smallmouth bass in gill-net surveys (2007-2022) and age-1 and older smallmouth bass and largemouth bass in shoreline electrofishing surveys (2011-2022) for Oneida Lake. Significance levels are based on simple linear regression. Data are presented in Appendix 2 Tables A2 and A6. Trend indicates direction (+ or -) over time, with  $r^2$  and  $p$  reported for regressions. Significant trends indicated by bold type.**

Species	Variable	Trend	$r^2$	$p$
Smallmouth bass	Gill net	-	<b>0.35</b>	<b>0.02</b>
	Electrofishing	-	0.18	0.23
Largemouth bass	Electrofishing	+	0.01	0.83



**Figure 21. Time trends of age-1 and older smallmouth bass catches in gill-net surveys for Oneida Lake since 1957.**

Age structure of smallmouth bass captured in spring electrofishing surveys and gill-net surveys confirm suggestions of variable recruitment (Table 8). Catches of older (age-7 and older) smallmouth bass that declined after the mortality event initially reported in the fall of 2017 have increased.

**Table 8. Percent composition by age of smallmouth bass collected in spring electrofishing surveys and gill-net surveys in Oneida Lake since 2011. Ages are from scales for electrofishing surveys and from otoliths for gill-net surveys. Note smallmouth bass are not fully recruited to gill nets until age-3.**

Year	N	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age>7
Electrofishing survey									
2011	30	36.7	16.7	3.3	10.0	6.7	6.7	6.7	13.3
2012	49	14.3	30.6	14.3	8.2	8.2	6.1	10.8	8.1
2014	44	2.3	22.7	29.5	4.5	20.3	6.8	20.5	11.3
2015	51	3.9	7.8	29.4	15.7	5.9	7.8	13.7	15.7
2017	73	58.9	16.4	6.8	0	4.1	5.5	5.5	2.8
2018	18	5.6	38.9	27.8	11.1	0	5.6	5.6	0
2019	18	11.1	22.2	22.2	27.8	11.1	5.6	0	0
2020	28	14.3	35.7	17.9	21.4	3.6	7.1	0	0
2021	40	2.5	20.0	20.0	17.5	12.5	17.5	5.0	5.0
2022	22	4.5	36.4	13.6	9.1	9.1	4.5	9.1	13.6
Gill-net survey									
2011	75	0	2.7	13.3	20.0	13.3	20.0	12.0	18.7
2012	53	1.9	9.4	11.3	28.3	17.0	5.7	20.8	5.7
2013	34	8.8	20.6	29.4	11.8	8.8	8.8	0	11.8
2014	43	0	16.3	25.6	7.0	7.0	4.7	7.0	32.6
2015	38	0	5.3	44.7	31.6	0	2.6	0	15.8
2016	40	2.5	10.0	7.5	25.0	15.0	5.0	10.0	25.0
2017	24	0	33.3	29.2	0	12.5	4.2	4.2	16.7
2018	35	2.9	11.4	57.1	5.7	2.9	8.6	0	11.4
2019	17	0	11.8	23.5	52.9	0	5.9	5.9	0
2020	28	0	21.4	10.7	39.3	10.7	3.6	0	14.3
2021	36	5.6	27.8	27.8	8.3	16.7	5.6	0	8.3
2022	17	0	11.8	29.4	23.5	11.8	5.9	5.9	11.8

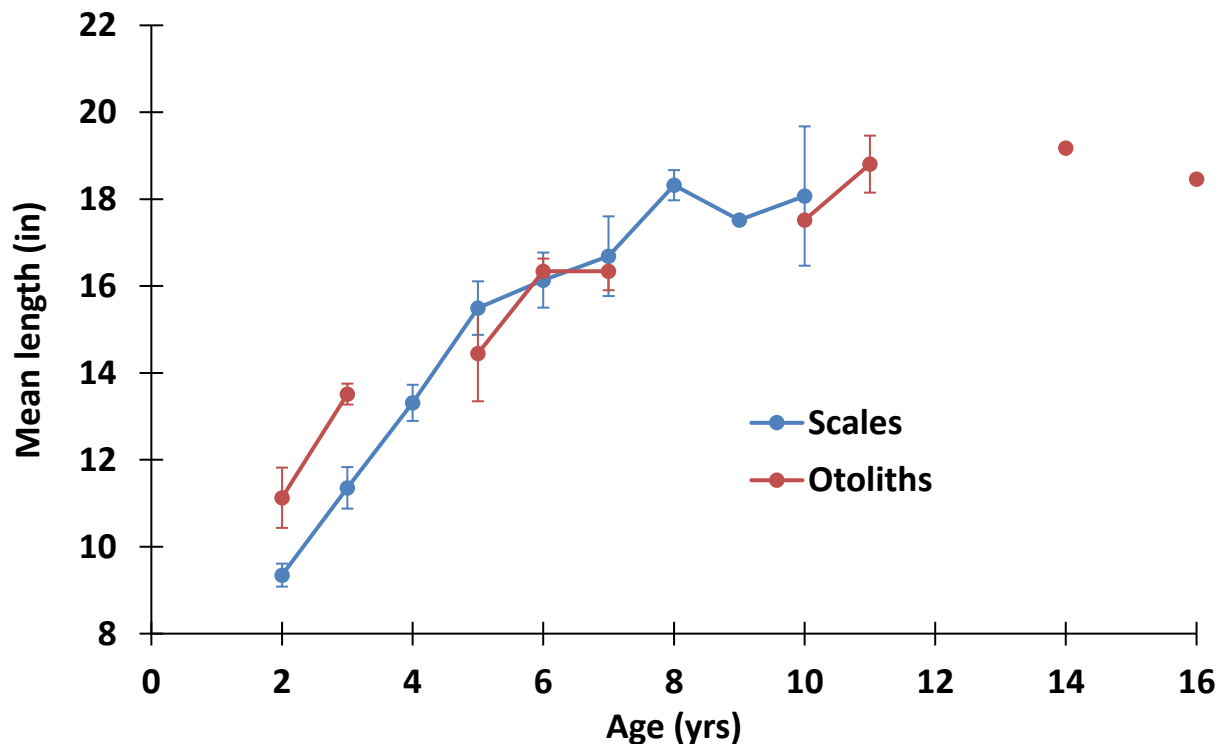
Age structure of largemouth bass captured in spring electrofishing samples confirms suggestions of variable recruitment indicated by size structure analyses (Table 9). Catches in 2019 indicated small 2017 and 2018 year classes, both consistent with age-0 fyke-net samples. The strong 2019 year class was reflected in catches at age-1, age-2 and age-3, also consistent with age-0 fyke-net samples. Spring electrofishing is currently our only index of age-1 and older largemouth bass abundance.

**Table 9. Percent composition by age of largemouth bass collected in spring electrofishing surveys in Oneida Lake since 2011.**

Year	N	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age-7	Age>7
2011	83	7.2	6.0	14.5	15.7	9.6	18.1	16.9	12.0
2012	113	8.8	13.3	20.4	11.5	6.2	10.6	8.0	21.3
2014	105	1.9	16.2	28.6	10.5	8.6	5.7	11.4	17.3
2015	76	0.0	0.0	9.2	18.4	22.4	5.3	3.9	40.8
2017	100	24.0	13.0	27.0	1.0	4.0	12.0	7.0	12.0
2018	175	4.0	26.9	40.0	17.1	4.0	2.3	2.9	2.8

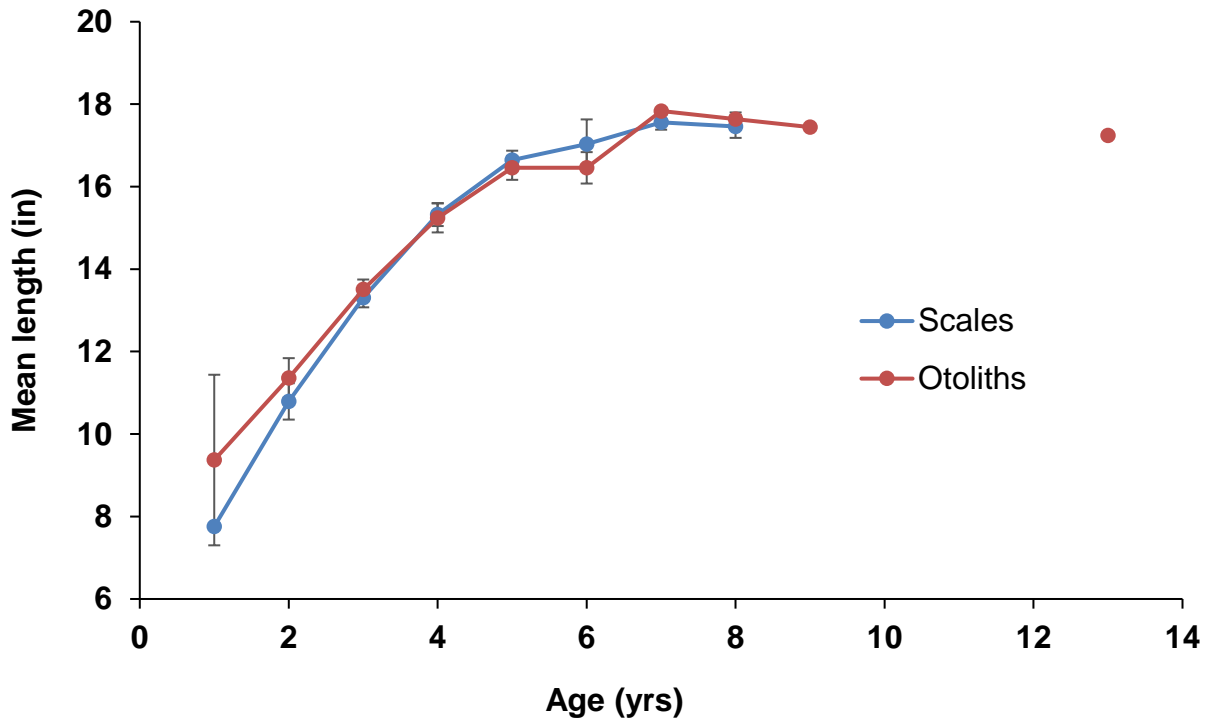
2019	60	0.0	8.3	26.7	31.7	15.0	6.7	5.0	6.7
2020	113	27.4	11.5	8.8	11.5	12.4	11.5	8.0	8.8
2021	75	4.0	22.7	30.7	10.7	9.3	13.3	4.0	5.3
2022	129	0	16.3	43.4	12.4	5.4	10.1	6.2	6.2

To date, scales were the structure of choice for aging largemouth bass because collection is non-lethal (Besler 1999). However, scales are unreliable due to the difficulty in distinguishing annuli with increasing age and decreasing growth (Beamish and McFarlane 1987). Unlike scales, the annuli in otoliths continue to be discernable during periods of minimal growth (Marshall and Parker 1982, Beamish and McFarlane 1987). In 2022, otoliths were collected in addition to scales from 57 largemouth bass caught in electrofishing surveys. Ages determined from scales and from otoliths were in agreement for 25% of all fish aged, and for 29% of fish age-7 or less. Ages were within +/-1 year for 84% of all fish aged, and 90% for fish under age-8. Ages determined from scales were higher for 77% of age-2 and age-3 fish, and by as much as 2 years, resulting in significantly lower length at age for those ages (Figure 22). The maximum age from scales was age-10, whereas otoliths indicated 9% (5 fish) were older than age-10, with one fish estimated at age-16.



**Figure 22. Length at age for largemouth bass determined by scales and by otoliths (error bars provide 90% CIs).**

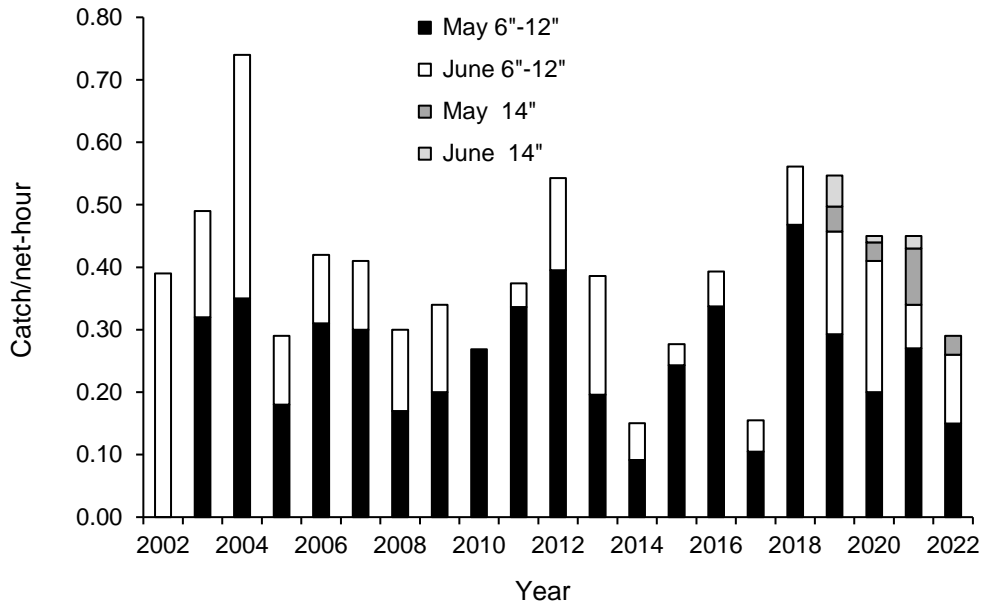
A similar comparison of ages determined from scales and from otoliths was conducted for smallmouth bass caught in gill-net surveys in 2021 and 2022 (Figure 23). Ages were in agreement for 74% of all fish aged, and were within +/-1 year for 94% (N=53). Ages determined from scales were higher for 21% of young (ages 1-3) fish but not by more than 1 year, and were lower for 33% of older (age-4 and older) fish by 1 to 5 years. Mean lengths calculated by the two aging structures were not statistically different for any age.



**Figure 23. Length at age for smallmouth bass using scales versus otoliths (error bars provide 90% CIs).**

The status of the smallmouth bass population is now an issue of concern. Recent decreases in adult indices combined with relatively poor young abundances suggest the population will not recover to levels observed from the late 1980s to early 2010s any time soon. Reasons for these decreases remain unclear but the timing is consistent with the establishment of a round goby population. Young and adult abundances will continue to be monitored closely in an attempt to identify factors contributing to these decreases. There is no indication that the adult largemouth bass population has changed significantly since monitoring began in 2011.

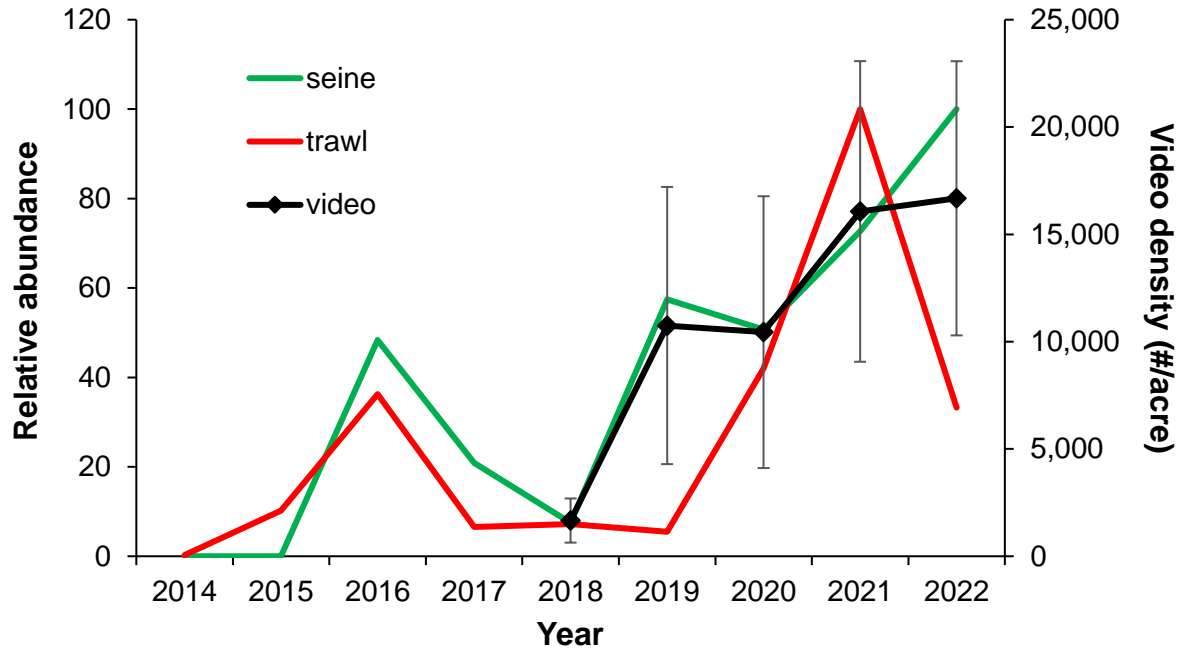
Lake sturgeon - Lake sturgeon catches from directed sampling with large mesh gill nets in 2022 were within the range observed since surveys started in 2002 (Figure 24; Appendix 2 Table A15). Fourteen lake sturgeon were caught in the 6-12 in mesh panels in 2022, with the 14 in panels contributing an additional two fish. Lake sturgeon stocking was terminated in 2004 but began again in 2014 with the stocking of 500 fish (stocking at that level has continued annually since). To date, catches since stocking was resumed have shown a significant increasing trend but only marginally (6-12 in mesh only, simple linear regression:  $N=8$ ,  $r^2=0.28$ ,  $p=0.09$ ). This trend should strengthen as stocking continues and if natural reproduction increasingly contributes to the population. Catch records now include evidence of successful natural reproduction and survival of young from 10 year-classes between 2011 and 2020 (none from 2018). Twenty-five fish were either aged to years that lake sturgeon were not stocked or were untagged and aged to years that all stocked fish were tagged. Likely spawning locations include Fish Creek (spawning activity reported by anglers) and other tributaries to the lake.



**Figure 24. Time trends in spring large mesh gill-net catches of lake sturgeon for Oneida Lake since 2002. Note 14 in mesh panels were added to the gill-net gang in 2019.**

Round goby - Round goby first appeared in CBFS trawl surveys in 2014 and has since been caught in other sampling gear. While several standard gears used in our sampling capture round goby, the catches in these gear show considerable annual variability that do not correlate well among gear. The use of videos to assess round goby abundance has become increasingly popular (Schaner et al. 2009) and has been found to be the best technique for assessing round goby size and density across a wide range of substrates (Johnson et al. 2005; Andres et al. 2020). In 2018 an annual lake-wide video survey that samples depths and substrates in proportion to their availability was initiated. Video surveys in 2018 and 2019 were comprised of 97 sites, but the survey has since been reduced to a more efficient 46 sites in a random stratified design that is conducted in early July.

The round goby population has increased since the die off in 2016. Round goby density estimates from video surveys were 16,000/acre (39,700/hectare) in 2021 and 16,700/acre (41,200/hectare) in 2022, up from a low of 1,700/acre (4,100/hectare) in 2018 (Figure 25). Low catches of round goby early in 2017, combined with reports and direct observations of concentrations of dead round gobies along shore prior to ice on suggested a die off in the winter of 2016-2017. There has been no evidence of die offs in other winters, so it is uncertain if the 2016-2017 die off was an isolated event related to disease or some other factor.



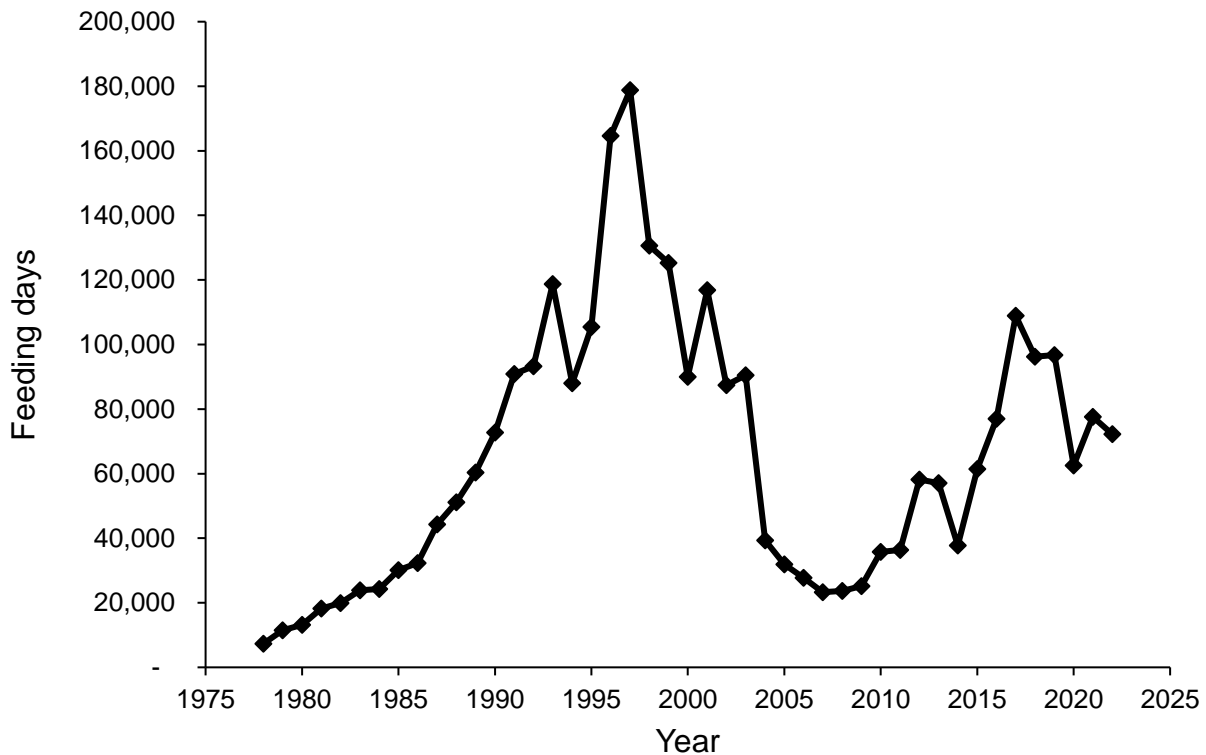
**Figure 25. Relative abundance of round goby (seine and trawl) since 2014 and densities from video surveys since 2018. Error bars represent 90% confidence limits.**

It is uncertain as to what round goby densities we can expect for Oneida Lake because studies that provide density estimates in other systems are few and estimates generated from video surveys need to be assessed for round goby attraction/avoidance to the video apparatus. Karatayev et al. (2021) estimated the round goby density in the 33 to 115 ft depth range of Lake Ontario at 17,000 fish/acre. Taraborelli et al. (2009) estimated round goby densities as high as 15,702/acre in the shallowest areas of the lower Bay of Quinte 6 years after round goby invasion. Andres et al. (2020) estimated the round goby density for main portion of Cayuga Lake shallower than 60 ft at 7,365/acre with lower densities in the vegetated north end 6 years after invasion. This year's lake-wide video estimate of 16,700 fish/acre for Oneida Lake 8 years after invasion approaches the highest observed in the literature. However, potential attraction/avoidance to the video apparatus has not been accounted for by most of these studies including ours. Andres et al. (2020) found that a camera mount with a larger on-bottom foot print than our camera stand increased the effective area sampled due to attraction by a factor of four in Cayuga Lake, New York.

Establishment of a round goby population appears to be having mixed effects on other biota in Oneida Lake. Since their arrival, round gobies have been utilized as a prey resource for piscivores. Yellow perch and white perch appear to be taking advantage of their arrival most with round gobies occurring in 8.3% of diets of each species examined from gill nets, followed by smallmouth bass (7.4%) and walleye (5.7%). Since the arrival of the round goby and the reappearance of the burrowing mayfly, mean lengths of age-0 smallmouth bass as well as adult yellow perch and white perch have increased significantly (Brooking et al. 2022). In Lake Erie, round gobies 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). Analyses indicate round goby is having a negative impact on benthic invertebrate densities (Brooking et al. 2022). Continued sampling should allow detection of any responses in terms of fish diets and growth. We should be well-positioned to detect any longer-term changes in the limnology of the lake and its fish community

given that both pelagic and littoral sampling have been underway for some time in advance of the arrival of round goby.

Double-crested cormorants - Since the early 2000s the double-crested cormorant population on Oneida Lake has been managed to varying degrees by USDA Wildlife Services and then NYSDEC. For a more detailed description of the double-crested cormorant management history on Oneida Lake see Coleman et al. (2016). Management since 2010 has been conducted by NYSDEC and was focused initially on efforts to push migrants off the lake because summer numbers of resident double-crested cormorants remained low and there were no observed nesting attempts. In 2013, summer counts and nesting efforts exhibited increases and NYSDEC began implementing a full season hazing program in 2014 with a target goal of no more than 100 double-crested cormorants on the lake and no successful nesting. Management efforts have had a direct effect on the number of feeding days by double-crested cormorants on Oneida Lake (Figure 26).



**Figure 26. Total annual feeding days of double-crested cormorants on Oneida Lake since 1978. Feeding days calculated from weekly bird counts conducted by USDA Wildlife Services (2004-2009) and NYSDEC personnel.**

Diets were examined from 192 birds in 2022. A total of 967 prey items were identified (Appendix 2 Table A16). The most common prey items numerically were round goby (75%) followed by yellow perch (10%) and gizzard shad (8%). No other species accounted for more than 3% of observed diets. Gizzard shad, which was typically the most common species found in fall diets, fell from an average of 4.7/bird (2004–2019) to 0.08, 0.19 and 0.47 per bird from 2020 to 2022, respectively. By weight, yellow perch made up 38% of double-crested cormorant diets, walleye 22%, round goby 16% and gizzard shad 13%, with no other species accounting for more than 6%. Analyses of double-crested cormorant diets over a 20-year span found positive selection for schooling, soft-bodied prey such as gizzard shad when they were



available, so buffering of potential impacts on percids by fall migrating double-crested cormorants was realized in years when gizzard shad were abundant in the fall (DeBruyne et al. 2013). But gizzard shad fall densities have been low since 2019 (see Hydroacoustic survey, above) so species other than gizzard shad were consumed to meet metabolic requirements, mainly yellow perch and walleye. In the absence of gizzard shad, consumption of percids by double-crested cormorants can be substantial. To date, round goby has been a minor contributor to double-crested cormorant diets accounting for an average of 15% (range: 5-32% since 2015) of the total biomass of fish consumed. But evidence from other systems suggests that round goby can dominate double-crested cormorant diets (Johnson et al. 2010) which could happen in Oneida Lake if round goby becomes more abundant especially in larger length classes.

### Creel survey

The current approach for monitoring angler effort and success on Oneida Lake is to conduct an abbreviated summer creel survey each year, basing effort on boat counts from May, June and July and basing catch and harvest rates on exit interviews conducted at public boat ramps during June and July. The abbreviated summer survey is complemented by a full (summer and winter) roving survey every fifth year (2022-23). Estimates of angler effort and success in 2022-23 focus on the full roving survey as it provides data spanning the entire fishing season and likely better represents the Oneida Lake angling population. Exit surveys sample angling parties that utilize public boat ramps only and do not sample lakeside resident angling parties or angling parties that utilize marinas or private boat ramps.

Open water angler effort in 2022 (201,000 boat-h) was similar to the average observed since 2010 (203,000 boat-h, Figure 27, Appendix 2 Table A17). As with most years, effort increased from May to June, peaking in July and then decreasing through the remainder of the open water season. Angling parties that included walleye as a target species accounted for 71% of all trips and angling parties that included bass as a target accounted for 15% of all trips. Angling parties interviewed at access points included walleye as a target species on 56% of all trips and bass as a target species on 38% of all trips.

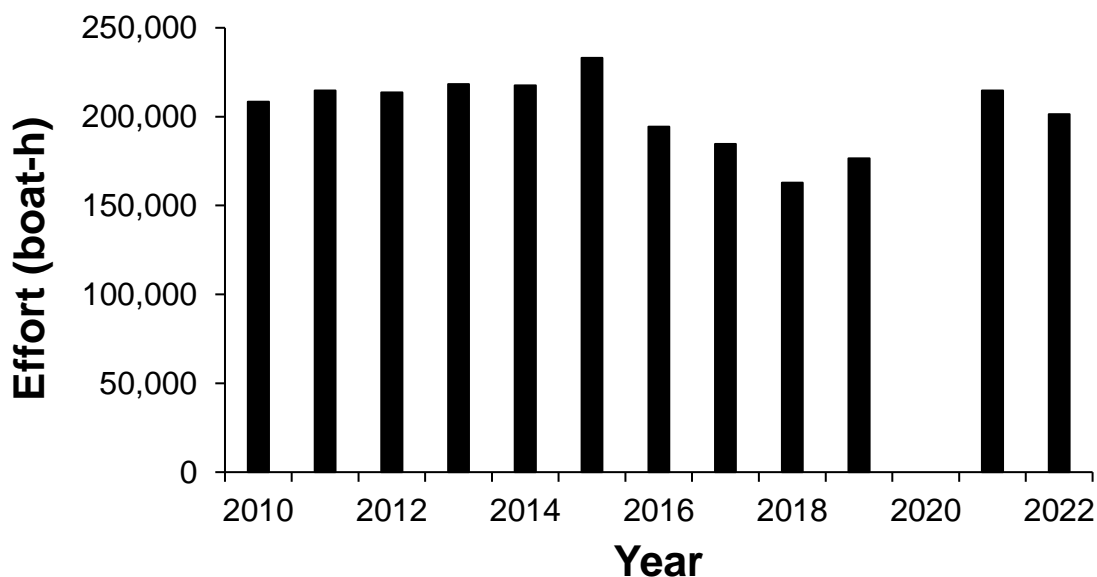
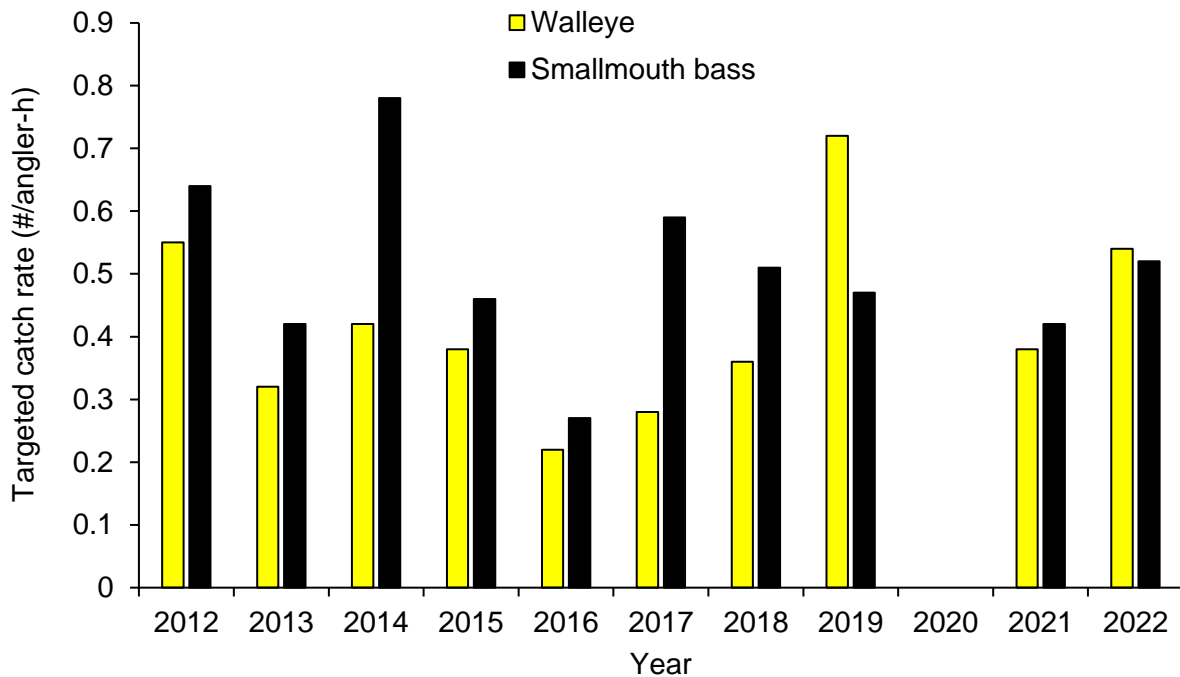


Figure 27. Oneida Lake open water (May-September) angler effort (boat-h) since 2010.

Estimated catch rate for walleye (all trips) from 1,419 roving surveys during the 2022 open water season averaged 0.42/hr (Appendix 2 Table A18), and the mean targeted catch rate was 0.55/hr. The targeted catch rate for walleye was above the average for the period 2012-2021 (0.41/hr, Figure 28). Festa et al. (1987) 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 trips, catch rates exceeding 0.20/hr were above average and rates approaching 0.50/hr were considered excellent. The walleye harvest rate (all trips) was 0.26/angler-h, the highest observed since 2010 (mean=0.15/angler-h). Smallmouth bass catch rate (all trips) averaged 0.09/hr and the mean targeted catch rate was 0.52/hr. The targeted catch rate for smallmouth bass was within the range observed during the current survey period.



**Figure 28. Targeted angler catch rates for walleye and smallmouth bass for Oneida Lake since 2012. No angler data was collected in 2020.**

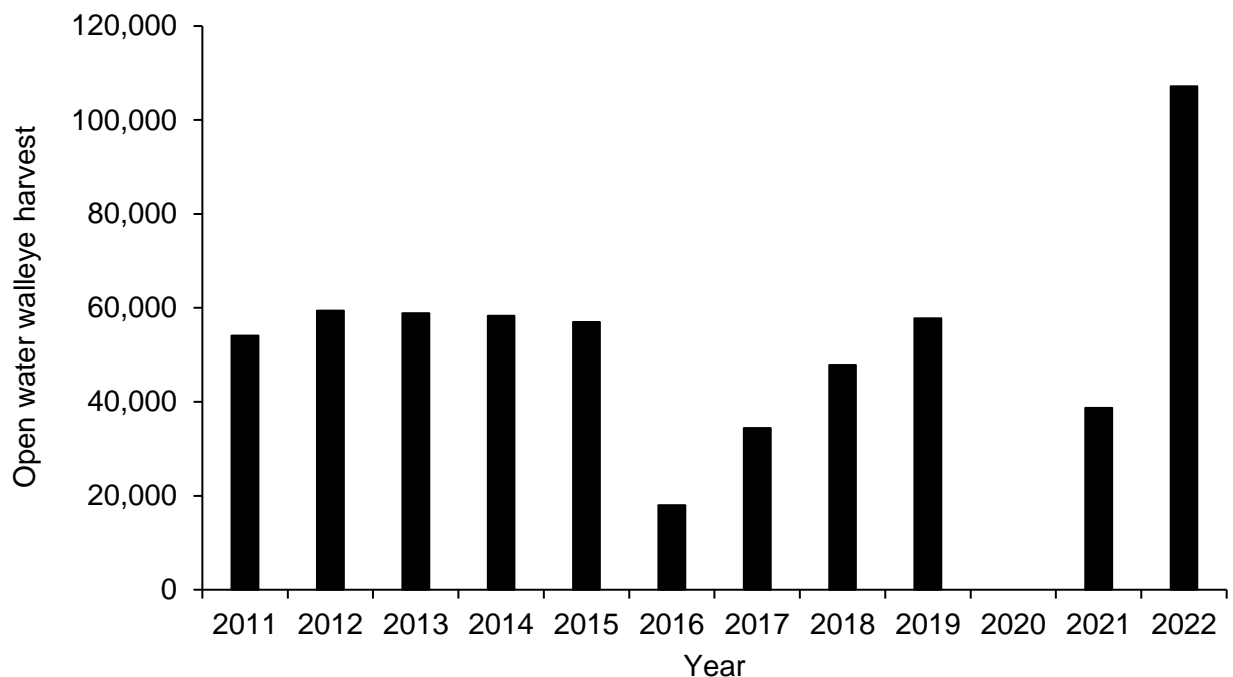
Historically, the Oneida Lake black bass fishery was dominated by smallmouth bass. Creel surveys in the late 1950's indicated largemouth bass comprised less than 5% of the total black bass catch reported by anglers (Grosslein 1958). An angler diary program from 1994-98 and a full creel survey in 1997 indicated largemouth bass still accounted for less than 5% of the black bass catch. However, the contribution of largemouth bass in the total black bass catch started to increase in the early 2000s. Full creel surveys conducted from 2002-2007 indicated largemouth bass comprised between 10 and 19% (mean=14%) of the black bass catch. More recently, the contribution of largemouth bass estimated from abbreviated surveys conducted from 2011-2022 increased further to between 18 and 39% (mean=28%). It is unclear whether this increase is due to a largemouth bass population that is increasing in response to warmer water temperatures and expanding macrophyte coverage or due to more anglers targeting largemouth bass specifically.

In 2022, angling parties interviewed in roving and exit surveys were asked to specify which black bass species they were targeting. Prior to 2022, target species entries were not differentiated between black bass species. Both survey methods resulted in 5 potential responses: black bass only, black bass in addition to other species, smallmouth bass only, smallmouth bass in addition to other species, and largemouth bass only (Table 10). Both survey methods indicated anglers targeting only largemouth bass accounted for less than 5% of total black bass effort. Future creel surveys will continue to differentiate between the targeted black bass species.

**Table 10. Percent of angling parties targeting black bass by category.**

Target species	Boat ramp surveys	Roving surveys
Black bass only	0.51	0.11
Black bass and other species	0.06	0.03
Smallmouth bass only	0.37	0.84
Smallmouth bass and other species	0.03	0.01
Largemouth bass only	0.04	0.01

Estimated total harvest of walleye for the 2022 open water season was 107,200 fish (Figure 29). With the exceptions of this year and 1959 when over 400,000 walleye were harvested, the open water walleye harvest did not exceed 60,000 fish during years creel surveys were conducted. Total open water harvest of yellow perch was estimated at 145,000.



**Figure 29. Open water walleye harvest for Oneida Lake since 2011. No angler data was collected in 2020.**

The creel limit for walleye increased from 3 to 5 fish/day on May 1, 2022. Because roving surveys intercept anglers as they are fishing, few (0.5%) angling parties reported harvesting a 5 fish/angler limit. Under the 3 fish/angler limit, 145 angling parties (10.2%) would have reported harvesting 3 or more walleye/angler (4.3% reported a harvest greater than 3 fish/angler).

Roving interviews indicated that 85 (4%) of the 2,142 walleye harvested were caught after a 3-fish bag was attained. By applying this rate to the total harvest, 4,280 additional walleye were harvested due to the daily limit increase. A similar analysis using data from exit interviews in June and July indicated 56 angling parties (9.7%) reported harvesting 3 or more walleye/angler (7.3% reported a harvest greater than 3 fish/angler and 3.5% reported a 5 fish/angler limit). Twelve percent of the 781 harvested walleye reported by exit interviews were caught after the 3-fish bag was attained.

The 2022-23 winter season was dominated by abnormally poor ice conditions. Ice cover recorded at CBFS resulted in only 13 days of complete ice cover, by far the lowest since the 2001-02 winter of no complete ice cover. Unsafe main-lake ice conditions restricted 2022-23 ice fishing to the bays, and also required modification of the planned creel survey methodology. The creel survey was designed so that the creel clerk traveled the lake by snowmobile to conduct both angler counts and angler interviews. Unsafe ice conditions required the clerk to conduct counts and interviews from 13 access areas located around the lake.

Poor 2022-23 ice conditions likely resulted in relatively low angler effort. Angler counts were conducted from mid-January through early March. Angler effort for the season was estimated at 57,400 angler-h, with 81% of the effort taking place in February. Comparatively, angler effort estimated for the 2018-19 winter season was 190,300 angler-h.

A total of 197 angler interviews were conducted from mid-January through February. January interviews were dominated by angling parties in Big Bay (56%) but dropped to 28% in February as safe ice formed in other bays around the lake. Anglers targeted panfish (including yellow perch) on almost all trips in January with few anglers targeting walleye (14%). As anglers expanded into other bays around the lake in February, anglers targeted yellow perch on 71% of all trips, followed by walleye (54%) and sunfish (28%). Targeted angler catch rates for the season were 0.23/angler-h for walleye, 1.46/angler-h for yellow perch and 2.75/angler-h for sunfish. A total of 58,000 yellow perch were harvested, followed by 52,100 sunfish and 4,600 walleye.

Angler opinion and behavior survey - As a complement to the catch 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. Four questions were developed with NYSDEC staff and incorporated into angler interviews, 2 of which were new in 2022. Some questions were designed to allow tracking of opinions over time, and some questions were replaced with others, depending on developing issues related to the fishery.

**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?

From 2013 through 2015, anglers indicated a high level of satisfaction with the quality of angling on Oneida Lake with average scores of 4 or higher. Satisfaction scores fell to 3.2 in 2016, but rebounded to 3.7-4.1 in 2017-2022.

**Question 2.** Are you aware that the daily limit regulation for walleye on Oneida Lake increased from 3 fish/day to 5 fish/day on May 1 of this year?

Ninety-seven percent of the angling parties interviewed said they were aware of the angling regulation change.

**Question 3.** Do you think that the current number of bass fishing tournaments on Oneida Lake is acceptable?

Of the 1,419 angling parties interviewed during the roving survey, 571 (40%) did not think the number of bass tournaments on Oneida Lake was acceptable. Of these parties, 3 thought there were not enough bass tournaments on the lake while the remaining 568 thought there were too many tournaments. A total of 317 parties provided 1 or more reasons they believed there were too many tournaments.

Reasons for too many tournaments:

Anticipated	
1. Fish caught too many times/too much fishing pressure	39
2. Fish don't survive	54
3. Fish get relocated	6
4. Launches/lake too crowded	163
Unanticipated	
5. Bass anglers are inconsiderate/rude	170
6. Should not fish bass that are guarding nests	9

**Question 4.** On a scale of 1 to 5, with 5 being very satisfied, how satisfied are you with the job the NYSDEC Bureau of Fisheries does managing Oneida Lake?

Anglers indicated a high level of satisfaction with NYSDEC's management of Oneida Lake in 2022. The average satisfaction score was 4.5 out of 5, which was the highest score since adding this question to the survey in 2013. The lowest score was 3.8 in 2018.

## DISCUSSION

Over the duration of our research on Oneida Lake, several ecological changes, some ongoing, have been identified that have affected, or are likely to affect, the fish community. These have included warming water temperatures, species invasions, and increased water clarity resulting from dreissenid mussels and reduced nutrient inputs. The data collected in 2022 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 with reduced primary production from the early decades of studies when the lake was classified as eutrophic. Some of the productivity has shifted from the pelagic to the littoral zones including increases in littoral macrophytes and benthic algae production (Cacela et al. 2008) with concomitant increases in abundance of nearshore fish species. There is now evidence of reduced *Daphnia* spp. production, a typical response to dreissenid colonization, but one that did not occur with only zebra mussels present. The arrival of spiny water flea has exacerbated this decrease. Continued declines in *Daphnia* spp. densities and conversion of the zooplankton community to one dominated by copepods may have implications for planktivores and planktivorous life stages of important sport fishes.

The current adult walleye population is estimated at 630,000 fish, a decrease from what was observed the previous 4 years but slightly higher than the long-term average (600,000). Accompanying this decrease were increases in condition and growth. Projected recruitment should maintain the adult population at about current levels in the near future. Yellow perch recruitment appears to have increased elevating the adult population to historic highs. Low winter exploitation due to the abnormally short 2022-23 ice season, and projected recruitment of the 2020 year class will likely increase the adult population further in 2023. The presence of round goby and burrowing mayfly may be aiding percid early life survival. Both are available in the spring and early summer at the time when piscivores would otherwise feed on young of year fish. The round goby spawns multiple times in a growing season and young round gobies are providing a valuable food source for young piscivores although increased first-year growth has been documented for smallmouth bass only. Increased first-year growth of fishes has been related to increased over-winter survival (Forney 1976, Irwin et al. 2009). There is evidence that young percid densities are in part limited both through competition with white perch and through direct predation on percid fry by white perch; therefore, it is possible that historic increases in the white perch population may have acted as a constraint on the size of the adult percid populations. Consistently poor white perch year-classes in recent years have resulted in a return of the white perch adult population to levels closer to the 20 year average.

The past decade has seen age-1 and older smallmouth bass numbers decline from the highs observed from the late 1980s through 2012, and production of young smallmouth bass has been low the past 4 years. Based on record catches of young smallmouth bass in fyke nets in 2015 and of largemouth bass young in 2016, there were no early indications of a detrimental impact of round goby on production of young bass. However, the round goby is a known predator of bass eggs and larvae so their effects need to be monitored and reassessed. Bacterial lesions observed in 2017 and 2018 may have affected smallmouth bass, but few have been observed on age-1 and older fish since.

Round goby is now established in the lake and is affecting the lake's fish populations. Adult yellow perch and white perch growth has increased in the presence of round goby and burrowing mayfly (Brooking et al. 2022). Age-0 smallmouth bass growth has also increased in the presence of round goby. To date, there has been no observed change in age-0 walleye fall length despite round goby accounting for on average 50% of all the prey fish identified in age-0 walleye stomachs. The round goby population may also buffer sport fish populations from double-crested cormorant predation. Continuing analysis and monitoring of the Oneida Lake data set should provide information on the response to these ongoing ecological changes that are relevant not only to Oneida Lake but also other systems experiencing these changes.

Double-crested cormorant predation on subadult percids resulted in decreases in recruitment to the fishery, but the establishment of a management program contributed to subsequent increases in adult walleye numbers and more recently adult yellow perch numbers. Hazing efforts by NYSDEC personnel continue to keep predation pressure by double-crested cormorants at levels that are well below those observed prior to any management being implemented, especially during the summer months. However, high fall migrant numbers have resulted from cessation of management of populations further north and are increasing impacts on young percids, especially in years when gizzard shad densities are low. In the absence of gizzard shad, percids accounted for 74% of the fish by weight in double-crested cormorant diets in both 2020 and 2021 and 60% in 2022. Evidence from other systems suggests that round goby can dominate double-crested cormorant diets (Johnson et al. 2010). Round goby was for the first time in 2016 numerically more common in double-crested cormorant diets than any other species. Round goby was the most commonly consumed species numerically again in

2022 but accounted for less than 20% of fish in diets by weight. Round goby may provide a buffer for sport fish species against double-crested cormorant predation in Oneida Lake in the future but densities and size may need to increase for that to happen.

Oneida Lake offers diverse, high quality sportfishing opportunities and should continue to do so into the foreseeable future, but recent poor year classes of smallmouth bass will likely have an effect on angler catch rates for that species. Angler catch rates of walleye and smallmouth bass in Oneida Lake have been as dependent on prey abundance as sport fish abundance (Forney 1961; VanDeValk et al. 2005). Moderating predator abundances may increase the likelihood of higher prey fish abundances and lower angler catch rates.

## **RECOMMENDATIONS FOR MANAGEMENT AND FUTURE RESEARCH**

Fisheries management on Oneida Lake includes stocking of walleye larvae, size and creel limits for walleyes, black bass and other species, and control of double-crested cormorants.

Stocking of walleye larvae. Continue stocking at current levels. Our best estimates suggest that the number of naturally produced walleye larvae in the lake is about 20% of the numbers stocked (Rudstam et al. 2016b). However in 2020, a year with no fry stocking, the larval walleye abundance estimate was similar to the long-term average. Consequently, stocking walleye larvae in Oneida Lake should be re-evaluated.

Size and creel limits. We recommend maintaining the current size and creel limits for walleye, black bass and other species. Data from the 2022 creel survey indicate that the increase from 3 to 5 fish/angler resulted in an increase in harvest of only 5% so this regulation change should have little impact on an adult walleye population that is currently near the long-term average.

Double-crested cormorant control. We recommend maintaining current hazing efforts. We have observed an increase in walleye and yellow perch populations concomitant with more intensive double-crested cormorant control. This suggests that removing double-crested cormorants does increase percid recruitment to the fishery. Our data show that a rebuilding of summer double-crested cormorant numbers will likely reduce subadult walleye and yellow perch survival, and potentially reduce populations to the point where recent harvest rates are not sustainable (DeBruyne et al. 2013, Coleman et al. 2016). Current hazing efforts should prevent the rebuilding of a large summer population and minimize fall migrant numbers.

Given the results and discussion in this report, we recommend the following research and monitoring activities in 2023:

- 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, spring weekly trawl surveys from mid-July through October, monthly seine surveys from July through September, video assessment of round goby in early summer, pelagic prey fish survey with acoustics, midwater trawl and pelagic gill nets at the end of August, fyke-net sampling for nearshore fish in September, fall trawling and electrofishing to monitor age-1 and older walleye diet and condition, and large mesh gill nets for lake sturgeon monitoring.

- 2) Continue the spring Centrarchid survey, and conduct an additional fall Centrarchid survey in 2023 and 2024 to determine if a fall survey is better suited for black bass population assessment in Oneida Lake.

- 3) Conduct an analysis of the 3 nearshore fish community assessment gears (seine, fyke net, and electrofishing) to determine if 1 or 2 of the methods can be eliminated from the standard sampling program due to data redundancy.
- 4) Continue diet analyses of double-crested cormorants in coordination with NYSDEC. Diet information is critical to assessing double-crested cormorant impacts annually.
- 5) Conduct a creel survey at launch sites in June and July. This low-cost creel survey provides data that is comparable to a full survey and provides information on angling success and impacts useful for management of the resource.
- 6) Initiate an acoustic telemetry study on adult walleye. This study will ultimately provide a more comprehensive understanding of walleye spawning locations and their relative use in and around Oneida Lake. This study will also describe seasonal walleye movements and habitat use, as well as post-spawn distributions of the Scriba Creek spawning population.
- 7) Collect both otoliths and scales from largemouth bass caught in 2023 centrarchid surveys. While method consistency is critical when comparing data among years, misrepresentation of growth during early years can lead to misguided management actions. If the discrepancy persists for another year, consider otoliths for largemouth bass aging moving forward.



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## Appendix 1: Data collection methods

Limnology. Zooplankton samples are collected weekly (May-October) from 1-4 sites with a 153  $\mu\text{m}$  mesh nylon net (1.6 ft, 0.5 m diameter) using a vertical tow from 1.6 ft (0.5 m) above the bottom to the water surface. Samples are preserved in 70% ethyl alcohol. Zooplankton are identified, counted, and measured (to the nearest  $\mu\text{m}$ ) using a digitizing tablet and microscope. Mean May-October biomass is calculated from weekly averages using the length – dry weight regressions in Watkins et al. (2011). Integrated water samples for total phosphorous (TP) and soluble reactive phosphorous (SRP) are collected using a 7.5 in (1.9 cm) inside diameter Nalgene tube lowered to a depth of 3.3 ft (1 m) above bottom, and frozen for later analysis. For chlorophyll-a measurements, lake water (up to 2.0 L) is filtered through Whatman 934-AH glass fiber filters and the filters are frozen for later analysis. Annual averages are calculated as the average of weekly values collected at one to four stations from May to October. All four 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 of the original five sites (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 from each station were processed. 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. Nutrient 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-SiO<sub>2</sub> C for SRS (APHA 1998). Beginning in 2013, chlorophyll a was analyzed with a Turner Design fluorometer after acetone extraction following the EPA standard operating procedure LG405 with the exception that all samples are run during the winter after the completion of the field season (EPA 2013). A description of the historical methods used prior to 2010 are in the metadata available on the web ([www.knb.org](http://www.knb.org)).

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. Beginning in 2021, distance towed is measured using GPS and is about one mile (1.6 km) at a speed of 8 mph (13 kph). 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).

For early years when larval walleye densities were estimated from the 9 mm walleye survey, walleye densities were adjusted based on a subset of years when both the 9 mm walleye survey and the 8 mm yellow perch survey were conducted. In years when both surveys were conducted, the larval walleye estimates from the two surveys were correlated ( $r^2 = 0.58$ ,  $p = 0.01$ ,  $N=10$ ). With one outlier removed (2002, when few stocked walleye larvae survived a cold period after stocking), the correlation improves ( $r^2 = 0.88$ ,  $p = 0.0002$ ,  $N=9$ ). The equation is:

$$WD_{YP} = 203.6 + 0.722 WD_{9mm} \quad (1)$$

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.

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 150 ft (45.75 m) long by 6 ft (1.83 m) deep sewn together to form one 600 ft (183 m) long net. Each gang consists of six 25 ft (7.6 m) panels with 1.5 in (38 mm), 2.0 in (51 mm), 2.5 in (64 mm), 3.0 in (76 mm), 3.5 in (89 mm) and 4.0 in (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), weighed, sexed, stomach contents recorded, and scales taken. Large mesh gill nets were used to monitor lake sturgeon reproductive status and abundance and growth in four different substrate types. Nets comprised of two 37.5 ft (11.4 m) panels of 6 in (152 mm), 8 in (203 mm), 10 in (254 mm), and 12 in (305 mm) stretch mesh monofilament gill nets [total net length 300 ft (91 m)] were set for approximately 4 hours at 12 sites monthly in May and June. In 2019 two panels of 14 in (356 mm) were added to the gang. 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.

Abundance estimates for age-2 and older yellow perch are based on gillnet catches corrected for gill net selectivity by age to be consistent over years except for 1974 (see below). The corrected gill net catch (GNCC) is based on back-casted likely population size given the average annual mortality of 33% obtained from catch curves for ages 5 to 7 and observed catches. The corrections are based on relative selectivity of the mesh sizes and time of sampling used for the 15 standard sets. With these data, we calculated relative selectivities of 0.203 for Age 2, 0.499 for Age 3, 0.727 for Age 4, 0.934 for Age 5, 1 for Age 6, 0.934 for Age 7 and 0.372 for Age 8 and older. These values are similar to estimates of selectivity based on marked fish and based on girth/length indirect estimates of gill net selectivity of yellow perch in Oneida Lake (Rudstam et al. 2016). The total abundance of age-3 and older fish for a given year is first calculated based on the relationship of GNCC (summed for Age 3 and older) and mark-recapture estimates (MR, in fish/ha) with a 0 intercept (the intercept was not significantly different from 0):

$$MR = 0.0627 (SE 0.0054) * GNCC, R\text{-squared} = 0.70, P < 0.001, N = 11$$

Age specific abundance is calculated based on corrected age specific gill net catches for each year and the total population obtained from this equation. Because this is derived from mark-recapture estimates representing April populations, the adult population estimate represents April abundance. Note that this equation is specific for Oneida Lake gill net sampling design.

We chose to base the data series on gill net catches to be consistent across time, and because mark-recapture estimates sometimes were based on limited number of recaptures causing the confidence limits to be large. Catches of adult yellow perch in trawls were not significantly correlated with mark-recapture estimates and were therefore not used. Abundance of different age groups are based on the age structure of the fish caught in the standard gill nets. Gillnets were not used in 1974, for that year the estimate is based on the 1973 and 1975 mark-recapture estimates assuming constant mortality from 1973 to 1975.

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. An 18 ft (5.5 m) otter trawl is towed for 5 minutes, sampling approximately 0.25 acre (0.10 hectare) per haul. Ten standard sites are sampled in each survey. Age-0 fish are identified, counted, total weight by species recorded, and a subsample of fish measured for length. Lengths are recorded and scale samples taken on all older fish. Regression analysis of catches and lengths (log-transformed) of age-0 walleye and age-0 yellow perch versus date is used to estimate density and mean length by species on September 1 and October 15. If a regression is not significant at the  $p=0.05$  level, the mean of the 3 October surveys is used for analyses. 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.

We predict future walleye recruitment using the average of catches in trawls and gill nets of age-1 and age-2 walleye. 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. 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:

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

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

Hydroacoustic surveys: Pelagic fish biomass is estimated around September 1 using hydroacoustics. Surveys are conducted using a 123 kHz split beam unit (Biosonics DT-X, pulse length 0.4 ms, 7.8° beam width) along a set of eight transects from the east to the west ends of the lake. Surveys are typically conducted during two consecutive nights starting one half hour after sunset. Acoustic data are analyzed with EchoView (v6.1 in 2020-21). 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). Analyses are conducted using each transect as a sampling unit.

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 6 ft (2 m) x 6 ft (2 m) at the mouth and is mounted in a metal frame. The first 6 ft of the net is comprised of 0.5 in (12.7 mm) stretch mesh, the next 6 ft of 0.25 in (6.4 mm) stretch mesh, and the cod end of the net consists of a 1.6 ft (0.5 m) plankton net and bucket with 0.04 in (1 mm) mesh. At each site, one haul divided into 2.5 minutes at 4.3 to 20 ft (6.1 m) depth and 2.5 minutes at 6.6 ft (2 m) to 12.5 ft (3.8 m) depth (determined from rope angles) and a second 5-minute haul at the surface (sampling the top 6 ft (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, 70 ft (21 m) long, are set either on bottom or suspended from the surface. Each gill net consists of seven 10 ft (3 m) wide by 20 ft (6 m) deep panels of different mesh sizes (0.25, 0.3, 0.4, 0.5, 0.6, 0.7, and 1.0 in (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 6 ft (2 m) of the water column that are not surveyed with acoustics are accounted for by calculating the proportion of gizzard shad and emerald shiners caught in the top 6 ft in vertical gillnets set compared to the rest of the water column.

Video survey for round goby: An annual video survey is conducted each year to provide quantitative estimates of round goby. An underwater camera is mounted on a raised frame to count the number of round gobies in a known area of lake bottom. A GoPro Hero 4 or Hero 5 camera is used to record a video at each site. Camera settings are critical for achieving sufficient contrast and light in deeper areas of the lake. The settings used are 2.7k resolution, 60 f/s frame rate, and 6400 ISO sensitivity setting. Videos are recorded for 7.5 minutes at each site. It is often necessary to download the camera files onto a laptop or portable drive in the boat as the camera internal hard drive reaches capacity.

The camera is mounted on a black ½" tubular PVC frame with 4 legs designed for the camera face to be 2.0 ft (0.60 m) from the bottom facing straight down (Figure 1). The viewing area is 5.8 ft<sup>2</sup> (0.54 m<sup>2</sup>). A measuring bar of ¼" metal was placed on the bottom of one leg in the field of view and marked every 0.8 in (20 mm) to allow for estimation of fish length.



Figure 1. Frame used to mount down-looking camera for round goby video surveys.

Forty-six standard sites are sampled over 3-5 days during the first two weeks of July each year (Figure 2). Sites were randomly chosen *a priori* and were stratified, both spatially and by bottom substrate. Bottom substrate was stratified based on the map by Greeson (1971) with the following number of randomly stratified sites in each bottom type: cobble–16, gravel–7, sand–6, and mud/silt/clay–17. Actual depth was recorded from the boat depth finder.

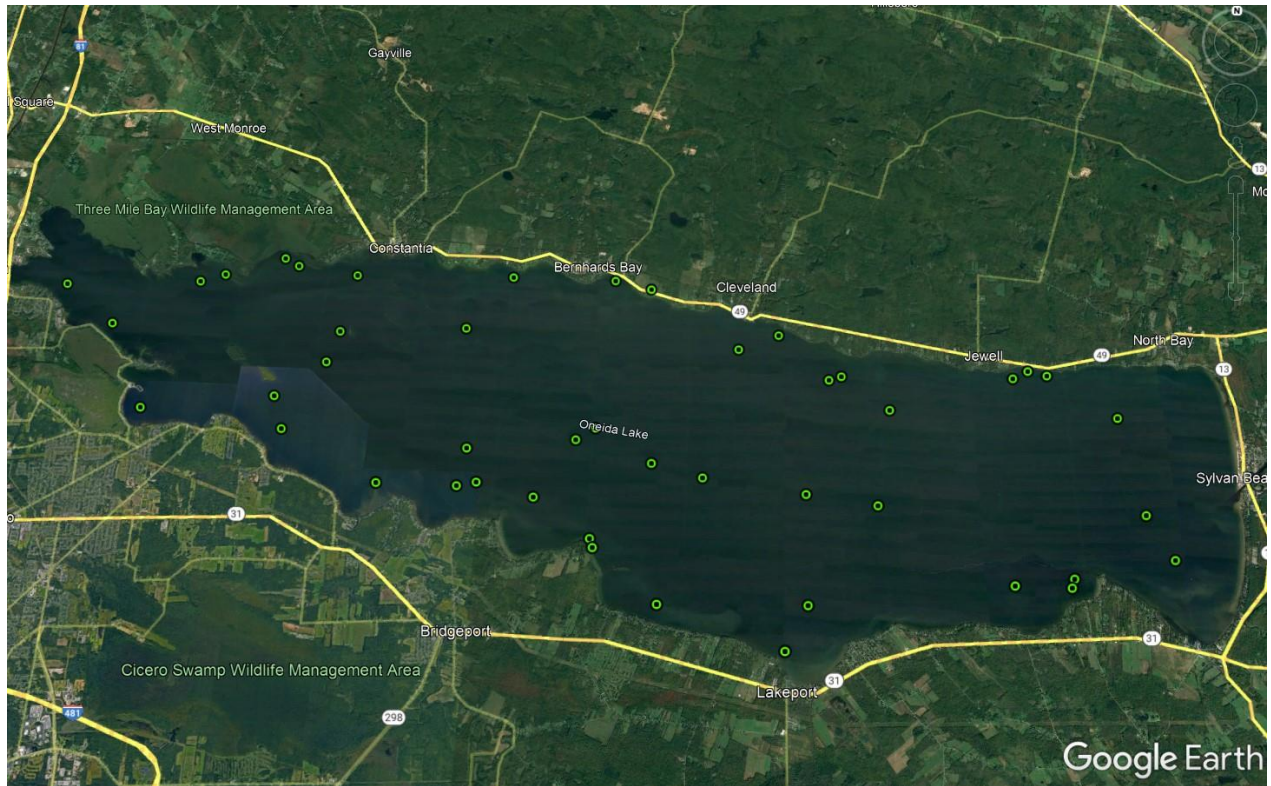


Figure 2. Map of Oneida Lake showing standard 46 round goby video survey sites.

Windy days or large precipitation events (especially near tributaries) should be avoided as they impair water visibility. The boat is maneuvered to each site location and anchoring is not necessary. The camera recording is started, and the camera frame is lowered on a rope attached to a buoy, with the boat allowed to float away from the site so as not to disturb fish. A timer is used to measure 7.5 minutes from the time the camera reaches bottom. The boat then returns to the site to retrieve the buoy, rope, and camera. The camera recording is stopped upon retrieval.

Recorded videos are analyzed later by projection onto a large computer screen. A screenshot still-frame from each video is saved at the 4, 5, 6, and 7-minute marks. Round gobies are counted at each interval and averaged to calculate the mean count for each site. The video footage is used to assist identification of round gobies using motion, as they are often difficult to detect from the still frame image. Only fish that are at least 50% in the viewing frame at the specified time interval are counted. It is often helpful to use a drawing program to circle each fish on the still-frame as it is identified.

Mean round goby counts at each site are divided by the viewing area to calculate the density at each site. Lake-wide density is estimated separately for the hard substrates and soft substrates (23 sites each). Average density (#/ft<sup>2</sup>) is multiplied by 43,560 to convert to acres, then by the lake area in each substrate class [Hard – 7,366 acres (2,981 ha), Soft – 43,784 acres (17,719 ha)] to get a lake-wide round goby population in each substrate class. The two estimates are added to provide the final population estimate and confidence limits calculated based on standard sampling theory for randomized stratified design.

Fyke-net Surveys: We use fyke nets to sample 18 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 3 ft (0.9 m) x 5 ft (1.5 m) frame fitted with ½ in (12.7 mm) delta knotless mesh. In 2008, we concurrently sampled 14 sites with a fyke net comprised of a 3 x 5 ft frame fitted with ¼ in (5 mm) delta knotless mesh. From 2009 onwards, all 18 sites were sampled with nets of both mesh sizes. Sampling is typically initiated around September 15 of each year.

Seine surveys: Daytime seining with a 75 ft (23 m) beach seine with ¼ in (5 mm) mesh is conducted monthly at 9 sites from July through September with noncontinuous long-term data available.

Centrarchid surveys: In spring 2011, we initiated a shoreline electrofishing survey directed at *Centrarchid* spp. Methodology for spring electrofishing surveys was similar to NYSDEC black bass surveys (Brooking et al. 2018). Sampling is initiated when water temperatures reach 20°C. 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. Spring centrarchid surveys are scheduled to be conducted 2 of every 3 years, with walleye mark-recapture years excluded.

Trap-net surveys: Trap-net surveys were conducted in spring and fall using a net design introduced to Oneida Lake by early settlers (Kingsbury 1964). The net consisted of a 6X6X6 ft crib, outside and inside wings with a combined length of 42 ft, and a first heart with turnaround that led into a second heart with turnaround that funneled into a third heart in the crib. The net utilized a 150 ft lead, and all sections were constructed of 1 in bar mesh multifilament netting. The net was set at the same site off Shackelton Point each season and was typically fished 7–10 d in April-May and October. The net was tended daily or as weather permitted. Spring trap-net surveys were conducted most years since 1992 and fall trap-net surveys were conducted in four years prior to 1961 and most years since 1980.

Creel surveys: The current approach is to conduct an abbreviated summer survey each year, basing effort on boat counts from a fixed location in May, June and July and basing catch and harvest on exit interviews conducted at three locations during June and July. A complementary full open water roving survey is conducted every fifth year. Methods for the full open water roving survey are provided in Krueger et al. (2009).

For the abbreviated survey, effort is estimated by fixed point boat counts conducted from a tower on the CBFS property. Counts are conducted at two random times on two randomly selected weekdays and both weekend days through the counting 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 boat-hours by the average party size calculated from exit interviews in June and July. 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).

Harvest rates of walleye from June and July are used to predict a harvest rate for the entire open water season, and this rate is combined with effort estimated for the entire open water season to predict total walleye harvest. Analyses of seasonal patterns in walleye harvest rates estimated during roving creel 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.

The open water walleye harvest rate was predicted by the relationship:

$$HR = 0.761(JJHR) + 0.012 \quad (3)$$

where HR is the harvest rate predicted for the entire open water season and JJHR is the mean of June and July harvest rates ( $r^2 = 0.85$ ;  $p = 0.003$ ).

Beginning with the 2016 season, we also estimate full open water season effort based on counts from a subset of months. We found that effort estimates from May, June and July predicted total season effort, accounting for 96% of the variability observed over 11 seasons of full effort data. The relationship was;

$$OWEFFORT = 31,302.9 + (1.2(ME+JnE+JuE)) \quad (4)$$

where OWEFFORT is effort predicted for the entire open water season and ME, JnE and JuE are May, June and July effort, respectively ( $r^2 = 0.96$ ;  $p < 0.0001$ ).

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## Appendix 2: Standard Data Tables

Table A1. Physical, chemical and biological characteristics of Oneida Lake since 1975. Secchi depth (ft), chlorophyll *a* ( $\mu\text{g/L}$ ), total phosphorous (TP,  $\mu\text{g/L}$ ) soluble reactive phosphorous (SRP,  $\mu\text{g/L}$ ), total zooplankton biomass ( $\mu\text{g/L}$ ), and *Daphnia* spp. biomass ( $\mu\text{g/L}$ ) are averages of weekly data from 1 to 5 stations from May to October. Mussel biomass is lake-wide average shell-on dry weight weighted by substrate in  $\text{g/m}^2$ . Ice in 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 2001-02. Summer temperature ( $^{\circ}\text{F}$ ) is the average temperature from June to Aug measured every hour at 6 ft depth at a site near Shackelton Point.

Year	Secchi	Chl-a	SRP	TP	Zoopl. Biomass	<i>Daphnia</i> Biomass	Mussel biomass	First Freeze Day	Ice Duration	Ice Out Day	Sum Temp
1975	9.2	9.0	17.6	45.9	211	107	0	no data	no data	87	72.0
1976	9.2	9.9	3.3	29.5	241	163	0	19	99	87	69.1
1977	8.9	11.2	5.2	36.2	209	53	0	3	118	90	69.6
1978	9.5	7.7	16.5	42.5	116	73	0	15	121	105	71.6
1979	10.8	7.6	29.0	56.9	226	101	0	29	96	94	67.6
1980	8.5	12.7	10.2	45.2	257	126	0	35	91	95	68.7
1981	7.5	11.7	13.8	31.3	243	45	0	15	95	76	70.9
1982	7.2	9.0	15.2	48.0	260	93	0	20	118	107	69.4
1983	8.5	8.0	21.7	38.6	261	107	0	13	74	87	72.1
1984	7.5	9.2	14.7	30.1	231	104	0	21	111	101	70.9
1985	7.2	10.5	11.6	38.3	261	82	0	40	79	88	68.7
1986	7.9	10.3	27.5	67.1	304	178	0	19	104	92	68.7
1987	9.5	6.5	7.3	27.6	178	97	0	35	86	90	71.1
1988	8.9	9.4	17.1	34.6	248	99	0	34	91	94	69.4
1989	11.2	5.2	9.4	24.1	185	81	0	16	102	84	71.4
1990	7.9	9.5	4.8	22.0	221	65	0	5	107	81	71.1
1991	7.9	11.7	4.6	23.2	188	67	0	31	78	78	73.4
1992	9.2	7.1	1.8	20.1	315	196	343	25	93	102	68.4
1993	12.8	5.1	5.9	15.8	157	64	276	24	99	105	70.5
1994	12.1	6.6	6.2	30.4	193	103	533	27	113	109	71.6
1995	16.1	3.2	10.0	22.9	207	140	234	39	75	97	73.8
1996	11.8	5.5	6.0	19.9	222	128	158	32	100	101	71.6
1997	11.8	5.3	3.3	14.7	300	135	351	39	88	96	70.9
1998	9.8	5.2	5.2	21.5	161	57	258	48	58	86	72.5
1999	10.8	6.0	6.3	15.2	206	82	359	33	94	96	73.9
2000	9.5	6.5	4.4	18.1	154	85	201	45	63	77	70.3
2001	11.8	5.3	10.4	27.8	237	101	261	12	117	103	72.3
2002	12.1	4.8	7.0	27.2	162	75	386	no freeze	0	-	73.4
2003	12.5	6.5	9.8	27.3	209	92	356	10	104	105	72.0
2004	11.2	7.7	10.8	29.0	233	99	142	21	90	95	70.7
2005	13.8	3.8	16.4	29.4	259	116	205	26	97	98	75.6
2006	10.2	7.3	10.6	29.2	209	77	279	18	72	91	73.2
2007	11.5	5.8	6.4	20.9	185	68	336	54	71	94	72.7
2008	13.8	3.8	12.2	24.6	165	45	246	19	83	92	72.5
2009	12.1	4.0		24.4	117	40	278	24	85	81	71.1
2010	14.4	2.6	11.1	28.5	139	48	373	23	85	81	74.1
2011	10.5	4.9	7.9	30.5	97	22	383	17	107	94	73.9
2012	15.4	2.9	15.3	31.5	183	63	673	46	21	53	75.4
2013	10.5	3.9	10.7	30.8	209	64	460	30	80	91	73.0
2014	10.8	4.2	11.1	28.0	176	43	488	30	118	103	72.1
2015	11.5	3.2	6.5	22.5	214	46	430	37	99	105	72.7
2016	14.1	3.7	7.8	24.5	167	42	414	45	74	57	74.1
2017	10.2	5.8	10.2	25.1	181	47	487	20	63	90	72.3
2018	11.5	4.5	4.9	15.8	152	38	331	27	98	94	73.9
2019	10.8	4.7	3.0	17.8	209	52	237	42	86	99	73.0
2020	11.5	4.9	5.9	19.4	175	34	105	20	65	84	75.4

<b>Year</b>	<b>Secchi</b>	<b>Chl-a</b>	<b>SRP</b>	<b>TP</b>	<b>Zoopl. Biomass</b>	<b><i>Daphnia</i> Biomass</b>	<b>Mussel biomass</b>	<b>First Freeze Day</b>	<b>Ice Duration</b>	<b>Ice Out Day</b>	<b>Sum Temp</b>
2021	12.1	4.4	5.8	18.9	155	41	275	41	63	75	73.6
2022	10.2	4.2	15.2	29.1	164	15	363	39	71	80	74.0
Avg	10.7	6.5	10.1	28.8	203	81	330	27.5	87.3	90.9	71.9



Table A2. Total annual catch of select species in gill-net surveys for Oneida Lake since 1957.

Year	chain pickerel	freshwater drum	gizzard shad	lake sturgeon	largemouth bass	longnose gar	pumpkinseed	redhorse sp.	rock bass	smallmouth bass	walleye	white bass	white perch	white sucker	yellow perch
1957	0	0	0	0	0	0	3	0	5	7	389	101	171	25	1001
1958	0	0	0	0	0	0	1	0	1	3	598	55	50	24	723
1959	0	0	0	0	0	0	5	0	7	15	458	149	227	26	1027
1960	0	0	0	0	0	0	21	0	5	17	405	45	474	92	1375
1961	0	0	0	0	0	0	5	0	2	8	430	13	98	47	1447
1962	0	0	0	0	0	0	18	0	8	18	479	9	142	31	1491
1963	0	0	0	0	0	0	11	0	5	9	432	24	199	38	1670
1964	0	0	0	0	0	0	36	0	12	23	543	15	233	35	1611
1965	0	0	0	0	0	0	12	0	4	22	778	9	254	21	1938
1966	0	0	0	0	0	0	7	0	10	16	601	3	129	70	1346
1967	0	0	0	0	0	0	12	0	5	10	583	4	106	104	1540
1968	0	0	0	0	0	0	13	0	5	8	569	0	73	54	1937
1969	0	0	0	0	0	0	7	0	12	7	837	0	65	48	1510
1970	0	0	0	0	0	0	25	0	9	18	519	2	175	68	1866
1971	0	0	0	0	0	0	9	0	9	6	116	0	45	12	830
1972	0	0	0	0	0	0	16	0	5	15	295	0	24	63	926
1973	0	0	1	0	0	0	13	0	23	12	173	2	28	22	1531
1975	0	11	0	0	0	0	5	0	5	2	281	12	415	10	1427
1976	0	5	0	0	0	0	18	1	13	22	454	3	501	9	1534
1977	0	8	1	0	0	0	5	2	4	15	432	8	208	20	1433
1978	0	7	1	0	0	0	6	0	9	16	510	6	100	22	1055
1979	0	1	0	0	0	0	6	0	10	7	293	1	509	67	1649
1980	0	2	7	0	0	0	4	0	6	15	399	8	353	68	2838
1981	0	8	1	0	0	0	4	1	1	5	638	6	963	21	2420
1982	0	13	0	0	0	0	14	2	7	6	511	5	486	27	1722
1983	0	2	8	0	0	0	12	0	12	6	757	0	420	28	1166
1984	0	22	12	0	1	0	22	0	10	26	372	0	424	44	1499
1985	0	12	60	0	0	0	5	1	5	16	504	6	666	42	750
1986	0	13	25	0	0	0	23	2	16	19	296	6	922	53	1081
1987	0	13	3	0	0	0	17	3	14	47	386	3	305	58	1285
1988	0	94	42	0	0	0	8	1	14	38	530	1	30	38	1236
1989	0	55	15	0	0	0	15	0	22	65	391	14	67	34	1245
1990	0	291	33	0	0	0	10	1	18	57	302	18	125	33	1008
1991	0	178	17	0	0	0	1	1	9	33	165	10	56	27	608
1992	0	107	49	0	0	0	1	0	5	20	246	23	78	40	814
1993	0	100	1	0	0	0	9	0	1	46	217	2	66	44	952
1994	0	154	2	0	0	0	11	3	1	37	177	10	41	47	316
1995	0	93	0	0	0	0	9	1	4	22	144	0	37	37	864
1996	0	49	0	5	0	0	5	1	0	24	108	11	40	41	617
1997	0	33	0	33	0	0	20	1	7	30	75	11	200	59	606
1998	0	83	0	12	0	0	15	4	3	29	198	4	196	54	773
1999	0	74	17	23	0	0	19	5	1	65	236	17	502	66	444
2000	0	35	9	26	0	0	33	2	1	31	248	3	209	64	796
2001	0	32	3	25	0	0	31	5	1	30	218	3	497	34	728
2002	0	69	9	13	0	0	20	5	2	70	437	10	450	34	1061
2003	0	34	2	14	0	0	9	2	0	46	255	5	345	17	460
2004	0	25	5	15	0	0	4	3	0	41	346	1	376	23	563
2005	0	32	2	20	0	0	2	1	0	70	255	7	450	32	728
2006	1	30	5	15	0	0	8	3	0	33	238	1	623	7	647
2007	0	22	30	20	0	5	8	1	3	48	237	4	771	23	493
2008	1	39	18	8	1	1	28	7	2	54	230	2	373	33	753
2009	1	33	15	2	0	0	22	4	0	29	234	8	742	29	547
2010	1	42	62	3	0	0	11	1	2	32	244	8	498	27	513
2011	3	34	24	3	0	0	38	4	3	75	308	21	541	32	522
2012	3	38	37	4	0	2	30	4	1	55	312	0	376	28	672
2013	4	80	91	1	2	1	45	2	7	34	405	0	548	20	695
2014	2	14	61	0	0	0	10	2	1	44	408	0	386	58	340
2015	3	19	2	0	0	0	22	5	2	39	347	0	445	23	423
2016	0	33	5	17	0	0	5	0	0	40	411	0	118	15	580

Year	chain pickerel	freshwater drum	gizzard shad	lake sturgeon	largemouth bass	longnose gar	pumpkinseed	redhorse sp.	rock bass	smallmouth bass	walleye	white bass	white perch	white sucker	yellow perch
2017	1	7	14	3	0	0	2	3	2	24	477	0	250	27	463
2018	0	10	14	13	0	2	6	1	0	35	400	0	304	19	881
2019	1	17	12	9	0	0	8	9	1	17	438	0	418	22	1016
2020	1	19	33	14	0	4	9	13	20	28	359	0	386	14	1444
2021	2	31	28	6	0	0	13	10	21	36	267	0	401	23	2106
2022	1	33	44	11	0	1	32	8	15	17	301	0	351	45	2279

Table A3. Age-0 catch (all ages for trout-perch and round goby) of select species in standard 18-ft trawl surveys for Oneida Lake since 1960.

Year	# hauls	Lepomis spp.	round goby	smallmouth bass	trout-perch	walleye	white perch	yellow perch
1960	96	156	0	30	8,576	210	21,834	79,416
1961	114	1,546	0	9	9,700	1,873	10,991	125,998
1962	96	211	0	36	13,350	1,617	3,128	128,905
1963	120	465	0	0	7,541	1,203	552	55,101
1964	140	1,560	0	3	3,737	1,370	655	180,475
1965	140	29	0	1	4,300	1,351	11,738	142,301
1966	140	24,019	0	15	7,125	228	14,379	46,679
1967	130	2,533	0	19	7,624	1,163	1,910	138,011
1968	140	672	0	0	8,081	3,083	159	266,826
1969	130	692	0	5	4,287	965	1,041	39,489
1970	100	1,779	0	18	1,296	321	1,930	44,970
1971	120	62	0	44	1,965	561	1,202	113,034
1972	110	4,477	0	9	2,426	335	288	11,515
1973	150	15,061	0	0	848	33	28,650	23,268
1974	140	951	0	12	269	744	4,651	27,400
1975	120	43	0	16	85	1,891	2,219	75,354
1976	130	1,329	0	14	87	106	3,464	32,861
1977	150	6	0	4	142	1,226	14,820	133,333
1978	140	585	0	104	593	550	442	40,337
1979	110	8,630	0	1	377	99	14,952	33,351
1980	130	98	0	0	358	238	77,273	47,038
1981	130	19	0	4	713	851	3,059	157,850
1982	120	458	0	0	2,500	307	50,294	67,715
1983	130	25,689	0	21	2,089	196	75,488	56,010
1984	130	1,405	0	62	4,381	147	6,448	24,325
1985	120	53	0	1	9,423	470	1,366	50,884
1986	130	498	0	0	6,543	80	190	4,366
1987	130	103	0	91	6,150	334	73,024	10,273
1988	130	111	0	13	3,014	141	56	27,198
1989	130	533	0	0	706	32	11,520	1,455
1990	130	897	0	36	1,294	108	999	19,494
1991	160	1,114	0	176	3,899	563	1,149	12,277
1992	140	17	0	2	8,855	226	488	17,897
1993	140	467	0	49	11,829	237	8,573	20,703
1994	140	237	0	392	15,472	257	851	29,936
1995	140	741	0	95	9,050	277	6,685	15,174
1996	150	60	0	5	2,858	36	681	9,618
1997	150	213	0	348	5,221	69	10,534	975
1998	140	27	0	66	4,927	42	1,663	18,160
1999	150	12	0	131	4,419	157	105	22,310
2000	140	36	0	0	5,529	49	6,587	9,452
2001	140	55	0	38	4,163	428	721	30,280
2002	150	556	0	68	7,759	57	14,043	59,123
2003	140	316	0	27	6,845	36	665	10,973
2004	150	12	0	65	10,297	315	18,536	18,248
2005	150	233	0	141	1,691	244	978	28,783
2006	130	88	0	20	1,054	23	1,216	13,287
2007	150	117	0	260	3,014	218	1,955	103,495
2008	140	197	0	198	3,542	77	3,052	13,062
2009	140	353	0	35	12,144	17	1,975	32,862
2010	150	18	0	92	16,532	161	463	25,332
2011	150	179	0	362	6,642	52	16,771	3,231
2012	150	113	0	116	674	326	2,097	4,224
2013	130	478	0	7	483	10	70	2,197
2014	140	87	64	379	2,208	137	487	21,205
2015	120	219	2,586	27	3,606	51	141	5,410
2016	130	40	4,954	1	1,267	130	118	15,918

Year	# hauls	Lepomis spp.	round goby	smallmouth bass	trout-perch	walleye	white perch	yellow perch
2017	130	591	4,810	39	6,155	110	13,283	15,157
2018	120	142	990	9	1,834	299	373	37,419
2019	120	860	1,807	0	1,594	60	3,033	24,010
2020	120	80	1,398	21	243	78	16	16,301
2021	120	1	2,246	3	85	82	61	14,139
2022	120	43	1,997	1	215	190	502	12,781

Table A4. Catch per unit effort (#/net-night) of select species in large (1/2") and small (3/16") mesh fyke nets set nearshore in Oneida Lake since 2007. The number of total sites was reduced from 24 to 18 beginning in 2015 (14 sites for small mesh net in 2008).

Year	Black crappie	Bluegill > yoy	Brown bullhead	Chain pickerel	Freshwater drum	Largemouth bass yoy	Lepomis sp. yoy	Pumpkinseed > yoy	Rock bass	Round goby	Smallmouth bass YOY	Walleye yoy	White perch yoy	Yellow perch > yoy	Yellow perch yoy
Large Mesh Net (1/2")															
2007	2.4	2.6	0.8	0.4	<0.1	1.2	3.3	9.5	3.1	0.0	11.6	0.2	1.4	16.0	18.2
2008	0.9	3.8	0.9	<0.1	<0.1	2.2	1.1	13.4	3.0	0.0	4.8	0.4	0.1	26.1	1.5
2009	0.9	9.3	0.8	<0.1	0.1	0.7	2.1	16.8	2.6	0.0	2.4	0.1	5.4	24.5	0.5
2010	0.8	3.5	0.6	0.7	0.3	0.8	3.2	7.0	3.3	0.0	1.3	0.2	<0.1	19.5	0.3
2011	3.3	4.3	0.5	0.6	0.4	0.8	10.7	7.5	2.0	0.0	1.0	0.1	4.5	19.6	1.0
2012	0.9	4.4	0.3	0.5	0.4	1.0	2.9	4.5	2.5	0.0	1.0	0.1	0.0	16.3	6.2
2013	6.2	19.5	1.8	1.0	0.4	1.3	3.0	10.1	3.7	0.0	0.4	<0.1	0.0	24.5	0.3
2014	2.2	5.2	0.5	0.5	0.2	2.9	1.0	7.0	3.3	<0.1	1.9	0.0	0.1	14.9	0.8
2015	1.4	1.7	0.9	0.8	0.1	1.8	4.7	6.4	2.8	0.8	14.3	0.1	0.9	25.7	4.5
2016	1.5	5.1	0.4	0.8	0.2	1.7	7.7	9.1	3.1	1.6	3.0	0.4	0.0	26.7	0.4
2017	2.9	10.6	1.1	0.1	0.4	0.1	0.2	14.3	2.7	0.4	3.2	0.1	4.2	23.4	0.0
2018	1.4	8.7	1.3	0.2	0.3	0.9	0.4	15.3	3.3	0.3	2.0	0.2	0.0	21.8	0.2
2019	1.1	2.2	0.3	0.3	0.7	1.3	4.1	6.7	3.2	0.7	1.1	0.7	0.9	15.2	1.4
2020	0.7	4.5	0.4	0.4	0.1	2.2	2.8	15.9	5.9	1.5	0.6	0.4	0.0	12.8	28.5
2021	3.6	4.4	0.3	0.6	0.4	1.4	0.4	6.6	5.0	0.1	0.1	0.4	0.0	19.7	12.1
2022	1.4	1.9	0.2	0.2	1.3	0.8	1.2	6.2	4.9	0.6	0.7	0.5	0.1	19.4	3.9
Small mesh net (3/16")															
2008	0.3	2.4	0.5	0.0	0.0	2.6	42.9	2.4	3.6	0.0	11.2	0.0	0.0	1.9	18.3
2009	0.1	4.4	0.2	<0.1	0.0	0.4	237.1	1.7	2.5	0.0	2.5	0.0	0.1	9.4	22.4
2010	0.5	5.3	0.2	0.1	<0.1	1.5	21.1	4.3	3.3	0.0	2.5	0.2	0.0	1.9	25.7
2011	0.9	3.5	0.2	0.1	<0.1	2.3	139.0	3.1	3.0	0.0	5.0	<0.1	6.0	3.8	11.8
2012	0.2	3.5	0.3	0.1	0.0	1.8	38.1	1.4	3.6	0.0	6.2	0.3	0.0	2.0	16.5
2013	0.9	10.0	0.4	<0.1	0.0	1.0	1009.7	2.3	2.9	0.0	0.8	0.0	0.0	7.0	9.2
2014	0.7	4.7	0.3	0.1	0.0	2.9	89.3	5.8	4.2	<0.1	9.1	0.0	0.1	6.9	18.0
2015	0.6	0.6	0.3	0.1	0.1	0.9	176.3	1.7	2.6	7.6	4.2	0.1	0.2	2.6	39.1
2016	0.2	1.2	0.7	0.1	0.0	3.4	68.7	0.9	2.7	27.1	1.7	0.1	0.0	5.4	31.6
2017	0.8	2.4	0.3	0.1	0.2	0.0	125.4	1.6	2.9	29.4	1.3	0.1	0.3	2.3	7.6
2018	0.4	8.3	1.2	0.1	0.0	1.1	179.4	3.4	4.1	13.4	0.9	0.3	0.0	6.1	54.6
2019	0.2	0.7	0.6	0.1	0.0	1.9	261.5	0.9	4.9	14.6	0.9	0.1	0.4	1.4	27.4
2020	0.2	2.1	0.4	0.0	0.1	5.2	100.0	2.9	8.9	29.6	1.7	0.2	0.0	0.6	59.2
2021	5.9	3.6	0.6	0.1	0.0	2.8	267.0	3.4	4.7	6.5	0.0	0.0	0.1	1.7	27.9
2022	0.5	1.3	0.8	0.0	0.2	0.6	325.4	0.7	4.7	33.2	1.3	0.0	0.0	1.9	131.6

Table A5. Mean catch per haul in 75 ft (22.9 m) standard beach seine for Oneida Lake in various years since 1959. Data for the 9 standard sites only. Surveys conducted once per month in July, August and September (some years surveys conducted in 1 or 2 of the months only; months sampled identified by subscript in # of surveys column). Data provided for the main species of interest (does not include less abundant species).

Year	# of surveys	Banded Killifish	Bluntnose Minnow	Chain Pickerel yoy	Darter spp.	Emerald Shiner	Gizzard Shad yoy	Largemouth Bass yoy	Lepomis spp. yoy	Logperch	Rock Bass yoy	Round Goby	Smallmouth Bass yoy	Walleye yoy	White Perch yoy	White Sucker yoy	Yellow Perch yoy
1959	3	8.2	0.9	0.0	4.4	0.6	0.0	1.8	42.1	11.8	1.4	0.0	1.8	9.8	0.1	17.3	192.9
1960	1 <sub>J</sub>	1.7	1.6	0.0	3.9	0.1	0.0	0.1	0.3	7.2	0.0	0.0	0.4	4.7	0.9	7.5	413.1
1961	3	12.3	0.8	0.0	9.1	0.1	0.0	1.1	13.8	21.9	3.3	0.0	1.7	14.8	1.2	34.8	232.3
1962	3	9.8	0.3	0.0	3.6	0.1	0.2	0.5	7.4	14.1	3.7	0.0	8.2	7.9	4.6	10.3	354.1
1963	3	10.2	0.4	0.0	7.4	0.4	0.0	0.3	12.9	18.8	2.1	0.0	0.2	19.7	0.5	15.8	391.4
1964	3	4.8	0.7	0.0	5.9	0.2	0.0	0.0	69.6	9.7	0.4	0.0	0.1	7.4	2.5	124.0	428.2
1965	3	46.1	0.7	0.0	3.6	2.7	0.0	0.4	19.2	7.5	0.8	0.0	0.2	0.3	1.3	31.9	154.9
1966	2 <sub>JA</sub>	44.4	0.3	0.0	5.0	0.2	0.0	2.0	39.1	7.3	1.9	0.0	2.2	3.9	1.0	36.5	187.3
1967	2 <sub>JA</sub>	51.9	0.8	0.0	3.8	10.2	0.0	2.8	4.3	5.5	7.2	0.0	4.0	7.7	1.1	20.6	273.7
1968	2 <sub>JA</sub>	8.8	0.2	0.0	3.7	0.2	0.0	0.6	8.1	9.5	0.3	0.0	0.1	37.6	0.1	24.7	364.6
1969	2 <sub>JA</sub>	16.1	0.0	0.0	5.5	0.0	0.0	0.1	8.7	7.4	2.6	0.0	0.8	37.2	4.7	18.0	467.0
1970	2 <sub>JA</sub>	4.0	0.2	0.0	5.8	0.0	0.0	0.4	14.6	11.7	6.6	0.0	1.8	13.2	4.8	19.9	530.7
1975	3	22.0	6.6	0.0	6.9	0.1	0.2	4.0	12.3	25.1	17.2	0.0	8.4	5.0	14.3	39.3	796.2
1976	2 <sub>JA</sub>	5.3	0.6	0.0	15.6	38.8	0.1	0.3	132.5	25.8	0.7	0.0	3.8	14.7	16.3	24.4	1118.3
1978	2 <sub>JA</sub>	2.6	0.2	0.0	4.5	0.7	0.0	5.0	11.8	65.0	7.8	0.0	5.8	13.0	1.6	10.0	937.4
1989	2 <sub>JA</sub>	3.0	9.6	0.0	5.6	260.0	0.0	0.3	0.2	54.6	1.8	0.0	3.6	6.3	0.6	42.5	849.5
1990	3	7.5	5.3	0.0	1.8	7.9	0.8	1.9	4.9	8.8	1.6	0.0	9.4	1.7	0.2	9.0	296.8
1993	2 <sub>JA</sub>	3.0	9.6	0.0	5.6	260.0	0.0	0.3	0.2	54.6	1.8	0.0	3.6	6.3	0.6	42.5	849.5
1994	3	7.5	5.3	0.0	1.8	7.9	0.8	1.9	4.9	8.8	1.6	0.0	9.4	1.7	0.2	9.0	296.8
2000	2 <sub>JA</sub>	2.9	0.7	0.0	0.1	17.5	0.0	1.6	6.3	6.3	0.3	0.0	0.0	1.8	64.9	6.5	519.8
2004	1 <sub>J</sub>	2.3	2.4	0.1	0.6	32.0	0.0	0.0	4.8	3.7	0.0	0.0	4.1	30.1	0.0	4.3	631.4
2005	2 <sub>JA</sub>	20.3	4.1	0.0	1.7	2.3	0.0	13.8	3.1	37.8	11.8	0.0	11.2	1.1	0.5	1.2	958.8
2006	1 <sub>A</sub>	8.8	1.0	0.0	2.0	0.0	0.0	9.5	3.8	5.8	3.8	0.0	3.3	0.0	13.3	0.3	382.5
2007	3	16.3	1.7	0.1	0.2	16.5	4.4	3.1	3.3	1.6	0.9	0.0	12.5	1.5	0.7	14.3	376.1
2008	3	47.5	3.5	0.0	2.7	5.8	0.3	6.0	8.0	1.3	4.1	0.0	14.2	1.2	0.6	13.6	502.4
2009	3	30.6	6.5	0.0	4.1	14.1	5.3	5.6	6.2	8.3	1.8	0.0	2.6	0.3	8.4	1.9	395.9
2011	2 <sub>JA</sub>	35.0	4.8	0.1	2.0	22.4	40.0	3.4	3.1	7.0	0.2	0.0	22.0	0.2	31.4	3.5	117.2
2014	1 <sub>J</sub>	10.6	6.8	1.2	0.7	63.9	0.0	5.6	0.0	26.7	0.3	0.0	28.9	3.0	0.6	10.7	468.3
2015	3	45.8	1.5	0.3	0.7	37.7	8.8	2.0	15.4	26.0	3.0	2.5	4.1	3.6	21.3	13.7	754.7
2016	3	37.5	5.8	0.3	0.5	1.6	19.9	3.8	5.5	8.0	3.4	68.6	3.4	0.3	0.1	1.2	309.7
2017	3	36.4	2.7	0.0	0.0	4.0	2.7	1.9	31.4	19.3	4.9	36.4	3.3	0.3	9.4	1.5	238.0
2018	3	27.8	1.4	0.0	0.0	33.3	25.6	3.1	8.8	11.1	7.8	23.2	3.4	0.5	0.3	3.0	287.0
2019	3	13.5	0.1	0.1	0.0	18.3	14.9	6.2	94.0	10.3	10.2	81.4	0.3	1.6	0.7	17.0	80.0
2020	3	38.9	1.3	0.0	0.0	1.7	1.1	2.7	15.4	9.2	5.5	102.0	1.7	0.2	0.0	0.5	68.4
2021	3	28.7	0.8	0.0	0.0	0.7	0.1	2.2	1.4	3.8	11.5	125.4	1.1	0.3	0.1	3.4	83.1
2022	3	33.4	1.7	0.0	0.0	21.2	0.2	1.8	4.7	9.6	3.5	123.7	0.5	0.0	0.3	4.9	138.3

Table A6. Catch per hour by species from predator only runs (1 hr) from spring electrofishing surveys conducted on Oneida Lake since 2011.

Year	Bowfin	Chain pickerel age-1	Chain pickerel age>1	Freshwater drum	Largemouth bass age-1	Largemouth bass age>1	Longnose Gar	Smallmouth bass age>1	Smallmouth bass age-1	Walleye age-1	Walleye age>1
2011	2.6	0.5	4.0	1.8	0.4	10.0	1.8	2.3	0.9	4.0	4.7
2012	1.6	0.0	3.7	5.4	2.1	8.2	2.0	3.7	1.0	1.5	8.0
2013	-	-	-	-	-	-	-	-	-	-	-
2014	2.6	0.6	6.6	1.8	0.2	12.0	2.2	3.7	0.2	3.3	4.8
2015	1.8	0.3	9.3	2.8	0.0	9.7	3.1	4.3	0.2	3.9	11.7
2016	-	-	-	-	-	-	-	-	-	-	-
2017	2.9	0.1	3.7	2.7	3.5	18.9	3.4	3.8	3.3	5.6	9.2
2018	3.1	0.0	4.8	3.8	0.6	17.0	3.8	1.6	0.1	0.9	13.0
2019	-	-	-	-	0.0	7.6	-	2.0	0.3	-	16.1
2020	2.5	0.1	3.8	2.9	3.2	8.3	2.6	2.0	0.3	4.7	10.2
2021	3.6	0.0	2.0	2.8	1.5	4.3	3.6	2.8	0.3	1.3	11.4
2022	2.5	0.0	1.4	3.6	0.0	16.6	3.3	2.6	0.1	2.3	7.9

Table A7. Catch per hour by species from all fish runs (15 min) from spring electrofishing surveys conducted on Oneida Lake since 2011.

Year	Banded killifish	Bluegill adult	Brown bullhead	Emerald shiner	Gizzard shad	Lepomis age-1	Logperch	Pumpkinseed adult	Rock bass age-1	Rock bass adult	Round goby	Yellow perch age-1	Yellow perch adult
2011	20.3	24.5	28.0	15.0	9.5	7.0	25.0	62.8	3.8	6.5	0.0	129.0	90.5
2012	3.0	6.5	37.0	30.3	10.0	13.3	26.8	22.8	0.3	5.5	0.0	24.5	19.3
2013	-	-	-	-	-	-	-	-	-	-	-	-	-
2014	2.3	12.8	44.0	3.0	3.0	0.8	8.0	42.0	0.0	15.0	0.0	51.5	98.0
2015	2.5	3.0	35.0	117.8	1.5	1.8	14.3	35.0	1.0	8.0	1.3	106.8	46.3
2016	-	-	-	-	-	-	-	-	-	-	-	-	-
2017	6.3	23.8	20.0	3.3	7.5	13.3	6.8	34.3	8.8	15.5	10.8	64.3	79.5
2018	2.3	10.5	14.6	20.5	1.8	3.3	8.8	7.8	0.8	5.3	1.5	29.8	34.0
2019	-	-	-	-	-	-	-	-	-	-	-	-	-
2020	16.8	1.5	15.3	23.5	1.5	9.8	29.0	12.8	2.3	20.0	15.8	35.0	30.3
2021	1.8	8.5	19.8	12.3	11.3	2.8	4.8	16.3	0.8	7.3	2.0	31.0	41.5
2022	-	-	-	-	-	-	-	-	-	-	-	-	-



Table A8. Abundance and biomass of pelagic fish (emerald shiners (ES), gizzard shad (GS), and *Alosa* spp. (blueback herring and alewife)) for Oneida Lake since 1993.

Year	Density (#/acre)					Biomass (lb/acre)				
	ES YOY	ES 1+	GS	<i>Alosa</i>	Sum	ES YOY	ES 1+	GS	<i>Alosa</i>	Sum
1993	2,704	300	2,592	53	5,650	8.4	2.9	39.3	1.3	52.0
1994	1,452	547	1,018	246	3,263	2.5	4.6	17.5	6.8	31.4
1995	142	321	218	233	913	0.7	3.6	19.3	10.4	34.0
1996	1,177	113	9	199	1,499	2.6	1.1	1.5	5.9	11.1
1997	6,854	712	41	6	7,613	16.8	7.2	0.7	0.2	24.9
1998	912	2,294	17	1	3,224	1.1	18.0	0.4	0.0	19.6
1999	3,051	1,656	294	0	5,001	6.8	11.2	9.8	0.0	27.8
2000	1,401	743	783	0	2,928	3.8	5.8	7.1	0.0	16.7
2001	6,520	988	995	0	8,503	17.0	10.1	26.3	0.0	53.5
2002	8,308	1,018	1,183	0	10,510	10.5	8.1	6.3	0.0	24.9
2003	1,070	3,298	1,001	0	5,369	1.9	26.1	15.5	0.0	43.5
2004	3,665	569	1,078	0	5,313	11.3	5.5	16.4	0.0	33.2
2005	1,051	529	896	0	2,476	2.9	5.5	53.6	0.0	62.0
2006	1,073	270	694	0	2,037	2.9	2.6	17.4	0.0	22.9
2007	105	54	579	0	739	0.4	0.2	16.0	0.0	16.7
2008	3,197	154	839	0	4,190	7.4	1.5	16.4	0.0	25.2
2009	405	616	2,416	2	3,438	0.8	4.9	21.1	0.6	27.3
2010	3,379	822	3,093	11	7,305	7.8	7.0	27.7	0.2	42.8
2011	14,536	1,646	1,894	0	18,075	26.2	13.0	16.8	0.0	56.0
2012	938	417	1,122	0	2,477	4.6	2.0	33.5	0.0	40.2
2013	299	43	500	2	844	0.8	0.4	7.9	0.1	9.1
2014	822	313	2,003	0	3,138	3.4	1.2	12.8	0.0	17.4
2015	1,280	488	463	0	2,231	4.9	1.9	7.6	0.0	14.5
2016	2,937	1,119	623	0	4,679	7.1	2.7	18.5	0.1	28.4
2017	1,745	665	1,832	100	4,342	5.9	2.2	27.9	1.9	37.9
2018	1,172	447	2,464	0	4,083	2.9	1.1	30.4	0.0	34.4
2019	1,559	594	249	0	2,402	4.4	1.7	5.3	0.0	11.3
2020	581	221	238	0	1,040	3.0	1.1	14.7	0.0	18.8
2021	707	269	67	5	1,048	4.6	1.8	0.8	0.1	7.3
2022	46	18	467	0	531	0.2	0.1	10.2	0.0	10.5
Average	2,436	708	989	29	4,162	5.8	5.2	16.6	0.9	28.5

Table A9. Walleye age-specific density estimates (#/acre) for Oneida Lake since 1957. Ages 1, 2 and 3 walleyes 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. 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	<b>0.2</b>	<b>2.5</b>	<b>0.4</b>	<b>1.9</b>	<b>4.9</b>
1958	3.7	0.6	1.9	<b>15.3</b>	<b>0.2</b>	<b>2.5</b>	<b>2.3</b>	<b>20.3</b>
1959	0.2	4.9	1.5	<b>1.1</b>	<b>13.8</b>	<b>0.1</b>	<b>3.8</b>	<b>18.8</b>
1960	2.0	1.5	9.2	<b>0.7</b>	<b>1.0</b>	<b>6.4</b>	<b>1.9</b>	<b>10.0</b>
1961	11.3	7.6	1.9	<b>8.4</b>	<b>1.0</b>	<b>0.9</b>	<b>6.0</b>	<b>16.3</b>
1962	6.4	5.9	5.1	<b>1.3</b>	<b>5.6</b>	<b>0.7</b>	<b>4.2</b>	<b>11.8</b>
1963	9.9	6.6	7.3	<b>5.4</b>	<b>1.0</b>	<b>6.2</b>	<b>3.1</b>	<b>15.7</b>
1964	14.0	7.8	4.2	3.7	3.6	0.7	6.2	14.1
1965	17.7	7.7	5.2	<b>3.5</b>	<b>2.2</b>	<b>2.9</b>	<b>4.3</b>	<b>12.9</b>
1966	8.9	12.8	6.1	4.7	2.9	1.8	5.9	15.3
1967	1.6	7.8	11.8	<b>4.2</b>	<b>3.3</b>	<b>1.5</b>	<b>4.2</b>	<b>13.2</b>
1968	9.0	1.2	8.4	<b>7.0</b>	<b>2.3</b>	<b>1.6</b>	<b>3.6</b>	<b>14.5</b>
1969	37.9	12.6	2.0	5.2	5.6	1.9	3.8	16.5
1970	1.3	15.3	4.4	<b>0.5</b>	<b>3.4</b>	<b>3.9</b>	<b>3.7</b>	<b>11.4</b>
1971	1.6	0.2	3.2	3.9	0.4	2.2	4.9	11.4
1972	32.5	3.7	0.6	<b>9.3</b>	<b>2.5</b>	<b>0.3</b>	<b>4.6</b>	<b>16.8</b>
1973	0.3	17.7	1.9	0.6	5.1	1.5	2.9	10.1
1974	2.5	0.9	19.3	<b>1.1</b>	<b>0.1</b>	<b>1.0</b>	<b>1.4</b>	<b>3.7</b>
1975	0.6	1.5	0.4	12.1	1.1	0.1	2.4	15.7
1976	37.5	1.5	1.3	<b>0.4</b>	<b>11.2</b>	<b>0.9</b>	<b>2.0</b>	<b>14.6</b>
1977	0.3	22.3	1.0	<b>0.8</b>	<b>0.2</b>	<b>6.1</b>	<b>1.6</b>	<b>8.7</b>
1978	14.9	0.4	12.7	0.6	0.7	0.1	6.7	8.2
1979	1.4	12.2	0.4	9.0	0.5	0.5	4.6	14.5
1980	1.0	1.8	9.0	0.4	5.8	0.3	3.3	9.9
1981	16.1	1.8	2.3	8.7	0.3	3.8	2.4	15.1
1982	10.9	9.2	1.6	1.4	7.1	0.2	4.2	12.9
1983	5.8	13.4	12.4	1.0	1.2	5.1	2.9	10.2
1984	4.0	3.8	8.4	5.6	0.9	0.8	5.4	12.7
1985	4.1	2.8	5.8	10.9	4.7	0.6	4.2	20.4
1986	6.1	3.7	2.8	4.0	9.1	3.5	3.1	19.8
1987	1.3	5.4	2.6	3.2	3.3	6.8	4.5	17.7
1988	42.8	0.9	5.1	<b>4.2</b>	<b>2.0</b>	<b>3.9</b>	<b>9.0</b>	<b>19.2</b>
1989	1.6	20.6	1.1	3.3	3.1	3.1	5.4	14.9
1990	3.2	3.4	20.2	<b>0.5</b>	<b>2.4</b>	<b>2.2</b>	<b>5.9</b>	<b>11.0</b>
1991	4.9	3.0	1.6	8.0	1.1	2.0	5.3	16.4
1992	18.5	3.7	2.7	0.7	6.8	0.5	4.2	12.2
1993	1.4	10.8	1.2	0.7	0.6	4.7	3.1	9.0
1994	3.5	1.0	9.4	0.9	0.5	0.4	5.2	7.0
1995	2.4	2.1	0.5	<b>2.3</b>	<b>0.6</b>	<b>0.3</b>	<b>2.5</b>	<b>5.7</b>
1996	3.9	1.1	1.1	0.5	2.2	0.4	2.0	5.1
1997	1.5	2.0	1.2	<b>0.6</b>	<b>0.5</b>	<b>2.2</b>	<b>1.6</b>	<b>4.9</b>
1998	9.0	0.6	1.7	0.2	0.6	0.5	3.0	4.3
1999	5.5	3.1	0.8	<b>0.6</b>	<b>0.2</b>	<b>0.6</b>	<b>2.8</b>	<b>4.2</b>
2000	3.9	4.8	2.6	0.1	0.7	0.3	2.9	4.0
2001	2.9	5.0	2.4	<b>1.6</b>	<b>0.2</b>	<b>0.9</b>	<b>2.8</b>	<b>5.4</b>
2002	13.0	3.7	3.4	1.5	1.3	0.4	3.1	6.2
2003	4.4	5.8	1.5	<b>1.1</b>	<b>1.6</b>	<b>1.1</b>	<b>3.4</b>	<b>7.1</b>
2004	2.6	5.2	4.9	1.9	1.6	1.0	2.8	7.3
2005	3.4	0.6	1.9	<b>2.5</b>	<b>2.0</b>	<b>2.2</b>	<b>2.4</b>	<b>9.2</b>
2006	2.2	3.9	0.5	0.5	2.7	1.1	3.8	8.1
2007	3.7	2.7	1.8	<b>0.5</b>	<b>0.4</b>	<b>2.9</b>	<b>3.8</b>	<b>7.6</b>
2008	0.8	0.9	0.4	1.9	0.5	0.4	5.9	8.6
2009	0.0	2.2	1.1	1.3	1.7	0.4	5.5	8.9
2010	0.7	2.1	1.5	<b>1.8</b>	<b>1.2</b>	<b>1.5</b>	<b>5.2</b>	<b>9.7</b>

Year	Age-1	Age-2	Age-3	Age-4	Age-5	Age-6	Age≥7	Total (Age≥4)
2011	3.4	1.1	2.8	1.1	1.4	0.9	5.0	8.3
2012	1.6	3.1	1.0	1.8	0.8	1.0	4.4	8.0
2013	2.2	2.6	3.9	<b>0.9</b>	<b>1.4</b>	<b>0.6</b>	<b>4.0</b>	<b>6.9</b>
2014	3.8	4.4	1.8	3.6	0.8	1.2	3.9	9.5
2015	4.6	4.2	2.3	1.3	3.3	0.7	4.3	9.9
2016	4.9	4.1	2.7	<b>0.9</b>	<b>1.3</b>	<b>3.0</b>	<b>3.1</b>	<b>8.4</b>
2017	13.3	5.5	4.2	3.5	0.8	1.2	5.4	10.8
2018	2.8	8.3	3.1	6.9	3.0	0.7	5.8	16.4
2019	4.6	1.4	6.8	<b>5.5</b>	<b>6.1</b>	<b>2.7</b>	<b>5.3</b>	<b>19.6</b>
2020	3.7	2.6	1.7	11.6	3.3	3.5	4.9	23.3
2021	4.5	2.2	1.9	2.4	6.2	1.4	5.2	15.2
2022	4.9	3.9	1.8	<b>1.2</b>	<b>2.2</b>	<b>5.9</b>	<b>3.0</b>	<b>12.3</b>

Table A10. Fish observed in stomachs of yearling and older walleye taken by trawls and electrofishing during October and November for Oneida Lake since 1971, expressed as numbers per pound of walleye (ES-emerald shiner; Gizz-gizzard shad; Morone-white perch or white bass; RG-round goby; YP-yellow perch; UID-unidentified).

Year	# examined	% empty	ES	Gizz	Morone	RG	YP	Other	UID	Total
1971	240	37	0.00	0.00	0.00	0.00	1.78	0.03	0.72	2.54
1972	163	58	0.00	0.00	0.05	0.00	0.46	0.28	0.40	1.20
1973	295	32	0.00	0.00	0.62	0.00	0.31	0.20	0.61	1.74
1974	228	27	0.05	0.00	0.52	0.00	0.96	0.17	0.80	2.51
1975	204	68	0.01	0.00	0.06	0.00	0.09	0.08	0.11	0.35
1976	156	36	0.07	0.00	0.40	0.00	0.60	0.34	0.53	1.95
1977	70	19	0.00	0.00	0.57	0.00	1.43	0.06	0.40	2.46
1978	85	56	0.00	0.00	0.05	0.00	0.23	0.21	0.34	0.84
1981	88	66	0.00	0.00	0.07	0.00	0.69	0.00	0.25	1.02
1982	122	11	0.00	0.00	2.40	0.00	0.17	0.00	0.25	2.81
1983	117	62	0.00	0.00	0.36	0.00	0.09	0.00	0.14	0.58
1984	148	59	0.00	0.44	0.20	0.00	0.10	0.03	0.21	0.98
1985	151	50	0.00	0.16	0.02	0.00	0.73	0.06	0.20	1.17
1986	193	45	0.00	0.02	0.07	0.00	0.73	0.07	0.22	1.11
1987	194	23	0.00	0.89	0.29	0.00	0.02	0.01	0.25	1.46
1988	180	55	0.00	0.14	0.00	0.00	0.16	0.03	0.15	0.48
1989	193	26	0.00	2.46	0.08	0.00	0.00	0.01	0.38	2.94
1990	179	28	0.00	2.23	0.00	0.00	0.01	0.00	0.30	2.55
1991	137	20	0.00	1.73	0.00	0.00	0.01	0.05	0.35	2.14
1992	65	58	0.00	0.10	0.01	0.00	0.08	0.03	0.15	0.36
1993	134	25	0.19	0.00	0.23	0.00	0.97	0.37	0.58	2.35
1994	120	55	0.08	0.32	0.03	0.00	0.16	0.02	0.34	0.95
1995	86	45	0.01	0.03	0.16	0.00	0.20	0.06	0.30	0.76
1996	184	32	0.03	0.05	0.17	0.00	0.39	0.24	0.63	1.50
1997	75	45	0.01	0.00	0.16	0.00	0.13	0.12	0.52	0.94
1998	78	40	0.05	0.00	0.07	0.00	0.13	0.08	0.30	0.62
1999	64	42	0.34	0.11	0.01	0.00	0.11	0.01	0.28	0.87
2000	134	21	0.00	1.05	0.13	0.00	0.02	0.00	0.42	1.63
2001	123	28	0.08	0.40	0.08	0.00	0.18	0.11	0.16	1.01
2002	83	41	0.07	0.47	0.02	0.00	0.01	0.01	0.14	0.73
2003	183	39	0.02	0.16	0.04	0.00	0.38	0.10	0.24	0.94
2004	135	13	0.26	1.07	0.17	0.00	0.14	0.03	0.41	2.08
2005	134	30	0.14	0.32	0.05	0.00	0.49	0.06	0.24	1.30
2006	110	25	0.07	1.14	0.13	0.00	0.17	0.04	0.23	1.78
2007	264	50	0.01	0.30	0.00	0.00	0.40	0.04	0.20	0.95
2008	324	16	0.01	1.61	0.04	0.00	0.26	0.04	0.63	2.59
2009	308	44	0.01	0.74	0.02	0.00	0.55	0.02	0.12	1.46
2010	164	13	0.02	1.79	0.00	0.00	0.01	0.00	0.51	2.34
2011	207	37	0.07	0.42	0.26	0.00	0.10	0.04	0.30	1.19
2012	206	21	0.01	1.02	0.00	0.00	0.01	0.01	0.42	1.48
2013	234	63	0.00	1.42	0.01	0.00	0.06	0.26	0.20	1.97
2014	196	30	0.00	0.84	0.04	0.00	0.22	0.03	0.49	1.62
2015	152	14	0.17	1.32	0.00	0.03	0.06	0.22	0.85	2.65
2016	150	21	0.10	0.81	0.00	0.17	0.14	0.01	0.44	1.69
2017	202	12	0.00	2.62	0.04	0.93	0.08	0.04	0.54	4.24
2018	220	15	0.12	2.66	0.00	0.06	0.17	0.03	0.47	3.52
2019	219	38	0.03	0.29	0.02	0.25	0.15	0.08	0.41	1.23
2020	205	37	0.01	0.02	0.00	0.08	0.11	0.05	0.19	0.45
2021	252	37	0.03	0.22	0.00	0.34	0.15	0.10	0.48	1.31
2022	166	25	0.01	0.80	0.00	0.20	0.11	0.04	0.27	1.43

Table A11. Young of year and age-1 walleye density estimates and mean lengths for Oneida Lake since 1961. Larval walleye density (#/acre, 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 (#/acre) and mean lengths (TL, inches) on October 1 are from trawl surveys surrounding the October 1 date (5 dates, 50 trawls), and age-1 walleye densities (#/acre) and mean lengths on May 1 are from trawl surveys around May 1 (3 dates, 30 trawls). Densities calculated based on area swept assuming no avoidance.

Year-class	Larval Density	Age-0 Density	Age-0 Length	Age-1 Density	Age-1 Length
1961		46.3	5.5		
1962		55.0	5.6	17.9	6.2
1963		39.9	4.8	15.3	6.0
1964		32.6	5.4	29.7	6.3
1965		32.1	6.0	53.8	6.4
1966	546	2.5	5.4	3.6	5.8
1967	391	33.3	5.0		
1968	639	88.6	5.6	74.5	6.4
1969	226	20.2	5.6	6.9	6.3
1970	919	10.4	4.7	9.9	6.5
1971	125	17.0	6.5	50.2	7.1
1972	647	2.4	4.7	5.1	6.1
1973	90	0.6	6.4	1.8	6.8
1974	592	6.0	3.9	2.4	5.6
1975	551	60.1	6.7	23.9	7.2
1976	942	0.6	5.2	0.6	6.2
1977	267	29.0	5.3	43.7	6.6
1978		5.9	4.8		
1979		1.9	5.7		
1980		7.2	6.0	11.3	6.4
1981		23.4	5.8		
1982		9.1	6.3	11.2	6.9
1983		11.3	6.0	10.3	6.5
1984		2.4	5.2	10.6	5.9
1985		12.5	5.5	12.7	6.2
1986		2.2	5.5	1.5	6.4
1987		12.1	6.9	10.1	7.3
1988		4.2	5.5	0.9	5.7
1989		1.2	6.2	6.9	6.0
1990		5.8	6.8	6.1	6.9
1991		18.9	6.7	17.8	6.8
1992	135	5.0	5.9	2.0	6.1
1993		4.2	5.7	5.3	6.6
1994		4.6	5.1	4.7	6.4
1995		5.5	5.3	4.6	6.5
1996		0.7	5.9	2.0	6.6
1997		3.2	6.2	0.3	5.5
1998	111	1.0	8.1	1.2	7.4
1999	718	5.0	5.6	1.1	4.8
2000	489	1.2	6.9	5.8	7.1
2001	1,028	7.8	6.0	13.4	6.0
2002	86	1.5	6.8	5.0	7.0
2003	399	1.0	5.4	7.9	6.5
2004	1,293	6.2	5.9	8.5	6.3
2005	3,280	2.3	4.2	5.4	5.6
2006	528	0.9	6.4	3.8	6.7
2007	381	3.0	5.1	1.3	7.1
2008	2,065	2.2	5.1	1.5	5.1
2009	387	0.6	6.0	0.7	5.6
2010	363	5.8	5.1	11.1	6.3
2011	102	1.0	7.1	0.0	
2012	1,090	0.4	4.1	0.1	5.5
2013	214	0.7	6.5	1.2	6.8

Year-class	Larval Density	Age-0 Density	Age-0 Length	Age-1 Density	Age-1 Length
2014	590	4.8	5.7	0.3	5.2
2015	672	0.9	5.4	0.4	4.8
2016	626	3.6	4.8	2.0	5.3
2017	235	2.3	5.8	0.3	7.0
2018	720	5.3	5.3	4.5	6.3
2019	794	1.5	5.9	0.4	6.7
2020	623	1.5	5.5	2.0	6.2
2021	1,091	1.2	4.8	1.2	5.8
2022	339	7.2	7.4		

Table A12. Yellow perch density (#/acre) estimates for Oneida Lake since 1961. Data are from mark-recapture (bold) or based on the catch in gill nets using age-specific net selectivity.

Year	Age-2	Age-3	Age-4	Age-5	Age-6	Age>7	Total (Age>3)
1961	40.5	6.8	22.8	2.3	2.0	3.7	37.6
1962	27.3	21.4	8.5	11.4	2.9	1.8	46.0
1963	10.4	17.5	15.6	9.3	7.4	4.1	54.0
1964	14.6	7.8	17.0	11.6	7.6	3.3	47.4
1965	16.6	24.9	4.5	16.6	8.6	3.0	57.5
1966	24.5	11.3	10.3	5.0	8.7	3.2	38.5
1967	1.2	29.7	10.3	7.1	4.5	4.9	56.5
1968	32.2	2.2	30.9	4.9	4.5	9.4	51.8
1969	34.5	<b>11.5</b>	<b>2.7</b>	<b>16.5</b>	<b>3.4</b>	<b>5.7</b>	<b>39.8</b>
1970	9.4	28.9	9.5	2.8	15.5	9.6	66.2
1971	2.6	<b>3.6</b>	<b>11.2</b>	<b>3.0</b>	<b>0.9</b>	<b>6.1</b>	<b>24.7</b>
1972	54.4	0.9	2.4	6.0	2.1	5.0	16.5
1973	3.6	<b>48.0</b>	<b>0.7</b>	<b>1.6</b>	<b>6.1</b>	<b>11.2</b>	<b>67.6</b>
1974	2.3	3.5	37.1	1.2	2.4	10.7	54.9
1975	63.9	<b>1.6</b>	<b>2.2</b>	<b>16.8</b>	<b>0.5</b>	<b>7.7</b>	<b>28.9</b>
1976	6.7	33.8	1.3	3.2	13.5	4.9	56.7
1977	5.7	<b>5.8</b>	<b>23.5</b>	<b>0.8</b>	<b>1.9</b>	<b>16.1</b>	<b>48.1</b>
1978	17.2	2.1	3.4	10.5	0.8	8.4	25.2
1979	120.9	6.7	2.1	1.9	7.4	4.8	22.8
1980	5.6	107.0	5.0	2.0	2.5	11.9	128.4
1981	17.2	7.3	51.7	5.3	0.9	8.7	74.0
1982	42.5	6.3	4.3	27.7	1.1	2.7	42.1
1983	2.7	17.6	3.2	1.7	14.7	2.2	39.5
1984	21.9	6.8	16.9	4.7	2.6	9.7	40.7
1985	25.7	4.4	1.9	6.2	0.8	6.3	19.6
1986	27.2	14.4	4.3	1.9	6.5	2.5	29.6
1987	14.9	16.7	11.0	3.5	1.3	8.7	41.2
1988	12.2	<b>6.2</b>	<b>14.3</b>	<b>6.6</b>	<b>2.0</b>	<b>10.5</b>	<b>39.7</b>
1989	32.0	4.0	6.6	8.4	5.1	10.8	34.9
1990	7.0	<b>19.8</b>	<b>2.3</b>	<b>4.0</b>	<b>4.7</b>	<b>6.6</b>	<b>37.4</b>
1991	3.9	2.3	7.3	1.8	2.0	7.9	21.3
1992	37.0	3.5	2.0	5.3	1.4	3.5	15.8
1993	36.0	15.8	2.4	1.7	3.5	4.0	27.3
1994	1.5	6.1	3.4	0.4	0.2	2.8	12.9
1995	19.3	<b>2.4</b>	<b>11.5</b>	<b>3.5</b>	<b>1.1</b>	<b>4.3</b>	<b>22.7</b>
1996	30.9	6.4	1.5	2.1	0.8	1.5	12.3
1997	21.5	<b>11.9</b>	<b>3.9</b>	<b>1.0</b>	<b>0.6</b>	<b>0.8</b>	<b>18.3</b>
1998	10.3	12.1	2.1	3.0	1.0	1.5	19.7
1999	4.4	<b>2.8</b>	<b>1.0</b>	<b>3.1</b>	<b>0.9</b>	<b>1.4</b>	<b>9.3</b>
2000	18.3	4.9	3.0	5.6	2.7	2.6	18.8
2001	3.9	<b>10.5</b>	<b>4.1</b>	<b>2.9</b>	<b>2.9</b>	<b>7.2</b>	<b>27.5</b>
2002	6.8	5.4	15.9	3.1	2.3	10.6	37.3
2003	1.6	1.5	2.8	5.8	1.2	3.2	14.5
2004	3.8	3.1	2.0	2.3	3.9	7.2	18.4
2005	3.4	6.0	4.4	1.4	2.3	13.9	28.0
2006	10.0	4.2	4.1	2.0	0.7	8.0	18.9
2007	14.0	5.5	2.3	1.9	0.9	5.4	15.9
2008	7.1	15.2	5.9	2.2	1.3	1.9	26.5
2009	10.8	2.7	5.2	3.7	0.8	2.9	15.3
2010	7.9	6.2	1.7	3.8	1.5	3.4	16.6
2011	6.8	3.6	4.6	1.8	3.1	2.9	16.0
2012	6.4	3.3	7.8	4.8	0.8	5.0	21.7
2013	10.7	8.3	2.8	2.8	3.5	5.8	23.1
2014	13.5	3.2	1.7	0.6	1.0	2.5	9.2
2015	5.5	9.2	3.0	1.2	0.2	0.5	14.2
2016	17.2	3.4	8.0	1.3	0.4	0.0	13.0
2017	14.2	6.6	2.2	2.8	0.6	0.3	12.4

Year	Age-2	Age-3	Age-4	Age-5	Age-6	Age>7	Total (Age>3)
2018	26.6	15.7	5.1	1.2	1.6	0.5	24.0
2019	17.2	16.8	10.5	3.5	0.4	1.0	32.2
2020	22.5	16.2	14.4	9.2	2.6	3.0	45.4
2021	61.3	13.0	15.3	11.3	6.5	2.1	48.2
2022	85.3	31.2	8.8	7.9	6.5	3.8	58.2



Table A13. Young of year and age-1 yellow perch density (#/acre) estimates and mean lengths for Oneida Lake since 1961. Larval yellow perch densities (at 18 mm) are estimated from Miller sampler surveys. Age-0 yellow perch densities, age-0 mean lengths (TL, in) are estimates for October 15 obtained from regression analysis of weekly catches throughout the season. Age-1 yellow perch densities are from trawl surveys around May 1 and from mid-July through October. Age-1 yellow perch mean lengths (TL, in) are from spring trawl surveys centered on May 1 since 1961.

Year-class	Larval Density	Age-0 Density	Age-0 Length	Age-1 Density	Age-1 Length	Summer Age-1 Density
1961		1,153	2.3			7.9
1962		1,724	2.8	196.7	3.0	75.6
1963		316	2.3	28.7		6.4
1964		1,425	2.8	343.6	2.8	237.1
1965	56,698	1,056	2.3	12.1		0.8
1966	16,269	69	2.8	10.1	2.9	15.9
1967	24,767	907	2.8			55.2
1968	57,386	2,711	2.6	242.0	2.9	23.1
1969	28,005	85	2.5	0.8		0.2
1970	32,376	376	3.0	63.9	3.3	18.0
1971	87,576	1,425	2.2	21.0	2.4	12.3
1972	48,847	40	2.6	1.6	3.0	0.3
1973	6,718	206	3.4	25.5	3.5	18.6
1974	12,950	130	2.8	13.4	2.9	3.8
1975	76,366	182	2.5	2.0	2.9	1.7
1976	18,859	73	2.8	4.9	3.0	1.9
1977	26,386	1,675	2.7	1,369.9	2.7	97.7
1978		73	2.8			5.5
1979	41,764	146	2.9			2.6
1980	53,258	202	3.2	47.8	3.2	40.8
1981	84,257	1,048	2.2			1.9
1982	143,019	397	2.5	10.1	2.7	4.3
1983	18,454	287	3.1	38.4	3.1	10.6
1984	6,475	328	2.8	41.7	2.8	13.0
1985	36,868	1,093	2.7	70.4	2.9	12.1
1986	5,909	28	3.2	0.8	3.3	0.7
1987	1,497	89	2.7	51.8	2.7	39.6
1988	30,838	89	3.2	7.7	3.2	1.8
1989	1,497	8	3.2	6.9	3.2	5.3
1990	47,349	186	2.8	74.5	2.7	49.3
1991	13,760	138	3.2	285.3	3.3	67.4
1992	24,605	40	2.8	5.3	3.1	2.2
1993	13,274	130	3.3	28.3	3.3	22.8
1994	8,822	113	3.2	113.7	3.2	12.2
1995	6,111	36	3.5	151.0	3.5	23.7
1996	17,645	32	3.1	29.9	3.2	9.8
1997	1,862	12	3.1	9.3	3.1	7.1
1998	23,108	283	3.2	184.9	3.3	40.2
1999	17,038	437	3.2	7.3	3.3	7.2
2000	7,811	57	3.0	29.5	3.1	2.9
2001	14,650	109	3.3	188.6	3.4	2.5
2002	9,470	672	3.0	153.8	3.1	7.1
2003	27,722	24	3.3	15.4	3.3	2.1
2004	24,565	73	3.4	14.6	3.3	2.3
2005	14,690	166	3.6	113.3	3.6	5.5
2006	23,675	97	3.1	47.3	3.1	7.9
2007	55,034	745	3.2	56.3	3.3	0.8
2008	27,285	291	2.8	42.1	3.0	3.7

Year-class	Larval Density	Age-0 Density	Age-0 Length	Age-1 Density	Age-1 Length	Summer Age-1 Density
2009	45,614	588	2.9	20.2	3.0	2.8
2010	25,429	335	2.8	19.0	3.0	7.2
2011	1,907	8	2.8	6.5	2.8	1.1
2012	9,023	7	3.4	8.1	3.3	11.7
2013	2,693	53	3.3	25.1	3.3	5.5
2014	4,870	173	3.0	7.7	3.0	3.4
2015	11,397	23	3.2	8.9	3.1	9.1
2016	13,548	514	2.9	176.0	3.0	18.9
2017	7,554	210	3.0	12.1	3.0	7.3
2018	10,951	341	2.7	52.2	3.0	14.6
2019	39,158	227	3.4	6.1	3.2	2.3
2020	17,717	53	3.4	4.9	3.7	5.2
2021	20,215	94	3.2	7.7	2.9	5.4
2022	40,244	334	3.0			

Table A14. Relative abundance of white perch year-classes at successive stages of development for Oneida Lake since 1961. 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	500	3.3	-	2	9	20	94	6	8	39	10	178	
1962	128	3.7	-	0	15	2	34	66	10	13	114	140	
1963	20	2.7	0.0	0	5	28	5	83	62	15	12	198	
1964	23	3.1	3.8	0	55	5	36	20	62	54	54	232	
1965	390	3.0	0.0	6	7	59	9	56	43	74	9	254	
1966	533	3.0	0.0	0	19	5	28	8	54	19	5	133	
1967	54	3.3	-	0	3	35	9	15	26	19	16	107	
1968	5	3.4	0.0	0	0	6	18	6	20	22	7	72	
1969	33	3.1	0.0	0	0	5	10	21	6	23	3	65	
1970	107	3.2	0.0	0	4	16	20	46	37	56	25	179	
1971	35	3.0	0.2	1	0	3	7	2	9	23	<b>69</b>	45	
1972	12	3.3	0.0	0	11	3	0	0	2	8	<b>9</b>	24	
1973	852	3.3	1.2	0	6	14	1	1	0	6	551	28	
1974	144	2.8	0.0		No Gill Net Data							15	
1975	84	3.4	0.0	0	240	5	143	14	2	11	3	415	
1976	127	2.5	0.0	0	4	311	5	101	39	41	8	501	
1977	387	3.0	4.9	0	1	11	128	4	52	11	517	207	
1978	16	3.3	-	23	0	2	3	53	1	18	12	100	
1979	704	3.0	-	1	224	8	17	1	228	30	6	509	
1980	2,603	3.1	0.8	0	8	293	0	1	3	48	59	353	
1981	113	2.9	-	0	1	4	775	28	22	132	10	962	
1982	1,952	2.9	0.0	0	21	5	10	411	8	31	29	486	
1983	2,699	3.1	0.0	0	0	38	5	6	343	28	249	420	
1984	145	2.8	0.2	0	6	10	141	10	13	244	297	424	
1985	41	2.7	0.2	1	31	23	12	212	15	372	38	666	
1986	7	2.8	0.0	4	142	218	29	26	195	309	15	923	
1987	2,128	2.4	0.0	1	27	155	31	11	11	69	17	305	
1988	1	3.2	0.0	0	1	11	7	0	3	8	3	30	
1989	359	3.0	0.0	3	4	14	34	4	0	8	8	67	
1990	30	2.8	0.0	2	0	13	19	56	18	17	2	125	
1991	35	3.5	0.0	6	4	3	1	4	19	19	6	56	
1992	19	2.7	0.0	0	0	4	1	10	4	59	0	78	
1993	322	3.1	0.0	0	3	2	2	1	18	40	15	66	
1994	27	3.1	0.2	1	0	3	3	0	2	31	19	40	
1995	248	3.8	5.9	2	4	0	6	2	4	18	243	36	
1996	22	3.4	0.0	2	2	11	3	8	0	14	13	40	
1997	387	3.0	0.0	0	155	17	8	1	5	14	415	200	
1998	51	3.3	0.3	87	0	88	4	10	2	6	202	197	
1999	3	3.8	0.3	40	315	13	122	9	0	4	132	502	
2000	239	3.0	0.9	2	50	100	4	47	2	3	211	208	
2001	24	3.3	3.4	6	56	152	211	14	55	0	283	494	
2002	463	3.2	2.2	32	122	76	65	120	7	26	72	448	
2003	24	3.3	0.0	0	106	89	46	52	36	17	5	346	
2004	572	3.1	0.8	0	33	177	61	38	27	40	590	376	
2005	33	3.8	0.5	44	1	39	227	40	53	17	210	421	
2006	56	3.0	0.7	16	261	4	32	214	50	10	115	587	
2007	57	3.2	0.0	12	111	329	20	34	198	67	78	771	
2008	135	2.9	0.4	5	16	99	126	11	42	74	163	373	
2009	79	2.8	0.3	32	39	99	138	277	38	150	22	773	
2010	19	3.5	1.0	4	79	39	45	71	184	67	93	489	

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
2011	478	3.0	0.0	22	10	84	32	28	84	282	5	541
2012	58	3.9	0.0	0	25	12	68	22	33	216	270	376
2013	3	3.4	0.1	44	0	68	47	97	29	261	50	546
2014	20	3.2	0.0	3	108	5	25	20	64	97	34	322
2015	8	3.4	0.0	0	26	162	17	35	37	168	115	445
2016	6	3.6	0.0	7	12	24	40	3	6	26	286	118
2017	363	2.9	0.1	37	36	22	27	77	7	43	17	250
2018	17	3.2	0.1	0	82	79	9	37	54	43	21	305
2019	142	3.0	0.0	0	8	204	65	24	35	82	17	418
2020	1	4.0	0.0	3	12	9	232	42	11	78	incomplete	387
2021	3	3.6	0.0	4	9	9	8	245	40	86	incomplete	401
2022	22	3.3	0.0	0	67	8	20	6	177	74	Incomplete	351

Table A15. Catch/net-hour of lake sturgeon in large mesh gill nets at 12 standard sites for Oneida Lake since 2002.

Year	6"-12"mesh							6"-14"mesh	
	May	June	July	August	September	October	November	May	June
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	0.27		0.04	-	-	-	-	-	-
2011	0.34	0.04	-	-	-	-	-	-	-
2012	0.40	0.15	-	-	-	-	-	-	-
2013	0.2	0.19	-	-	-	-	-	-	-
2014	0.09	0.06	-	-	-	-	-	-	-
2015	0.24	0.03	-	-	-	-	-	-	-
2016	0.34	0.06	-	-	-	-	-	-	-
2017	0.11	0.05	-	-	-	-	-	-	-
2018	0.47	0.09	-	-	-	-	-	-	-
2019	0.29	0.16	-	-	-	-	-	0.33	0.21
2020	0.20	0.21	-	-	-	-	-	0.23	0.22
2021	0.27	0.07	-	-	-	-	-	0.36	0.09
2022	0.15	0.11	-	-	-	-	-	0.18	0.11

Table A16. Total annual consumption (tons = 2000 lbs) by double-crested cormorants and numbers of percids consumed by age-class for Oneida Lake since 1978. Feeding days to 2010 are based on Coleman et al. (2016), which also includes numbers consumed by age class for 1995 – 2010. Consumption estimate assumes a double-crested cormorant consumes 1.0 pound of fish per day.

Year	Feeding Days	Consum. (Tons)	Walleye				Yellow perch			
			Age-0	Age-1	Age-2	Age-3+	Age-0	Age-1	Age-2	Age-3+
1978	7,315	3.66	-	-	-	-	-	-	-	-
1979	11,497	5.75	-	-	-	-	-	-	-	-
1980	13,138	6.57	-	-	-	-	-	-	-	-
1981	18,184	9.09	-	-	-	-	-	-	-	-
1982	19,910	9.96	-	-	-	-	-	-	-	-
1983	23,872	11.94	-	-	-	-	-	-	-	-
1984	24,243	12.12	-	-	-	-	-	-	-	-
1985	30,118	15.06	-	-	-	-	-	-	-	-
1986	32,340	16.17	-	-	-	-	-	-	-	-
1987	44,252	22.13	-	-	-	-	-	-	-	-
1988	51,171	25.59	-	-	-	-	-	-	-	-
1989	60,326	30.16	-	-	-	-	-	-	-	-
1990	72,718	36.36	-	-	-	-	-	-	-	-
1991	90,878	45.44	-	-	-	-	-	-	-	-
1992	93,212	46.61	-	-	-	-	-	-	-	-
1993	118,756	59.38	-	-	-	-	-	-	-	-
1994	88,004	44.00	-	-	-	-	-	-	-	-
1995	105,412	52.71	-	-	-	-	-	-	-	-
1996	164,612	82.31	-	-	-	-	-	-	-	-
1997	178,794	89.40	-	-	-	-	-	-	-	-
1998	130,609	65.30	-	-	-	-	-	-	-	-
1999	125,317	62.66	-	-	-	-	-	-	-	-
2000	89,968	44.98	-	-	-	-	-	-	-	-
2001	116,868	58.43	-	-	-	-	-	-	-	-
2002	87,380	43.69	-	-	-	-	-	-	-	-
2003	90,479	45.24	-	-	-	-	-	-	-	-
2004	39,375	19.69	-	-	-	-	-	-	-	-
2005	31,899	15.95	-	-	-	-	-	-	-	-
2006	27,706	13.85	-	-	-	-	-	-	-	-
2007	23,275	11.64	-	-	-	-	-	-	-	-
2008	23,639	11.82	-	-	-	-	-	-	-	-
2009	25,203	12.60	-	-	-	-	-	-	-	-
2010	35,809	17.90	-	-	-	-	-	-	-	-
2011	36,335	18.17	-	-	-	-	-	-	-	-
2012	58,186	29.09	13,586	0	0	0	87,805	13,482	2,214	0
2013	57,051	28.53	9,231	17,208	1,801	0	63,336	391,991	29,237	17,004
2014	37,702	18.85	4,180	529	2,502	480	30,168	16,835	1,472	7,231
2015	61,447	30.72	16,841	6,975	8,783	7,062	233,179	85,044	1,766	14,173
2016	76,967	38.48	29,803	44,705	0	0	268,231	100,111	0	0
2017	108,900	54.45	5,188	4,932	2,857	7,534	124,311	54,027	20,781	35,066
2018	96,195	48.10	22,480	6,747	4,928	12,204	97,048	93,232	24,936	49,766
2019	96,701	48.35	5,397	6,047	4,649	25,588	445,281	37,781	19,441	47,895
2020	62,486	31.24	13,221	6,611	1,671	14,065	277,646	28,811	2,020	26,808
2021	77,552	38.78	4,852	1,213	0	17,271	258,384	110,203	13,632	50,188
2022	72,292	36.15	18,389	3,678	1,839	16,533	49,651	23,897	12,829	42,209

Table A17. Open water daytime (0800-dusk) angling effort (boat-hours) as determined by tower counts for Oneida Lake.

Year	Month					TOTAL
	May	June	July	August	September	
1957	-	-	-	-	-	334,000
1958	-	-	-	-	-	271,200
1959	-	-	-	-	-	496,100
1997	17,000	34,600	38,600	32,400	16,700	139,300
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
2015	50,372	51,784	58,005	48,020	24,957	233,139
2016	32,828	50,517	52,422	-	-	194,366
2017	23,396	49,789	54,560	-	-	184,731
2018	32,079	36,615	43,775	29,127	21,343	162,900
2019	27,511	48,730	44,538	-	-	176,634
2021	43,102	57,700	51,917	-	-	214,725
2022	38,638	46,606	62,627	34,266	19,196	201,332

1957-59 from Grosslein (1961) and total boat-hours include October.

Table A18. Open water daytime angler catch rates (fish/angler-hour) for walleye and smallmouth bass as determined by angler interviews for Oneida Lake. Launch catch rates are from completed trips in June and July only. Roving catch rates from incomplete trips from May through October.

Year	Survey type	Walleye		Smallmouth bass	
		All trips	Targeted	All trips	Targeted
1957	roving	0.04		0.02	
1958	roving	0.08		0.03	
1959	roving	0.34		0.02	
1997	roving	0.19	0.21	0.10	0.32
2002	roving	0.23	0.35	0.19	0.52
2003	roving	0.43	0.58	0.24	0.84
2004	roving	0.63	0.75	0.15	0.62
2005	roving	0.19	0.25	0.17	0.70
2006	roving	0.22	0.31	0.19	0.69
2007	roving	0.19	0.30	0.19	0.74
2011	launch	0.22	0.57	0.16	0.35
2012	launch	0.31	0.55	0.30	0.64
2013	roving	0.21	0.32	0.18	0.42
2014	launch	0.22	0.42	0.41	0.78
2015	launch	0.23	0.38	0.19	0.46
2016	launch	0.08	0.22	0.20	0.27
2017	launch	0.16	0.28	0.30	0.59
2018	roving	0.23	0.36	0.16	0.51
2019	launch	0.44	0.72	0.20	0.47
2021	launch	0.27	0.38	0.19	0.42
2022	roving	0.42	0.55	0.09	0.52

1957-59 from Grosslein (1961).



Table A19. Catch of select species in spring trap-net surveys since 1992.

Year	net-nights	black crappie	bluegill	bowfin	brown bullhead	burbot	chain pickerel	channel catfish	freshwater drum	largemouth bass	longnose gar	northern pike	pumpkinseed	redhorse	rock bass	smallmouth bass	walleye	white bass	white perch	white sucker	yellow perch
1992	9		3	1	487	1		44	64	4			25	4	14	21	29	15	34	12	1
1993	9	2	6	3	110	1		17	40	7			19	6	27	20	83	92	4	13	1
1994	4				58			5	42					4	4	3	46	27	4	8	
1995	6				5	10		122	39							11	34	3		12	9
1998	13	4		3	46	2		4	50	1		1	4	1	2	39	50	3		6	
1999	7	3		3	222	7	1	16	104	2		1	2	3	18	91	112	26	9	9	3
2000	9	5			534	3	2	33	217	2		2	5		46	214	216	18	131	16	4
2002	7	5		3	209	1	5	1	84	2			8		13	90	163	3	59	20	
2003	7	3			252		2	13	136	6			15	2	12	261	331	5	157	18	4
2004	8	9	2	1	161	1	6	7	77	4			3		9	83	175	25	29	9	1
2005	9				195		1	19	76	2		1			1	20	43	3	101	8	3
2006	9			1	50	1		11	220	2			4		3	51	35	1	132	10	2
2007	6				73		3	15	25	2			2		5	31	42	7	140	2	
2008	8		2	3	461	1	2	15	434	2	2		2		46	279	209	2	185	7	8
2009	9		5	1	429	10	7	1	415	1			1	1	54	127	199	2	286	4	
2010	10		4		184	2	7	2	160	4	1	2	10		4	59	45		7	4	
2011	11	3	4		48	4	7	5	185	3			6		28	22	48	1	26	5	1
2012	13	1	3	4	179	14	10	2	325	7			8		65	90	16	1	39	7	5
2013	14	9	9	4	371	16	34	5	279	2			15		23	71	122		48	13	1
2014	9	9	7	1	200	21	85	5	216	6	3		30		32	50	145		69	15	18
2015	8	1	5	4	304	22	47	5	260	4		2	12		27	30	76		8	6	1
2016	9	2	5	4	170	2	31	2	228	10	1	1	19	1	24	74	169		25	12	
2017	8			3	236	5	15	1	80	4	10		10	2	36	95	166		37	31	3
2018	8	4		7	49	10	69	3	129	13		3	5	1	52	30	167		22	14	2
2019	10			2	45		3	1	184	4			3		21	45	73		72	9	2
2020	15		1	3	65	1	7	2	158	2	3	0	3	0	57	44	100	0	6	8	2
2021	16	0	0	4	61	0	1	1	217	0	1	1	2	0	41	47	179	0	10	1	13
2022	11	1	0	4	41	0	5	0	50	4	0	0	0	0	18	38	37	0	19	7	6

Table A20. Catch of select species in fall trap-net surveys since 1957.

Year	net-nights	black crappie	bluegill	bowfin	brown bullhead	burbot	chain pickerel	channel catfish	freshwater drum	largemouth bass	longnose gar	northern pike	pumpkinseed	redhorse	rock bass	smallmouth bass	walleye	white bass	white perch	white sucker	yellow perch
1957	13		1		592	64		1		8			47		70	22	249	17	3	12	135
1958	16				24	20						1	8		25	20	296	8		26	46
1959	15				161	94	6	2				2	2		20	11	257	7		10	87
1960	18	1	14		162	111	2	1		1			34	1	30	14	106	33	8	13	1417
1980	13				60	68		3	4				3		2	15	323	2	2		252
1981	9	1			67	48							3		6	20	246		2	2	425
1983	13				24	88		5	2			1	30	1	9	40	419	3	27	9	480
1984	28	1			127	193		225	22				169		6	81	663	24	24		269
1986	17				54	52		2	7			1	20		10	48	716	4		35	45
1987	23				295	15		39	14	1			54	1	14	35	262	2	7	32	13
1988	23	61	7		252	105		57	12	4			91	2	52	22	1336	5	3	34	300
1989	3	2	5		212	50		4	6	2			7		1	13	168		3	26	86
1991	22	1	2		186	458		130	36	4			18	1	4	67	512	5	2	22	13
1992	8	2	3		43	43		12	6				29		6	8	965	6	2	77	2
1993	5	3			24	37		7	3	5					1	4	295		1	62	
1994	9	7			73	44		70	77	4			7	1	18	287	24			34	7
1995	13	1	1		10	14		24	71				2		2	15	249	6		19	8
1996	13			4	160	21		49	476	3		2	26	1	8	460	318			64	12
1997	13	68	2		112	75		5	48	4			32		5	24	121	9	1	16	10
1998	9		3	5	16	4	47	65	2	2			5	2	10	146	16		19	2	2
1999	9	9	1	2	25	12	9	49	42	2	1		11	3	14	69	8	1	37	4	4
2000	10	4			26	15	7	17	87	5			2	1	6	177	5	1	4	1	1
2001	8		2	1	69	7	2	104	78				6	1	3	4	97	2	5	8	6
2002	10				92	7	2	10	154	6			3		3	217	7	2	7	10	
2003	10	2	2	3	83	8	4	46	99			1	8		26	359	5	2	14	4	4
2004	4				19			2	59				3		4	19				1	1
2005	10	4		5	163	2		1	91	1			6		12	6	214	2	1	38	27
2006	7	29	5	7	89	4	17	7	20	17	1		21		1	4	107		1	7	4
2007	10	2	1	4	28		5	23	127	9			3		4	260			3	12	1
2008	10	12	18	8	332	7	4	9	87	5			14		3	3	95			11	27
2011	11	15	5	2	139	112	14	7	203	2		1	50	2	3	6	664	2	4	22	44
2012	11	50	76	1	157	10	8	9	215	20			51		9	10	258		6	10	60
2013	9	27	56	9	41	26	48	1	21	6			290	1	8	8	260		2	11	21
2014	11	14	22	7	114	11	42	15	55	2			136		2	4	260		4	10	12
2015	9	3	6	8	165	9	30	14	78	8		1	30	4	10	3	393		3	39	4
2016	11	4	2	1	67	30	13	11	57	3	1		30	6	13	10	205			84	31
2017	9	1		8	59	14	16	3	37	6			20	1	4	20	670		2	11	9
2018	8	4	3	2	21	9	5		11	4			3		3	3	217		1	47	6
2019	11		1	4	45	2	7	1	38	1			1	1	7	2	404			7	18
2020	13	1	1	2	77	5	5	0	38	0	1	1	2	0	13	7	196	0	0	5	4
2021	13	7	15	13	42	1	12	0	14	7	2	0	11	4	12	6	482	0	0	18	6
2022	13	7	1	2	38	1	6	1	25	9	0	0	6	0	31	6	121	0	1	7	39

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