NYS DEC
LAKE ERIE FISHERIES RESEARCH UNIT
2022 ANNUAL REPORT

to the Lake Erie Committee
and the Great Lakes Fishery Commission

March 2023

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

Kathy C. Hochul, *Governor*

MOST OF THE WORK REPORTED IN THIS DOCUMENT IS SUPPORTED BY THE FEDERAL AID IN SPORT FISH RESTORATION PROGRAM

Full Report Citation:

> NYSDEC 2023. Lake Erie Fisheries Research Unit 2022 Annual Report. New York State Department of Environmental Conservation, Albany, New York, USA.

Example Report Section Citation:

> Markham, J.L. 2023. Coldwater gill net assessment. Section G in NYSDEC 2023, Lake Erie Fisheries Research Unit 2022 Annual Report. New York State Department of Environmental Conservation, Albany, New York, USA.

NYS DEC LAKE ERIE 2022 ANNUAL REPORT
to the
Great Lakes Fishery Commission's
Lake Erie Committee

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Acknowledgments

The Lake Erie Fisheries Research Unit recognizes the contributions of seasonal staff essential to completing an ambitious field schedule. During the 2022 field year these individuals included Fish and Wildlife Technicians Ryan Bohen, Jon Hoag, John Love, and Alexis Taylor. We also acknowledge contributions of DEC's Region 9 Fisheries Office, Buffalo State College's Great Lakes Center, Cornell University, SUNY Fredonia, the USGS Great Lakes Science Center, and the USFWS Northeast Fisheries Center.

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PREFACE

The Lake Erie Fisheries Research Unit Annual Report is prepared by the New York State Department of Environmental Conservation as a compilation of ongoing Lake Erie investigations mostly supported by Federal Aid in Sportfish Restoration. This annual report is intended as a resource document for other member agencies of the Great Lakes Fishery Commission's Lake Erie Committee, as well as information for Lake Erie's angling community and other interested stakeholders. Many initiatives reported under this cover are long term monitoring efforts which are updated each year. Other efforts may not always be updated annually if there were no new activities since the previous report.

The summaries contained in this report are provisional although every effort has been made to insure their accuracy. We strongly encourage researchers to contact NYS DEC Lake Erie Fisheries Research Unit before using or citing any specific data summary contained in this report.

TABLE OF CONTENTS

Lake Erie 2022 Annual Report
New York State Department of Environmental Conservation

Presented at the Lake Erie Committee Meeting
Hamilton, ON
March 29, 2023

NYSDEC Lake Erie Fisheries Research Unit
2022 Program Highlights

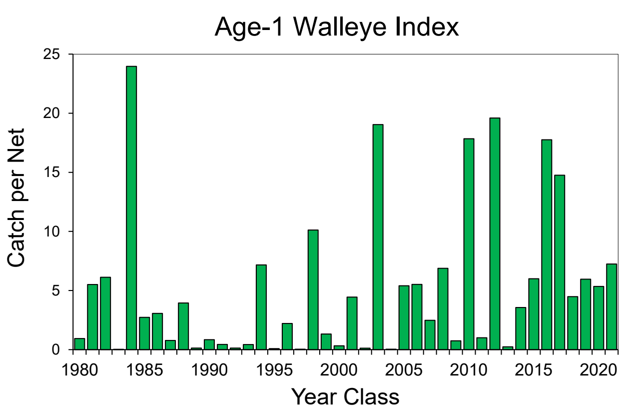
The New York State Department of Environmental Conservation's Lake Erie Fisheries Research Unit (LEFRU) is responsible for research, assessment, and management activities for one of New York's largest and most diverse freshwater fisheries. Our annual monitoring programs are designed to improve our understanding of the Lake Erie fish community, inform management and safeguard this valuable resource for current and future generations. This document shares just a few of the highlights from the 2022 program year. Our complete annual report is available on DEC's website at *http://www.dec.ny.gov/outdoor/32286.html*, or by contacting DEC's LEFRU office (contact information below).

Tributary Angler Survey

New York's Lake Erie tributaries consistently produce some of the highest quality fishing for steelhead in the nation. The tributary angler survey is conducted on a three-year cycle to monitor fishery performance and determine progress towards goals stated in the Steelhead Management Plan. The average steelhead catch rate from the most recent 2021–22 survey indicated excellent fishing quality (0.43 fish/hr.) well above the Plan target rate of 0.33 fish/hr. The highest angler effort occurred on Eighteen Mile Creek and catch rates were consistent between all the sampled streams.

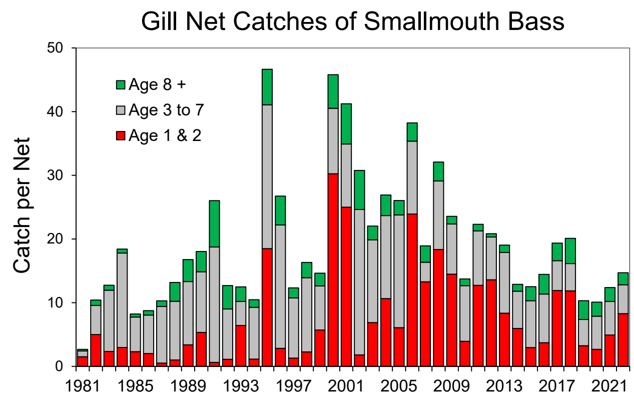
Walleye

Lake Erie's east basin walleye resource is comprised of adult walleye from local spawning stocks and substantial contributions of adult migrants from west basin spawning stocks. Walleye fishing quality in New York waters has been at record levels for the past six years with 2018 representing the highest catch rate in the 35-year survey. Recent increases in fishing quality are attributable to lakewide spawning success over the past decade. Juvenile walleye surveys indicate exceptional local year classes in 2016 and 2017 and potentially unprecedented west basin spawning success in 2018 and 2019. Adult walleye abundance and fishing quality in the NY waters will remain high for the near future.



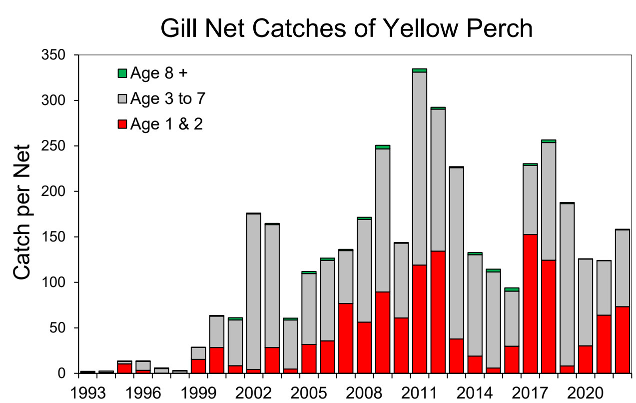
Smallmouth Bass

Lake Erie supports one of the finest smallmouth bass fisheries in the country. Bass fishing quality in 2022 was average for the 35-year survey. Increasing angler preference for catch-and-release has drastically reduced harvest to only 1.4% of the overall catch. High angler catch rates coupled with high growth rates produce frequent encounters with trophy-sized fish. Since 2000 overall abundance has steadily declined. Recent data indicate relatively stable adult abundance (age 3+) over the last decade with a decrease in older bass over the last three years. Juvenile abundance measures from 2022 suggest 2020 was a below average bass year class.



Yellow Perch

Lake Erie yellow perch populations have experienced wide oscillations in abundance over the last 30 years, from extreme lows in the mid-1990's to an extended recovery that has now lasted almost two decades. Perch fishing quality was above average in 2022 and relied almost entirely on the 2016 and 2019 year classes. The average length of yellow perch harvested in 2022 was 11.2 inches, the 5th highest in the 35-year survey. An above-average yellow perch year class in 2020 should begin contributing to the fishery in 2023. However, weak to moderate recruitment in 2017 and 2018, coupled with the 2016 year class beginning to age out of the population, will likely result in average fishing quality in 2023.



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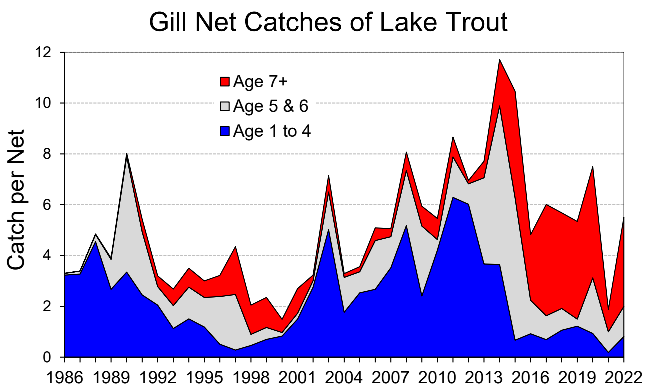
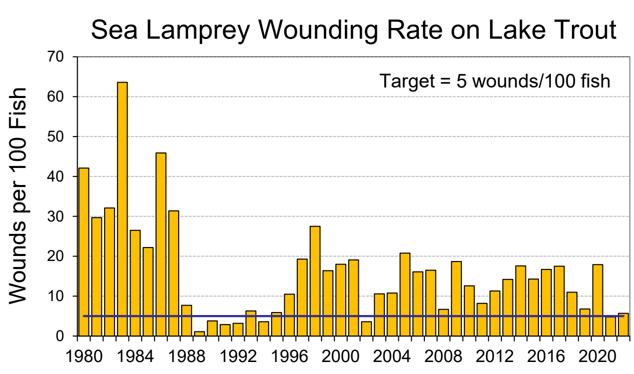
Lake Trout Restoration

Re-establishing a self-sustaining lake trout population in Lake Erie continues to be a major goal of the LEFRU. Lake trout have been stocked since 1978 and annual assessments monitor progress towards lake trout rehabilitation plan objectives. Adult lake trout abundance in New York waters has been relatively stable for the past seven years. Adult lake trout (age 5+) abundance remains high with older fish (age 10+) comprising over 60% of the adult population. Wild lake trout fry were detected for the first time in 2021 and again in 2022, and an analysis of unmarked fish indicated a low level of wild fish in the adult population. Stocking and sea lamprey control efforts must be continued to build and maintain the adult population necessary to support natural reproduction. A new lake trout rehabilitation plan completed in 2021 focuses on detection of early life stages, the extent of spawning success, and habitat preferences.



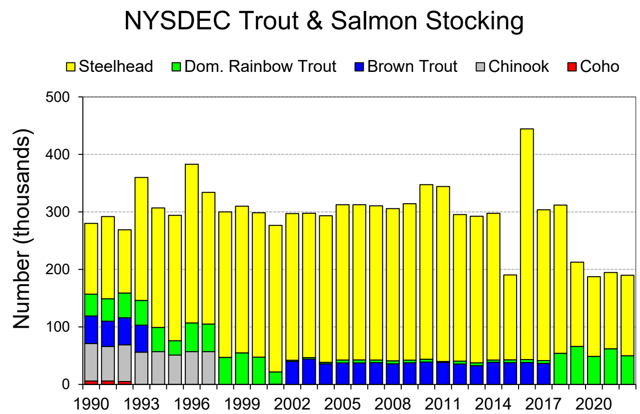
Sea Lamprey

Sea lamprey invaded Lake Erie and the upper Great Lakes in the 1920s and have played a major role in the demise of many native coldwater fish populations. Great Lakes Fishery Commission (GLFC) coordinated sea lamprey control in Lake Erie began in 1986 in support of lake trout rehabilitation efforts, and regular treatments are conducted to reduce sea lamprey populations. Annual monitoring undertaken by LEFRU includes observations of sea lamprey wounds on lake trout and other fish species. Wounding rates on lake trout have been relatively high and stable for decades, but were near or below target for the past two years. Inspections of sportfish have documented sea lamprey wounding on warmwater species as well. GLFC surveys conducted in recent years indicate a low abundance of adult sea lamprey in Lake Erie during the past four years.



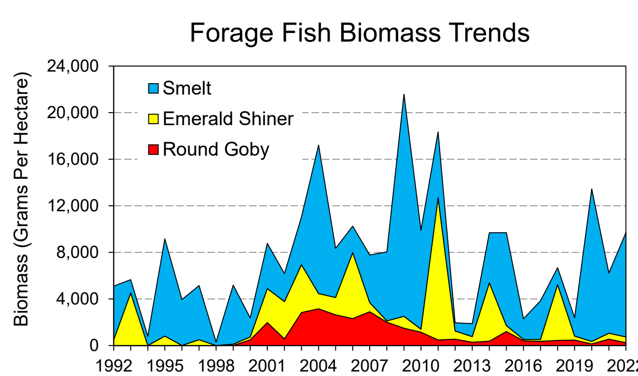
Salmonid Management

New York annually stocks approximately 142,500 steelhead and 50,000 domestic rainbow trout into the Lake Erie tributaries to provide angling opportunities. Wild steelhead reproduction occurs in some tributaries but is a minor contributor to the fishery. Combined steelhead and domestic rainbow stocking were near targets in 2022. Stocking targets for steelhead declined in 2020 to accommodate alternative rearing techniques at New York's Salmon River Hatchery to improve stocked steelhead size. Significant increases in both size and weight were achieved, resulting in a more consistent stocking product. However a growth ceiling was evident, likely due to limitations in water quality and quantity at the hatchery. An angler survey conducted in 2021–22 to access the quality of New York's Lake Erie tributary steelhead fishery found high catch rates (0.43 fish/hr) that exceeded the Lake Erie Steelhead Management Plan goal of 0.33 fish/hr.



Prey Fish

The LEFRU conducts surveys focused on understanding fish community structure, including trawling to assess prey fish abundance, predator diet studies, and lower food web monitoring. Since the onset of our trawl survey, rainbow smelt have dominated the prey fish community. Round goby abundance increased rapidly following their introduction in the late 1990's but has since stabilized at a lower level. Annual prey fish biomass is quite variable due to variability in adult smelt and emerald shiner populations. Biomass of soft-rayed forage fishes increased to an above average level in 2022 due to a high abundance of young-of-year smelt. Smelt dominated lake trout diets while goby dominated walleye diets in 2022. However, other fish species, including yellow perch, have been more prominent in diets over the past five years. East basin waters remained near optimal levels of productivity for both warmwater and coldwater species in 2022.



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B. Research Partnerships and Written Contributions

NYSDEC, as signatory to the Great Lakes Fishery Commission's (GLFC) "A Joint Strategic Plan for Management of Great Lakes Fisheries", is obliged to participate in joint management of shared fishery resources. The Lake Erie Fisheries Research Unit's (LEFRU) routine fishery management and research collaborators include the Pennsylvania Fish and Boat Commission, Ohio Division of Wildlife, Michigan Department of Natural Resources, Ontario Ministry of Natural Resources and Forestry, Department of Fisheries and Oceans Canada, United States Geological Survey, United States Fish and Wildlife Service, and the United States Environmental Protection Agency. The LEFRU also collaborates with investigators from various government and academic institutions on a broad array of research initiatives. In 2022 there were 12 written contributions to which LEFRU Staff made substantive contributions, including peer reviewed literature and technical reports. New York's LEFRU remains willing to pursue additional partnerships to the extent such collaborations are consistent with our mission.

Written Contributions by Lake Erie Fisheries Research Unit Staff in 2022

Peer Reviewed Literature:

Euclide, P. T., R. T. Kraus, A. Cook, J. Markham, J. D. Schmitt. 2022. Genome-wide genetic diversity may help identify fine-scale genetic structure among lake whitefish spawning groups in Lake Erie. Journal of Great Lakes Research. 48:1298–1305.

Markham, J. L., J.M. Robinson, C. C. Wilson, C. S. Vandergoot, P. D. Wilkins, R. C. Zimar, M. N. Cochrane. 2022. Evidence of Lake Trout (*Salvelinus namaycush*) natural reproduction in Lake Erie. Journal of Great Lakes Research. 48:1728–1734.

Lennox, R. J., F. G. Whoriskey, P. Verhelst, C. Vandergoot, J. Reubens, E.L. Rechisky, M. Power, I. Mulder, J. Markham, S.K. Lowerre-Barbieri, S. T. Lindley, N. A. Knott, S. Kessel, S. Iverson, C. Huveneers, L. C. Fetterplace, L.P. Griffin, C. Friess, A. Filous, R. Harcourt, A.J. Danylchuk, S.J. Cooke, E. J. Chávez, K. Whoriskey. Globally coordinated acoustic aquatic animal tracking reveals unexpected, ecologically important movements across oceans, lakes, and rivers. Zoological Journal of the Linnean Society. *Submitted*.

Technical Reports:

Cold Water Task Group. 2023. 2022 Report of the Lake Erie Cold Water Task Group. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

Forage Task Group. 2023. 2022 Report of the Lake Erie Forage Task Group. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

Habitat Task Group. 2023. 2022 Report of the Lake Erie Habitat Task Group. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

Markham, J. L., T. E. Kielbasinski, J. Hentges, P. Kinny. Evaluation of an alternative approach to improve steelhead stocking size at the Salmon River Hatchery. New York State Department of Environmental Conservation, Albany, New York, USA. *In preparation*.

NYSDEC 2023. Lake Erie Fisheries Research Unit 2022 Annual Report. New York State Department of Environmental Conservation, Albany, New York, USA.

Walleye Task Group. 2023. 2022 Report of the Lake Erie Walleye Task Group. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

Wilkins, P. D. and J. M. Robinson. 2022. Out-of-State Angler Participation in New York's Prominent Lake Erie Fisheries. New York State Department of Environmental Conservation, Albany, New York, USA.

Yellow Perch Task Group. 2023. 2022 Report of the Lake Erie Yellow Perch Task Group. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

Other Contributions:

State of the Great Lakes 2022 Report. 2022. An overview of the status and trends of the Great Lakes ecosystem. US Environmental Protection Agency. Department of Fisheries and Oceans Canada. State of the Great Lakes - 2022 Report (binational.net)

C. FORAGE AND JUVENILE YELLOW PERCH SURVEY

James L. Markham and Pascal D. Wilkins

Introduction

The Lake Erie Unit's annual bottom trawling program has been conducted since 1992 and replaced the Juvenile Percid Assessment conducted from 1986 to 1991 (Culligan et al. 1992). The principal objectives of the program are to assess trends in abundance of juvenile yellow perch and monitor forage fish community status. Data from this program are merged with those from other jurisdictions to generate lake-wide estimates of juvenile yellow perch and forage fish populations and are reported by the Lake Erie Committee's inter-agency Forage Task Group (Forage Task Group 2023) and Yellow Perch Task Group (Yellow Perch Task Group 2023).

Methods

This annual daytime trawling program is conducted during October–November at selected locations with trawlable substrate between the 50 ft and 100 ft depth contours in New York's portion of Lake Erie. Standard tow duration is 10 minutes. Survey procedures generally follow those performed for an inter-agency, western basin Lake Erie assessment that is reported annually in Lake Erie's Forage Task Group Report (Forage Task Group 2023). All agencies report measures of species density as mean number per hectare and biomass as grams per hectare (Forage Task Group 1998); a hectare is 2.471 acres. Species defined as forage include all life stages of rainbow smelt, emerald shiner, spottail shiner, round goby, alewife, trout-perch, log perch, and darters, young-of-the-year (YOY) and yearling (age-1) life stages of yellow perch, and YOY life stage of white perch, lake whitefish, walleye, white bass, smallmouth bass, and gizzard shad.

The standard gear for this trawling program is a 4-seam bottom trawl with the following characteristics:

Headrope length:	26.3 ft
Footrope length:	33.3 ft
Ground wire to doors:	50.0 ft
Trawl webbing:	2.0 inch stretch
Twine diameter:	21 thread
Cod-end webbing:	0.4 inch stretch

Species density is calculated from known trawl fishing dimensions obtained using trawl mensuration equipment (NETMIND) between 2004–2016 and individual tow distances estimated from vessel navigation electronics. An analysis completed in 2016 revealed a trawl wingspread (13.8 ft) that was slightly different than the previous value (14.2 ft) estimated from a more limited trawl calibration exercise conducted in the late 1990's. Density estimates for the entire time series were updated to reflect the new wingspread measurements. In 2019, a new trawl mensuration system from SIMRAD was purchased and installed. This gear was very similar in size and weight to the NETMIND equipment and produced net configuration measurements (e.g., wing spread, net height, angle, temperature) that allowed us to better determine if the net was fishing correctly and consistently in real-time.

An analysis was conducted in 2015 using a generalized linear modeling approach quantifying the effect of bottom temperature—as a proxy for fall turnover—on trawl catches of seven commonly encountered species and life stages (Markham and Robinson 2016). The effect of temperature on catches of warm- and cool-water benthic species and life stages (e.g., yellow perch, round goby, YOY rainbow smelt) was relatively modest compared to pelagic species (e.g., emerald shiner) and species with cooler temperature preferences (e.g., yearling-and-older (YAO) rainbow smelt). Varying bottom temperatures over the course of the survey period do not seem to be a significant impediment to characterizing year class strength for benthic warm water species. As such, the survey likely provides a more robust index for benthic warm water species and life stages compared to cool water and pelagic species, especially for temperatures at which the survey usually operates (57–64°F) and in years in which part or all of the survey is completed prior to fall turnover. As a result of this analysis, beginning in 2017 the fall trawling survey was conducted following fall turnover to provide more consistent estimates of all forage fishes, especially cool water and pelagic species.

Results and Discussion

A total of 34 valid trawl tows were completed in the New York waters of Lake Erie in 2022 (Figure C.1). Sampling was completed after fall turnover on four days between October 25 – November 4 with standard trawling effort totaling 340 minutes. Survey sampling temperatures (54–55ºF) remained within the long-term temperature range of the program (>50ºF).

Status of Forage Fish

The estimated biomass of forage-sized fish was 17,452 grams/ha in 2022 (Figure C.2). This was an increase compared to 2021 and above the time series average (15,459 grams/ha), ranking as the 12th highest total biomass (60th percentile) in the 31-year time series. Much of the increase compared to 2021 was due to a higher abundance of YOY rainbow smelt and alewife (all life stages). Clupeids (alewife, YOY gizzard shad) have typically been a relatively minor contributor to this forage fish assessment, but their biomass increased for the third consecutive year in 2022 and ranked as the 2nd highest in the time series. Clupeid populations, especially alewife, are typically limited by the impacts and duration of hard winters and ice cover. However, relatively mild winters in recent years have allowed expansion of the populations to near time-series highs.

FIGURE C.1. Locations of 34 individual 10 minute trawls between the 50 to 100 ft. depth contours used to assess the abundance of age-0 yellow perch and forage fish species in the New York waters of Lake Erie, October–November 2022.

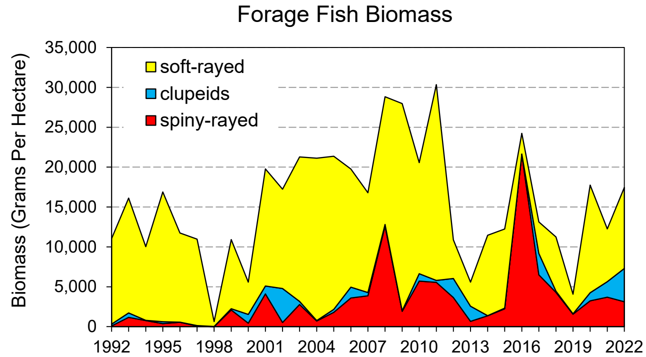

FIGURE C.2. Biomass (grams-per-hectare) of functional groups of forage fishes collected with a bottom trawl in the New York waters of Lake Erie, October–November 1992–2022.

Rainbow smelt (all life stages) were the dominant species by weight (51%) sampled in 2022 followed by Clupeids (24%) and YOY and yearling (age-1) yellow perch (15%; Figure C.3). The majority of the rainbow smelt biomass was comprised of YOY fish (84%). Round goby, emerald shiners, and all other species were relatively minor contributors (≤ 4%) to the biomass of the forage fish community in 2022. Worth noting was the detectable contribution of YOY walleye (2%) for the second consecutive year.

Time series trends of relative biomass (g/ha) for selected species of interest are presented in Figure C.4.

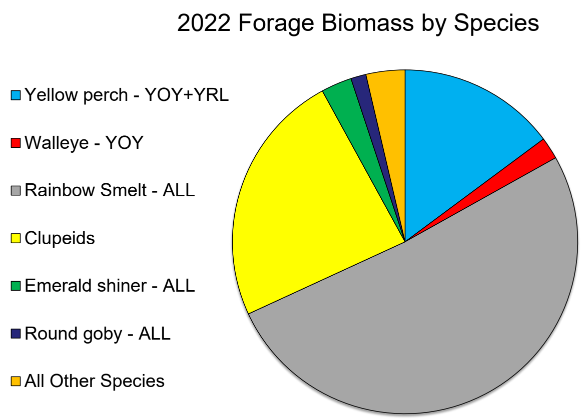

FIGURE C.3. Biomass (grams-per-hectare) of forage fishes by life stage collected with a bottom trawl in the New York waters of Lake Erie, October–November 2022. All other species includes spottail shiners, trout-perch, YOY lake whitefish, YOY white bass, and YOY white perch.

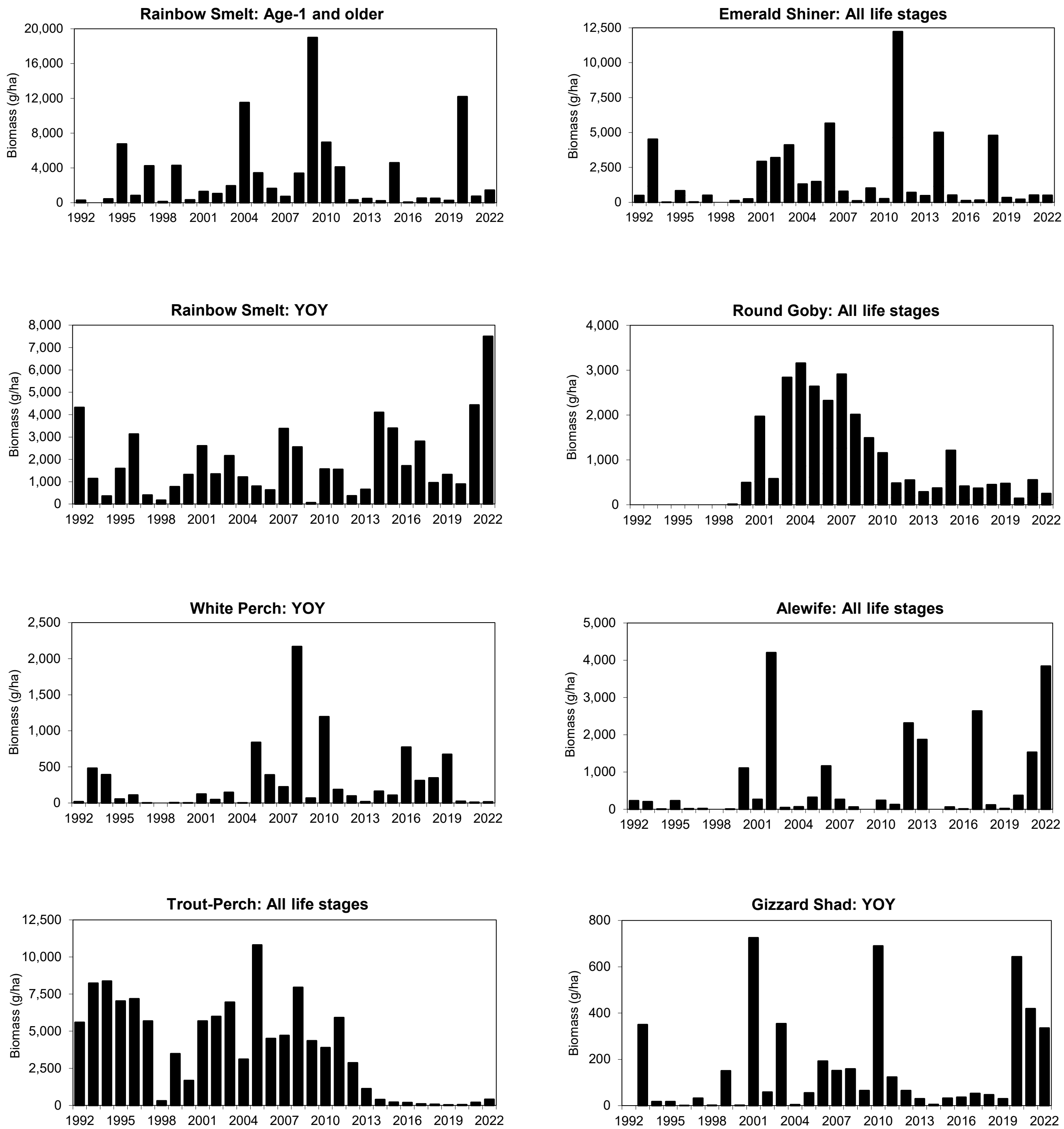

FIGURE C.4. Biomass (grams per hectare) of selected species collected with a bottom trawl in the New York waters of Lake Erie, October–November 1992–2022. Note different scales on the y-axis.

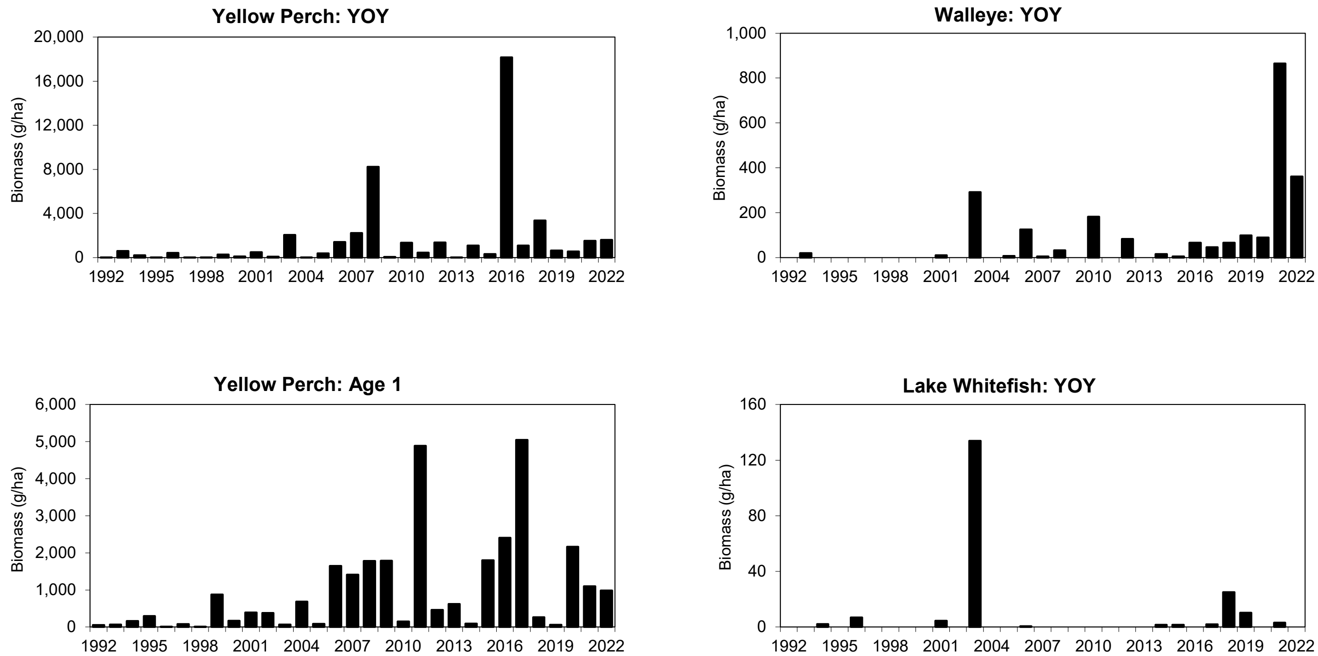

FIGURE C.4 (Continued). Biomass (grams-per-hectare) of selected species collected with a bottom trawl in the New York waters of Lake Erie, October–November 1992–2022. Note different scales on the y-axis.

Rainbow smelt often comprise the highest biomass of any individual species in this trawl survey. Rainbow smelt catches over the past decade have been dominated by the YOY life stage, including 2022 which was the highest estimated YOY smelt biomass in the time series (Figure C.4). Five of the largest year classes of YOY rainbow smelt have occurred since 2014, but these have not translated into high adult (YAO) smelt abundance. However, the moderate 2019 year class of smelt translated into the second highest adult biomass in this time series in 2020. Despite a high abundance of top predators (e.g., walleye, lake trout), rainbow smelt continue to thrive and play a major role in the predator-prey dynamics of the Lake Erie food web.

Emerald shiner biomass remained low in 2022 for the fourth consecutive year. Since 2001 emerald shiners have often contributed measurably to total forage biomass, but annual abundance is highly variable. Peaks in abundance have been evident in 2003, 2006, 2011, 2014, and 2018 with each followed by several years of low abundance.

Biomass indices for YOY gizzard shad (7th highest in time series) and alewife (2nd highest) were above average in 2022 while other species such as round goby (all life stages), YOY white perch, and trout perch (all life stages) were below average. Also of note was the second highest biomass in the time series for YOY walleye. YOY walleye have been at high relative abundance for seven consecutive years.

Soft-rayed forage fishes (rainbow smelt, emerald shiners, spottail shiners, trout-perch and round goby) typically comprise the majority of the overall biomass in trawl catches in the New York waters of Lake Erie (Figure C.5). From 2011–2019, a variable but generally declining trend was observed in this group, and biomass in 2016, 2017, and 2019 was in the lower quartile (<25th percentile) of the time series. However, increases in the biomass of this group have been evident since 2020, mainly due to a higher biomass of rainbow smelt.

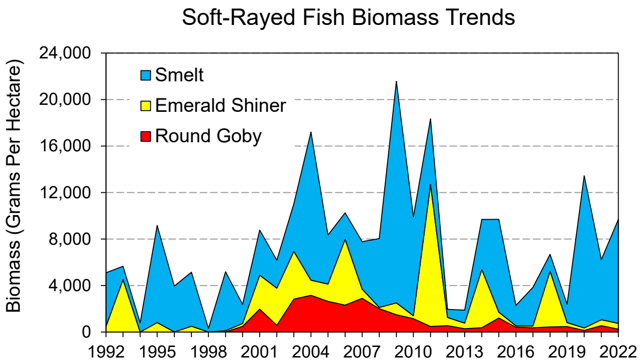

FIGURE C.5. Biomass (grams-per-hectare) of common soft-rayed forage fishes (all ages combined) collected with a bottom trawl in the New York waters of Lake Erie, October–November 1992–2022.

A complex interdependent relationship exists between prey fish and predator populations in Lake Erie. Predator abundance can influence prey fish abundance, which can in turn impact predator growth, condition, and feeding behavior. Management agencies often have limited options available to influence these predator-prey dynamics. However, monitoring metrics associated with predator-prey interactions is essential for making informed management decisions. The Lake Erie Fisheries Research Unit monitors several predator growth and diet indices that are directly influenced by prey fish population abundance and composition.

Growth and condition of smallmouth bass and adult lake trout continue to be generally high and stable (see Sections D and G). However, declines in juvenile walleye growth (currently 8th lowest in time series for age-2 walleye and 6th lowest for age-1 walleye) and condition indices of adult, angler-caught walleye have been observed over the past decade. This trend was especially evident in the condition of large walleye (28 inches) in 2018. However, an increase in condition of adult walleye has occurred over the last four years (see Section F). Predator diets between 2015–2019 and 2021–2022 also indicated that rainbow smelt were not the dominant prey item for east basin walleye as they were historically (see Section F). Greater diet diversity has also been generally observed in both walleye and lake trout in recent years. This may indicate that high predatory demand combined with low forage biomass, especially adult rainbow smelt, can impact adult predator growth and lead to alternative prey species being more important diet items for top predators.

Juvenile Yellow Perch Assessment

The 2022 mean density estimate for age-0 (YOY) yellow perch (297.1/ha) was above average (246.0/ha) and ranked as moderate to high (6th highest; 81st percentile) for the time series (Table C.1; Figure C.4). Four of the highest YOY yellow perch abundance indices have occurred in the past seven years with moderate levels of abundance in the other three years. However, YOY yellow perch abundance is not always strongly correlated with eventual year class strength—age 1 abundance is typically a better indicator. The age-1 yellow perch (2021 year class) density estimate was 26.8/ha in 2022, ranking it as the 13th highest (58th percentile) in the time series and above average (Table C.1; Figure C.4). Age-1 indices have been above average in six of the past eight years. Adult (age 2+) yellow perch relative abundance remained steady in 2022 (23.3/ha), ranking it as 20th highest (35th percentile) in the time series and remaining below average (Table C.1). The adult yellow perch trawl catch in 2022 was dominated by the strong age-2 (2020 year class) cohort with good contributions from the age-3 cohort. Overall, this trawling program continues to indicate a period of sustained but variable yellow perch recruitment success and overall elevated abundance since 2003. Average or better age-1 yellow perch indices have been recorded in eleven of the last 18 years, including 2015, 2016, 2017, 2020, 2021, and 2022.

Trends in juvenile yellow perch length-at-age indicate relative stability for both age-0 and age-1 groups since 2006 (Figure C.6). The average total length for age-0 yellow perch was 3.2 inches and age-1 yellow perch averaged 5.9 inches in 2022, which were equal to or higher than the time series averages (3.2 and 5.5 inches, respectively).

TABLE C.1. Density (number-per-hectare) of yellow perch collected with a bottom trawl in the New York waters of Lake Erie, October–November 1992–2022.

	Density (yellow perch per ha)		
Year	Age-0	Age-1	Age-2+
1992	10.7	2.4	9.5
1993	113.0	3.1	6.1
1994	49.0	8.6	1.0
1995	5.9	13.6	14.6
1996	105.8	0.3	7.0
1997	0.2	5.7	2.7
1998	1.3	0.4	0.3
1999	35.9	33.3	11.1
2000	23.9	7.0	28.4
2001	100.4	11.7	23.5
2002	9.5	16.0	37.9
2003	484.8	2.0	22.0
2004	1.5	29.4	62.2
2005	59.3	5.6	34.5
2006	290.6	40.9	29.8
2007	412.0	42.3	87.2
2008	1116.7	45.5	56.4
2009	11.9	64.1	44.1
2010	197.7	4.2	39.9
2011	89.5	141.8	25.7
2012	280.0	16.7	62.6
2013	4.4	24.4	40.6
2014	274.2	2.9	105.4
2015	68.6	57.3	79.5
2016	2178.2	53.0	45.5
2017	247.0	129.5	28.6
2018	662.4	11.4	112.2
2019	169.1	2.5	14.3
2020	91.6	56.2	22.0
2021	284.2	33.5	24.5
2022	297.1	26.8	23.3
Average	247.6	28.8	35.6

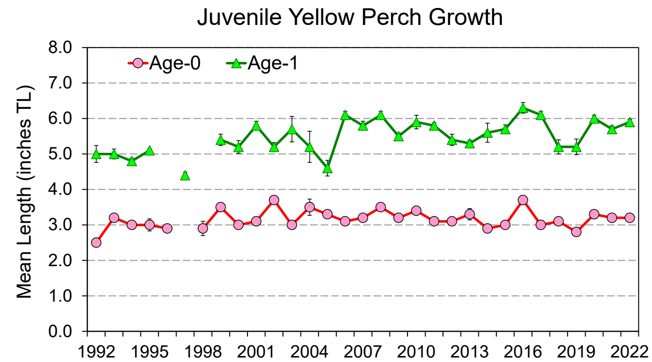

FIGURE C.6. Mean total length of age-0 and age-1 yellow perch collected by bottom trawl in New York waters of Lake Erie, October–November 1992–2022. Years in which sample sizes were less than 4 were excluded. Error bars are 95% confidence intervals.

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D. Warmwater Gill Net Assessment

Pascal D. Wilkins

Introduction

The annual warmwater fish community gill net assessment has been performed by New York's Lake Erie Fisheries Research Unit since 1981. The principal objective of this September assessment is to produce standardized indices of relative abundance, age composition, and growth of walleye, smallmouth bass and yellow perch in New York's portion of Lake Erie. Walleye and yellow perch relative abundance and age composition data are also contributed to the Lake Erie Committee's (LEC) interagency Walleye and Yellow Perch Task Groups for annual lake wide assessment (Walleye Task Group 2023, Yellow Perch Task Group 2023). Secondary objectives include monitoring abundance trends for other commonly encountered warmwater fish species and detecting rare or invasive species. Long-term index netting remains invaluable as a tool to quantify and understand the relationships between fishing mortality, age structure, and year class strength. This information is imperative for informed management and to ensure the continued sustainability of Lake Erie sport fish populations.

Methods

This annual assessment began in 1981, and methods were significantly altered in 1993 to adopt a standard interagency approach to fish community assessment. A detailed description of current survey methods can be found in Ryan et al. (1993). Several fixed sampling stations from New York's former (pre-1993) gill netting assessment on Lake Erie were retained to maintain continuity of a long-term data series for nearshore (<50 ft) waters. Long-term catch rates presented in this report focus principally on the nearshore stratum, where a standard sampling strategy has been performed since 1981. All nearshore catch rates obtained by the former (pre-1993) standard gill net were calibrated to the current standard as described by Culligan et al. (1994). An offshore stratum (>50 ft) was added in 1993, primarily to assess yellow perch status.

This assessment utilizes a stratified, random approach with stations selected from a 2.5-minute lat/long grid system. Both bottom and limnetic warmwater habitats were sampled with 700 ft. monofilament gill nets from 1993 through 1995. Beginning in 1996, only bottom habitat has been sampled and all measures reported for this survey are from bottom-set gill nets. Each net was made up of 14 individual gill net panels (50 ft long x 6 ft high) with stretch mesh sizes ranging from 1.25 to 6 inches. An examination of gill net catches from 1993 to 2004 found the 6-inch panel contributed miniscule catches for commonly encountered species, but experienced excessive net damage because interagency standard monofilament twine diameter is often too weak to retain species large enough to be entangled. Beginning in 2005, New York's new standard gill net became a 650 ft gang consisting of 13 panels ranging from 1.25 to 5.5 inches. Previous summary statistics were not re-analyzed with the deletion of 6.0-inch panel catches because separate evaluations confirmed the presence/absence of the 6.0-inch panel did not measurably change overall catch rates for all commonly encountered species.

The warmwater gill net sampling period extends from September 1 until the target number of net sets is achieved or the bottom water temperature in the sampling area reaches 59°F (15°C). Targeted sampling effort was reduced in 2021 from 40 overnight gill net sets to 32 nets following an analysis comparing catch-per-effort (CPE) trends for age-1 walleye (Wilkins, 2022). Effort is distributed between 17 nearshore and 15 offshore sites, with three to six nets set each sample day (Figure D.1). Nets are ideally set between 12:00 PM and sunset and retrieved between sunrise and 12:00 PM the following day. Data from gill nets that fished for more than one night, experience prolonged exposure to water temperatures <59°F (15°C), or that become badly damaged, tangled, or fouled by filamentous algae or other debris are omitted.

Catches from overnight sets are completely enumerated by species. Walleye, yellow perch, and smallmouth bass are measured, weighed, sexed, and scales, spines or otoliths are removed for age determination. Large catches of walleye, smallmouth bass, and yellow perch are sub-sampled as needed to process samples in a timely manner.

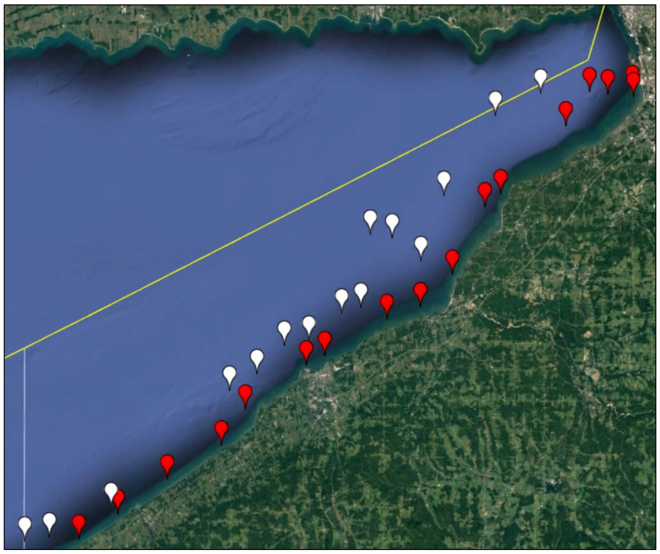

FIGURE D.1. Warmwater gill net sampling sites for 2022. Red markers represent nearshore sites (<50 ft), and white markers represent offshore sites (>50 ft).

Results and Discussion

Walleye

The walleye relative abundance index in 2022 was 28.2 fish per net, the 5th highest index in the 42-year survey (Figure D.2). Juvenile walleye are not captured consistently at offshore sites so only nearshore sites are included in the walleye abundance index. Nineteen walleye age groups were represented in the 2022 sample (nearshore and offshore). Age-2 walleye dominated the nearshore catch (2020 year class; 34%) followed by age-1 fish (2021 year class; 25%; Figure D.3).

Yearling walleye catch rates in 2022 ranked the 2021 year class as the 8th largest (7.2 age-1 walleye per net), falling within our established threshold for a “strong” year class (Figure D.4). Five of the six exceptional year classes observed during the 42-year survey have occurred in the last 20 years and are still represented in the current walleye population. Consecutive weak walleye year classes have not been observed since the early 1990’s and only a single weak year class has been observed in the last 17 years. Exceptional local walleye recruitment, especially the 2016 and 2017 cohorts, coupled with strong western basin recruitment (Walleye Task Group 2023) should contribute to excellent walleye fishing for several years (see Section F).

Age-1 and age-2 walleye were 0.8 and 0.5 inches below the long-term average length, respectively, in 2022 and ranked 6th and 8th lowest in average length for the time series (Figure D.5). However, the juvenile walleye growth seen in 2022 was a slight increase from the poor walleye growth seen over the last three years. Evidence of increased forage biomass (Section C) is likely influencing the improved walleye growth even at young ages.

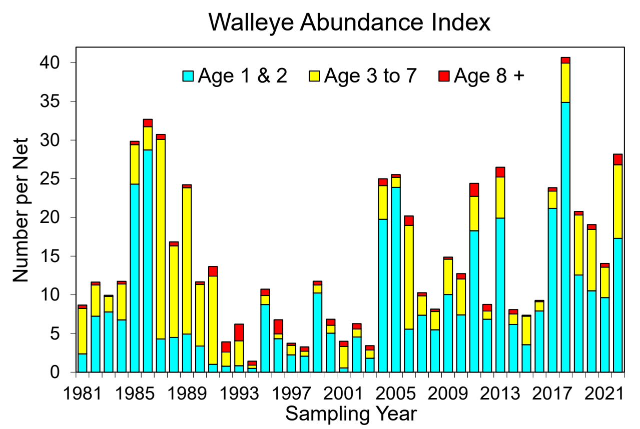

FIGURE D.2. Walleye catch by age category per gill net set from nearshore stations (< 50 ft) in New York waters of Lake Erie, September–October, 1981–2022.

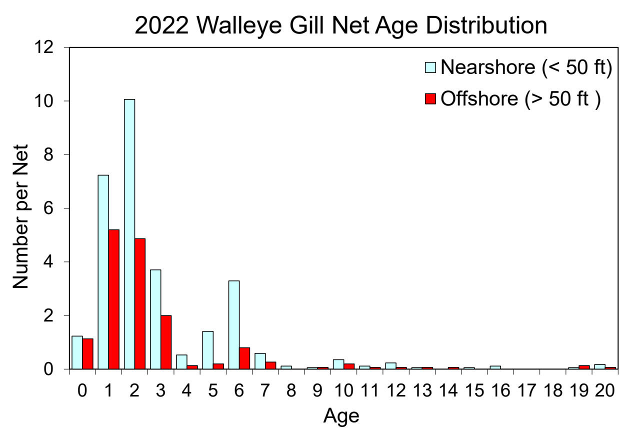

FIGURE D.3. Age composition of walleye caught in nearshore and offshore gill nets from the New York waters of Lake Erie, September–October, 2022.

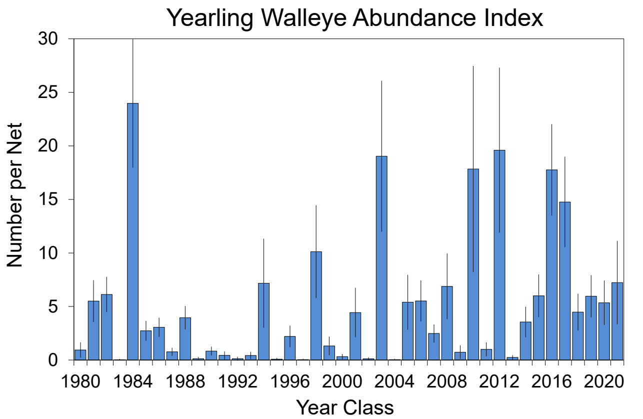

FIGURE D.4. Relative abundance of age-1 walleye collected from nearshore stations (< 50 ft) in New York waters of Lake Erie, September–October, 1981–2022. Error bars represent 95% confidence limits.

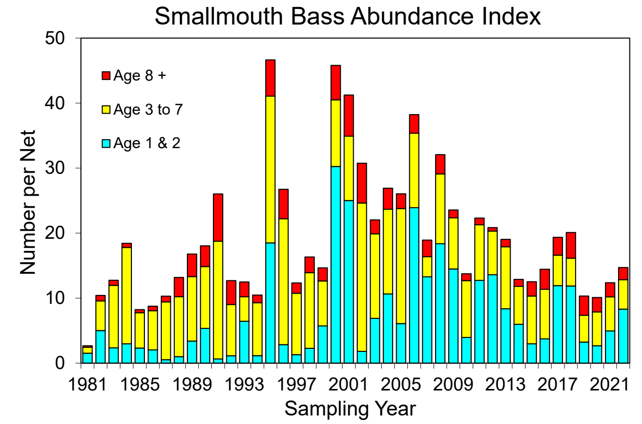

FIGURE D.6. Smallmouth bass catch rates by age category from nearshore stations (< 50 ft) in New York waters of Lake Erie, September–October, 1981–2022.

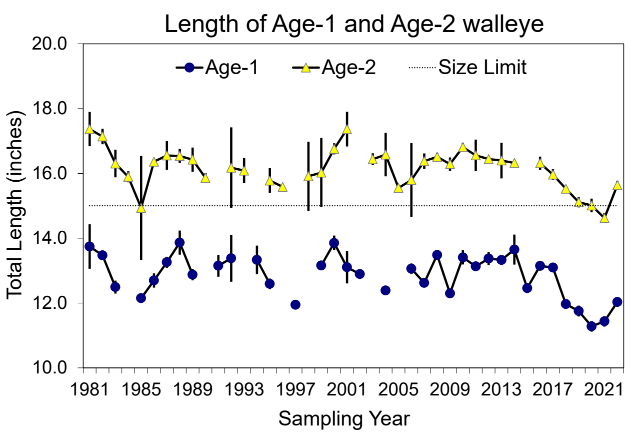

FIGURE D.5. Mean total length of age-1 & age-2 walleye collected from variable mesh gill nets in the New York waters of Lake Erie, September–October, 1981–2022. Years in which sample sizes were less than 6 were excluded. Error bars are 2 standard errors.

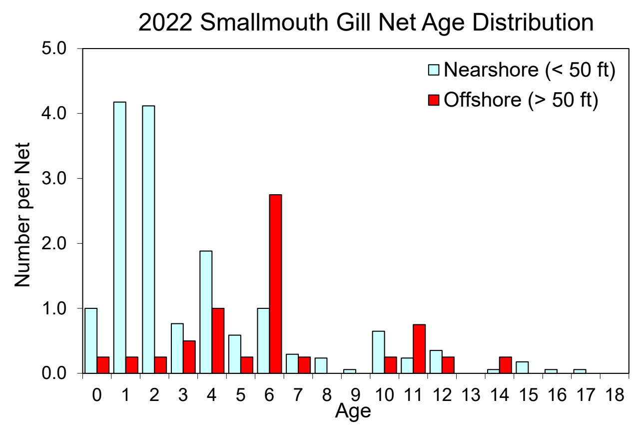

FIGURE D.7. Age composition of smallmouth bass caught in nearshore and offshore gill nets from the New York waters of Lake Erie, September–October, 2022.

Smallmouth Bass

The smallmouth bass index of relative abundance has declined substantially since its peak in the early 2000's, with the smallmouth bass relative abundance in 2022 (14.7 fish per net) being well below the time series average (19.2 fish per net; Figure D.6). Age-1 smallmouth bass dominated the 2022 nearshore sample (27%), which included fish from 17 of the last 18 year classes (Figure D.7). Offshore gill nets caught fewer sub-adult smallmouth bass and fewer smallmouth bass overall than nearshore gill nets, which is typical.

The relative abundance index for age-2 smallmouth bass ("recruitment index") in 2022 (4.1 fish per net) was slightly below the time series average of 4.3 fish per net (Figure D.8).

Age-2 and age-3 smallmouth bass averaged 12.6 inches and 14.8 inches total length, respectively (Figure D.9), well above the respective long-term averages of 11.0 and 13.0 inches. Beginning in the late-1990's, smallmouth bass showed significantly elevated growth rates that roughly correspond to the invasion of eastern Lake Erie by round goby (see Section C). Crane and Einhouse (2016) found that bass diet composition shifted from crayfish and a diversity of prey fish species to predominantly goby after the invasion. Increases in size at age and overall growth rate were attributed to a shift to goby as the major bass prey item. Presently, the observed mean length of Lake Erie smallmouth bass exceeds measures for New York's other fast-growing bass populations (Green et al. 1986, Perry et al. 2014). Reasons for the continued increases in bass growth are not understood but may be related to declining bass abundance.

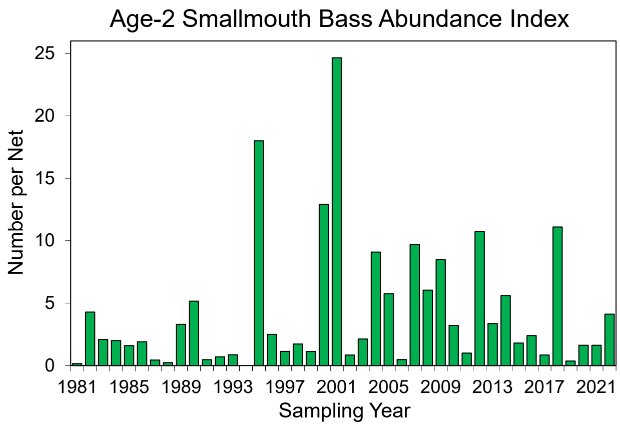

FIGURE D.8. Relative abundance of age-2 smallmouth bass collected from nearshore stations (< 50 ft) in New York waters of Lake Erie, September–October, 1981–2022.

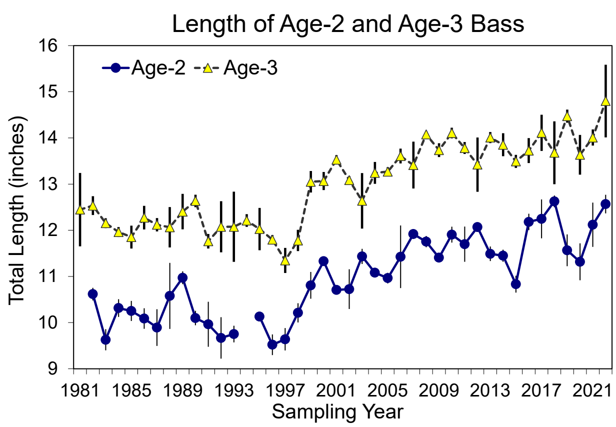

FIGURE D.9. Mean total length of age-2 and age-3 smallmouth bass collected from variable mesh gill nets in the New York waters of Lake Erie, September–October, 1981–2022. Error bars are 95% confidence limits.

From 2007–2014 older smallmouth bass (Age-8+) were less abundant than they were in the early to mid-2000's (Figure D.10), which was a source of concern for bass anglers. In response to these concerns, we examined trends in bass survival to better understand the possible reasons for the reduction in older bass. Figure D.11 illustrates the annual estimated survival rate of adult smallmouth bass in the New York waters of Lake Erie. Ages 3–10 were used to calculate annual survival estimates for each year class from 1978–2012 using catch curve analysis. Year classes that lived their entire life without goby, those that lived a portion of their life with goby, and those that lived their entire life with goby are separated in the figure to examine the potential role that goby introduction played in the observed changes in survival.

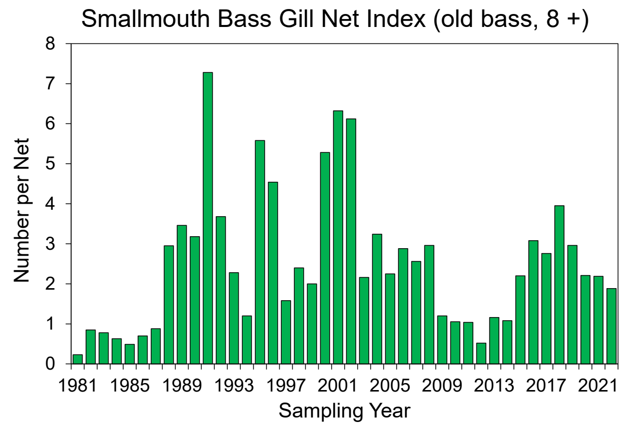

FIGURE D.10. Age-8 and older smallmouth bass catch rates from nearshore stations (< 50 ft) in New York waters of Lake Erie, September–October, 1981–2022. The ageing structure for large bass (>17 in) was changed from scales to otoliths in 1993.

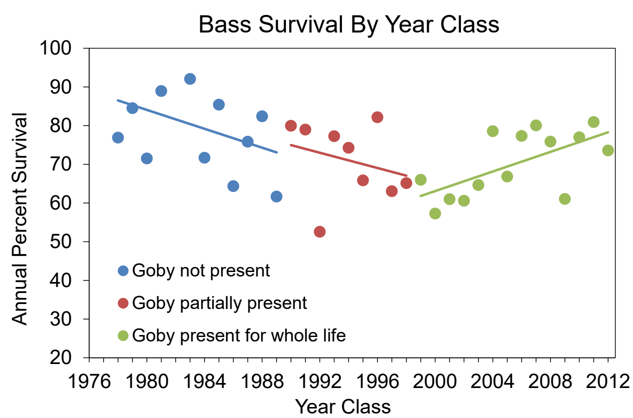

FIGURE D.11. Estimated survival of age 3-10 smallmouth bass from nearshore stations (< 50 ft) in the New York waters of Lake Erie. Each point represents the survival rate estimate of smallmouth bass by year class, 1978–2011.

From the 1970's to the early 2000's there was a substantial decrease in annual bass survival rates from approximately 84% for late 1970's cohorts to approximately 64% for early 2000's cohorts. Bass survival reached its lowest point in cohorts born in the late 1990's and early 2000's which coincides with the onset and peak of the goby invasion and the relative absence of older bass from those year classes. Cohorts born more recently (late 2000's) appear to be experiencing higher survival rates, as evidence by increased abundances of older (age-8+) bass in the population in recent years (Figure D.10). Bass survival rates over time correlate well with numbers of older bass in the population indicating that decreased survival, not recruitment issues, likely caused the paucity of older individuals in the population in the early 2010's. However, strong recruitment is necessary to maintain an abundance of older bass even with good adult survival. Bass recruitment has been sub-par in 6 of the last 8 years (Figure D. 8), and is likely to lead to a reduction in the abundance of adult bass in future years.

Yellow Perch

Yellow perch are not typically encountered in high densities in the shallower, nearshore (0 to 50 ft.) gill net locations. Therefore, the offshore gill net sets (Figure D.1, 50 to 100 ft.) are used to index yellow perch abundance. This deeper stratum has been sampled since 1993.

Yellow perch relative abundance was 158.4 fish per net in 2022, above the time series average of 127.2, and the 11th highest index observed (Figure D.12). Age-2 and age-3 yellow perch (2018 and 2019 year classes) dominated the catch in 2022, accounting for 31% and 33% of the yellow perch captured, respectively (Figure D.13). Yellow perch abundance has remained relatively high since a period of low abundance during the 1990's. Relatively consistent juvenile recruitment, coupled with a conservative harvest strategy by eastern basin management jurisdictions (Yellow Perch Task Group 2023) seems to have fostered improved and relatively consistent status of yellow perch in Lake Erie's eastern basin, the lake's least biologically productive zone.

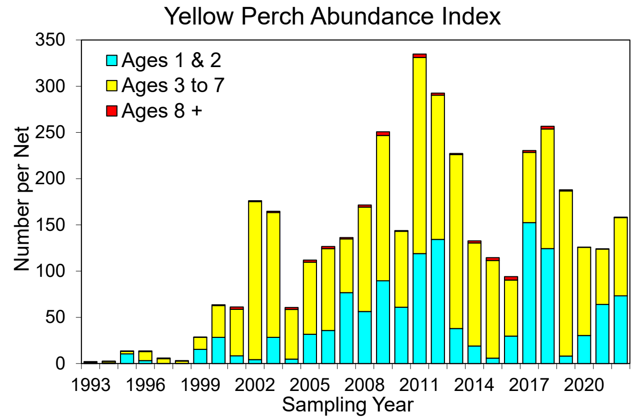

FIGURE D.12. Yellow perch gill net catch rates by age category from offshore stations (> 50 ft). in New York waters of Lake Erie, September–October, 1993–2022.

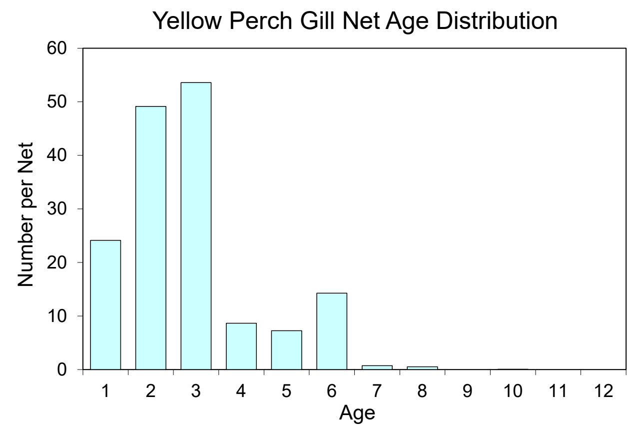

FIGURE D.13. Age composition of yellow perch collected in offshore, gill nets from the New York waters of Lake Erie, September–October, 2022.

Other Fish Species

Relative abundance (catch per net) for the 14 species most commonly encountered in the 42-year gill net series are reported in Figure D.14. All species were encountered within observed historic abundance ranges.

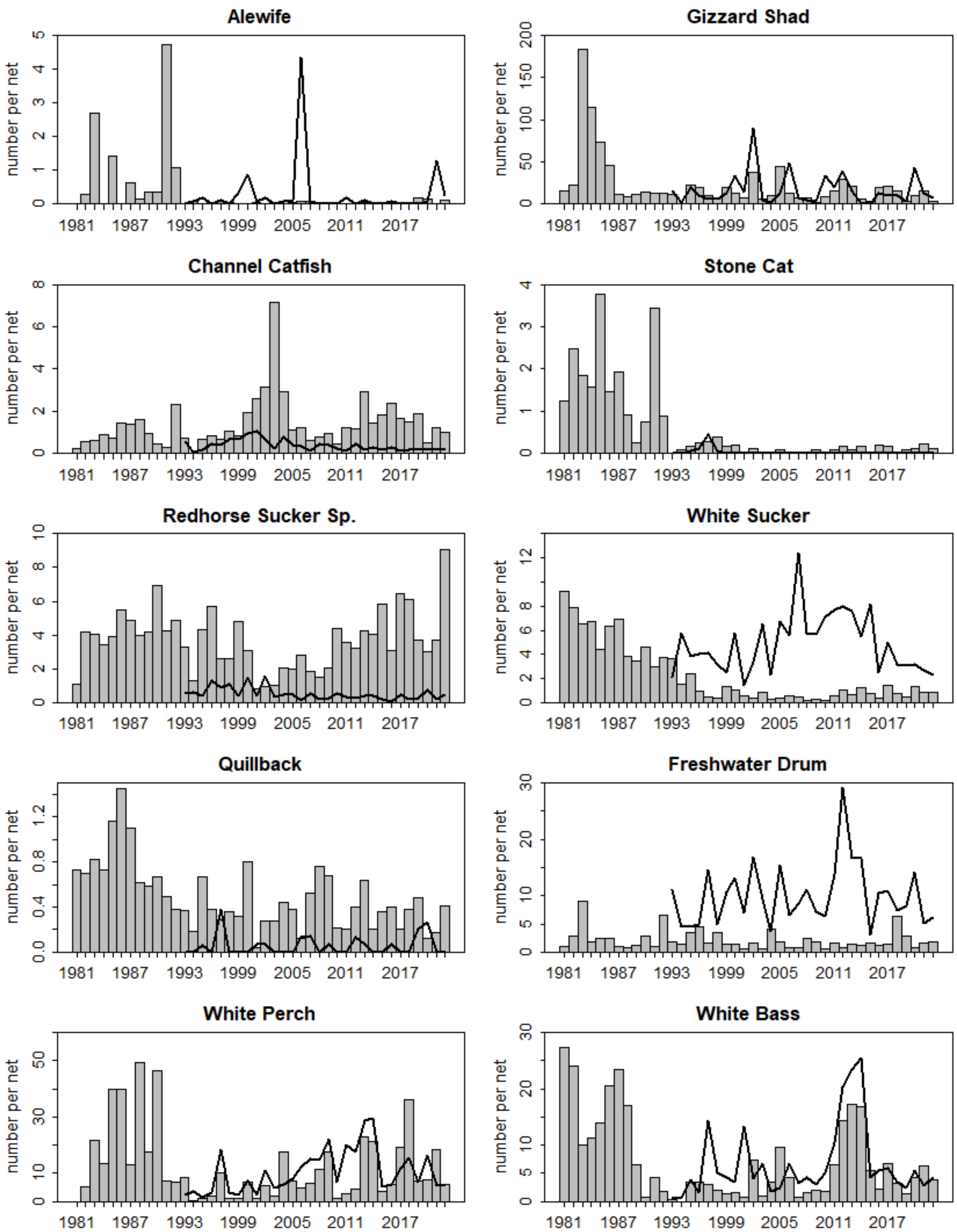

FIGURE D.14. Bar plots represent gill net catch rates for selected fish species collected in the nearshore (< 50 ft) stations in New York waters of Lake Erie, September–October, 1981–2022. The solid line represents gill net catch rates in the offshore (> 50 ft) stations from September–October, 1993–2022.

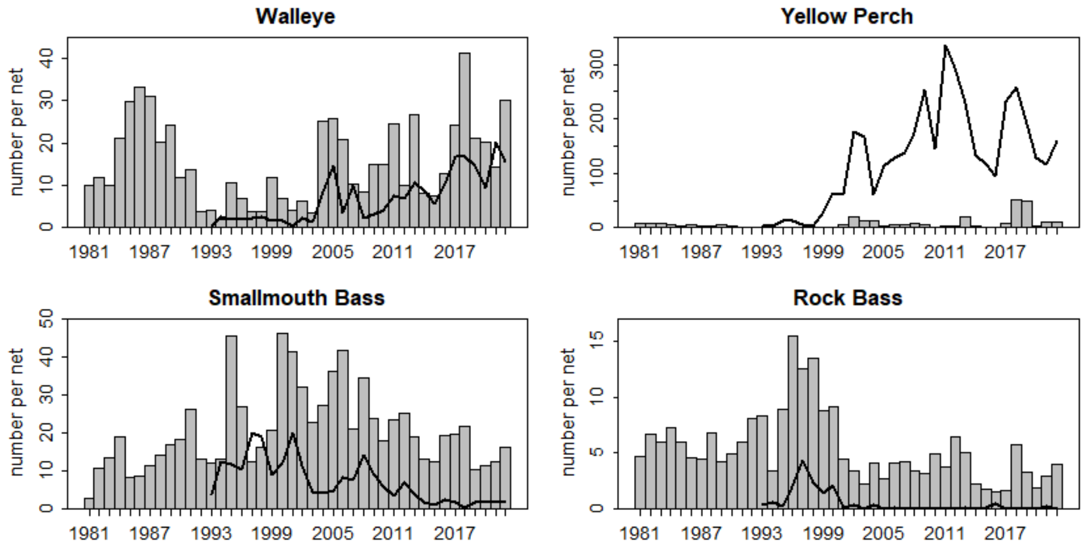

FIGURE D.14 (Continued). Bar plots represent gill net catch rates for selected fish species collected in the nearshore (< 50 ft) stations in New York waters of Lake Erie, September–October, 1981–2022. The solid line represents gill net catch rates in the offshore (> 50 ft) stations from September–October, 1993–2022.

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Yellow Perch Task Group, 2023. Report of the Lake Erie Yellow Perch Task Group. Presented to the Standing Technical Committee, Lake Erie Committee, and Great Lakes Fishery Commission.

E. Commercial Fishery Assessment

Pascal D. Wilkins

Introduction

Following 1986 legislation that prohibited the use of gill nets in the New York waters of Lake Erie, a small commercial trap net fishery targeting yellow perch near Barcelona Harbor emerged and has remained for the last 37 years.

Methods

Commercial fishermen are required to submit monthly reports summarizing daily fishing effort, catch, and harvest in pounds. The standard unit of effort is the number of net lifts per day, irrespective of the amount of time the gear may have fished. Non-target species returned to the lake are not always reported. Due to increased fishing activity, collections of yellow perch ageing structures (anal spines) resumed in 2005 to assess the age distribution of the commercial harvest. These data, along with harvest and effort totals, are reported to the Yellow Perch Task Group (YPTG) of the Great Lakes Fishery Commission's Lake Erie Committee to produce a yellow perch status summary and quota recommendation for Lake Erie's eastern basin (Yellow Perch Task Group 2023).

Results and Discussion

Four commercial licenses were issued and three license holders reported fishing activity in 2022. A combined total of 73 fyke nets and trap nets were licensed for commercial use (Figure E.1). The number of license holders has remained relatively constant recently while the amount of gear licensed has increased. Increases in reported effort have not kept pace with increases in the amount of gear licensed, indicating commercial license holders are only fishing a portion of their licensed gear.

Seasonal fishing activity extended from April through October, with the greatest yellow perch harvest occurring in May (Table E.1). Commercial fishing activity has been somewhat elevated during the most recent 17-year period (2006–2022), generally corresponding to a period of increased yellow perch abundance in Lake Erie's eastern basin (See section D).

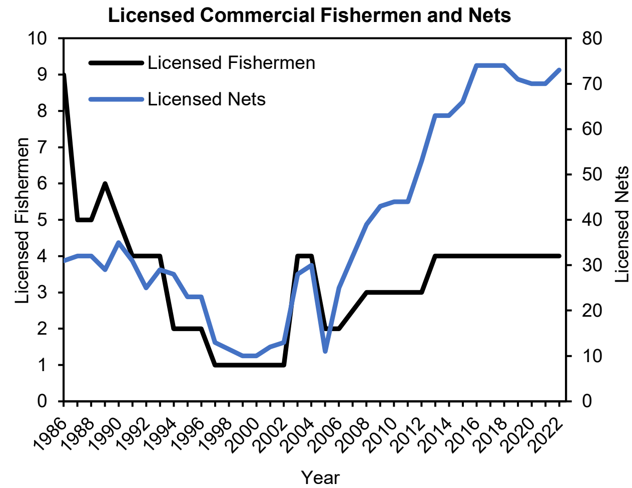

Figure E.1. Number of licensed commercial fishermen and combined licensed fyke and trap nets in the New York waters of Lake Erie, 1986–2022. Missing license and net data in 1998 and 2007 were interpolated.

Table E.1. Monthly effort and catch of the five most reported species in New York's 2022 Lake Erie commercial fishery. Not all species were harvested.

Month	Commercial catch of prominent species (lbs)					Effort
	Y. Perch	Burbot	W. Perch	Suckers	Drum	(# of lifts)
Mar						0
Apr	1,601	25	25	9		16
May	7,576	270	204	14		71
Jun	986	295		33	15	38
Jul	706	10	39	1	5	32
Aug	1,560					32
Sep	1,666					38
Oct	818					14
Nov						0
Dec						0
Total	14,913	600	268	57	20	241

A total of 241 net lifts were reported in 2022, which was the 19th highest (50th percentile) trap netting effort in the time series (Table E.1; Figure E.2). Reported commercial yellow perch harvest in 2022 totaled 14,913 lbs. (~33,664 fish) which was the 8th highest (81st percentile) in the history of the 37-year trap net fishery (Table E.1, Figure E.2). All yellow perch caught in 2022 were sold; white perch (77%; 268 lbs.) and lake whitefish (100%; 12 lbs.) were the only other captured species sold.

We sampled commercially harvested yellow perch on two occasions during periods of high commercial fishing activity in May to characterize the age and size distribution of the 2022 commercial harvest. Age determination from 150 yellow perch anal fin samples identified 8 cohorts that ranged from age-2 to age-9. Age-3 was the dominant cohort, comprising 51% of the sample (Figure E.3). The mean length and weight of yellow perch from this sample was 9.74 inches and 0.44 lbs., respectively. Sex ratio was skewed towards mature males; 73% of the yellow perch examined were males expressing gametes.

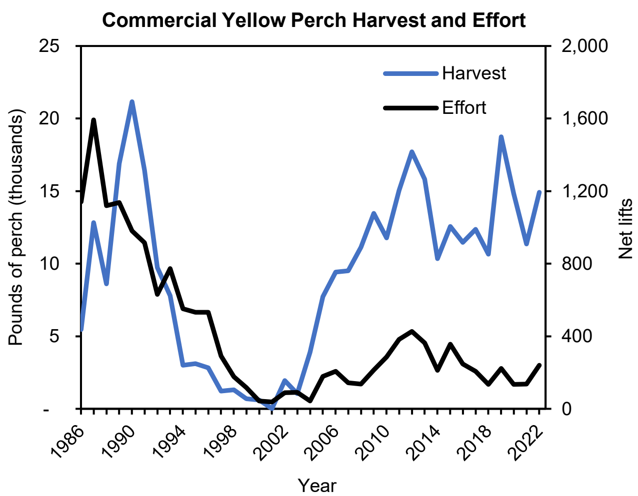

Figure E.2. Total commercial yield of yellow perch and trap net lifts reported by commercial fisherman operating in New York's portion of Lake Erie, 1986-2022.

In 2022, the commercial fishery harvest accounted for an estimated 25% of the total measured harvest by number of fish (18% by weight). The proportion of total harvest associated with the commercial fishery was the lowest since 2011 due to an increase in recreational effort. The commercial and recreational yellow perch fisheries remain spatially segregated; very little targeted recreational yellow perch effort is expended near Barcelona Harbor. Nevertheless, significant expansion of the commercial fishery is not recommended as it could become difficult to maintain New York's long-term yellow perch harvest within annually established total allowable harvest recommendations.

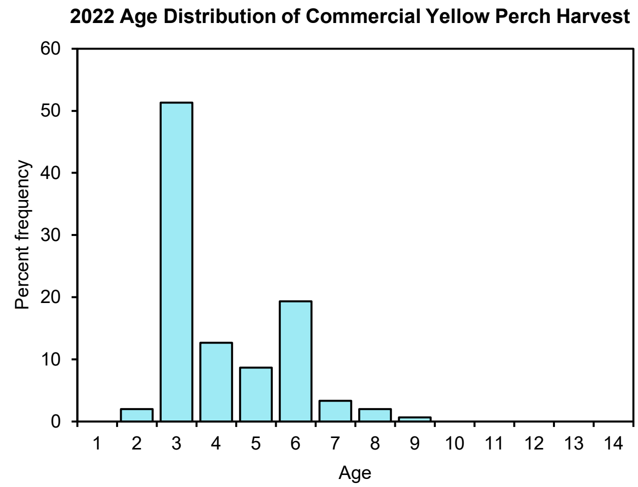

Figure E.3. Percent frequency age distribution of 150 yellow perch sampled from the commercial harvest in New York's portion of Lake Erie, May and June 2022.

References

Yellow Perch Task Group. 2023. Report of the Lake Erie Yellow Perch Task Group, March 2023. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

F. OPEN LAKE SPORT FISHING SURVEY

Pascal D. Wilkins

Introduction

Since 1988, a direct contact sport fishing survey has been conducted to monitor boat fishing activity. This has been a standard, annual program that extends from May through October along the entire New York portion of Lake Erie. The principal objective of this survey is to estimate angler effort, catch, and harvest for all fish species in the open water sport fishery in the New York waters of Lake Erie. Walleye and yellow perch effort and harvest-at-age data are also contributed to the Lake Erie Committee's (LEC) interagency Walleye and Yellow Perch Task Groups for annual lake wide assessment, quota setting, and compliance (WTG 2023; YPTG 2023).

Methods

Assessment of the daytime open lake sport fishery has historically occurred from May 1 through October 31 each year to capture the vast majority of open lake angler effort. However, an April start to the angling season has become more common over the past several years due to the lack of consistent ice cover. Beginning in 2021, the assessment began at selected harbors in mid-April to better document the spring yellow perch fishery. The 2022 assessment began on April 18 and April results were included in all analyses. Our current methodology employs stratification by day type (weekday/weekend day), harbor, and month. Although survey procedures changed in 2002, some independent measures of fishing and boating activity (annual paid launch totals at municipal ramps) suggest our results remain directly comparable for the entire 1988 to 2022 time series (Einhouse 2005). Daytime angler survey estimates for fishing effort, harvest, and catch rates, with associated precision measures (standard error or SE), were calculated for each stratum using the formulae described in Einhouse (2005) based on methods described in Pollock et al. (1994).

From 1988 to 2001, standard angler survey methodology included an aerial boat count to measure fishing effort. Standard survey methods from 1988 to 2001 were patterned after a study by Schmidt (1975), collecting effort and catch information as independent samples with two collection schedules of stratified random sampling. Aerial counts of fishing boats were conducted to measure daytime fishing effort. Catch and harvest data were obtained by roving between five to six representative fishing access sites to conduct interviews of boat anglers who had just completed their fishing trip. Angler interviews were conducted between 0900 EDT and 1 hour after sunset.

During 1991, and for all surveys after 2001, fishing effort has been estimated using an "access approach" using boat counts obtained at the five major harbors bordering New York's portion of Lake Erie (Pollock et al. 1994). The specific application of this method to the New York waters of Lake Erie is described in Einhouse (2005). A limited number of aerial boat counts were conducted from 2002 to 2004 to evaluate whether the change in survey methodology affected absolute measures of fishing effort and harvest. This investigation found that previous and current survey procedures produced very similar results, but the current methodology was more administratively efficient and remained statistically robust (Einhouse 2005).

From 1993 to 1997 this survey was augmented by a spring angler survey of the nighttime walleye fishery, and those results were reported annually in earlier editions of this report (Einhouse 2005). This nighttime survey component was suspended from 1998 to 2005, and then resumed during 2006 to update the status of this fishery. Nighttime surveys may be conducted intermittently in future years as determined by available resources and program needs.

Passive monitoring of bass tournaments in New York's portion of Lake Erie began in 2020 to document smallmouth bass tournament fishing effort in conjunction with the daytime angler survey. Tournament documentation and estimates of tournament effort and catch were completed based on methods described in Wilkins and Robinson (2022).

Results and Discussion

Estimated overall 2022 open water sport fishing effort in the New York waters of Lake Erie was 382,665 angler-hours, up 36% from 2021 and down 5% from the recent high in 2019 (Table F.1). Peak fishing activity occurred in July, but fishing activity remained high from June through August. The most frequently used site was Buffalo Harbor (Safe Harbor Marina, formerly Buffalo Small Boat Harbor), which accounted for 41% of estimated boat fishing effort in 2022 (Table F.1). Sturgeon Point Marina was closed in April and May due to a sandbar blocking lake access. Walleye was the most targeted sport fish, accounting for 59% of the overall angling effort (Figure F.1). Smallmouth bass and yellow perch angling accounted for 18% and 13% of the total effort, respectively.

A major declining trend in boat fishing effort extended through the 1990's and 2000's to a low point in 2009. Since 2009 effort has generally increased (Figure F.2). This increase is almost totally attributable to improvements in the status of walleye stocks and increases in targeted walleye effort. Lake Erie's major decline in boat fishing effort from the late 1980's through the 1990's is consistent with broad trends observed in other waters and is likely due to factors independent of fishing quality such as high fuel prices, aging of the boat angler population, and regional population decline.

A total of 19 species were encountered by boat anglers in 2022, resulting in a total catch of 395,861 fish (Table F.2). Eleven species were harvested resulting in a total harvest of 181,495 fish. Walleye and yellow perch accounted for 99% of the harvest and 59% of the catch.

TABLE F.1. The distribution of 2022 open water boat fishing effort (angler-hours) in New York's portion of Lake Erie.

Harbor	April	May	Jun	Jul	Aug	Sep	Oct	Total
Barcelona	-	5,034	11,338	17,212	9,169	8,141	312	51,205
Dunkirk	-	10,801	13,254	17,479	13,463	4,720	239	59,956
Cattaraugus	19,689	11,761	9,974	15,487	16,471	8,795	9,254	91,430
Sturgeon Pt.	-	213	8,856	7,882	5,807	659	1,145	24,562
Buffalo	14,258	25,386	37,664	27,449	31,795	15,418	3,544	155,513
Grand Total	33,946	53,194	81,086	85,509	76,705	37,732	14,493	382,665

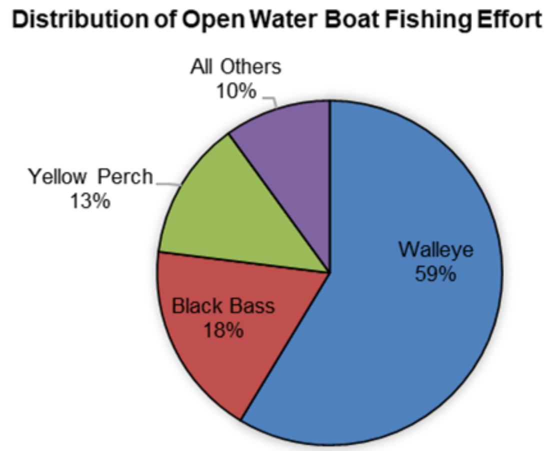

FIGURE F.1. Distribution of directed sport fishing effort by boat anglers in New York waters of Lake Erie, April–October, 2022.

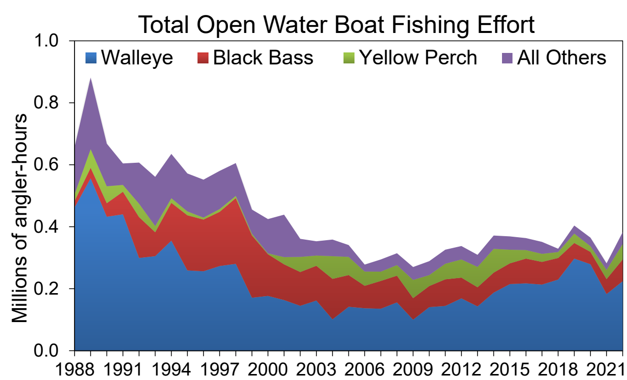

FIGURE F.2. Open water sport fishing angler effort in New York waters of Lake Erie for walleye, bass, yellow perch and all other species, April–October, 1988–2022.

TABLE F.2. Harvest, catch, and two standard errors (2SE) of selected species by boat anglers fishing on the New York waters of Lake Erie, April-October, 2022.

Species	Harvested	2SE	Caught	2SE
Yellow Perch	103,572	46,990	123,350	53,741
Walleye	75,774	14,017	109,892	19,327
Smallmouth Bass	1,154	682	82,309	19,067
Steelhead	251	142	698	336
Lake Trout	216	170	1,151	768
White Perch	206	160	3,054	1,109
*13 other species	324	160	75,408	11,257
Total	181,495	49,042	395,861	61,268

*60% of catch of other species were freshwater drum

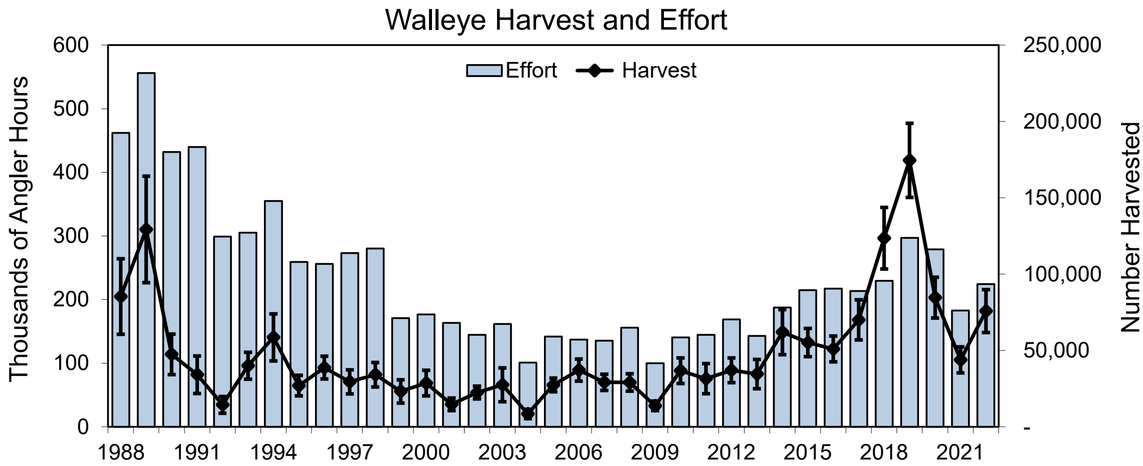

FIGURE F.3. Annual trends in walleye sport fishing effort (angler-hours) and number harvested from May–October, 1988–2022.

Walleye

Estimated 2022 targeted walleye fishing effort was 224,460 angler-hours, a 23% increase from 2021 (Figure F.3). Estimated 2022 total daytime walleye harvest was 75,774 fish, a 73% increase from 2021 (Table F.2).

Walleye was the second most frequently caught species in 2022 (Table F.2). Walleye catch peaked in July and harvest peaked in August, and the June–September period accounted for 96% of the total catch and 95% of the harvest (Table F.3). All five harbors were significant contributors to walleye catch and harvest in 2022. Walleye catch rates have been relatively high over the past decade and were at record levels from 2017–2019. The 2022 targeted walleye catch rate was 0.46 fish per hour, the fourth highest measured in the 35-year time series and well above the long-term average (Figure F.4).

TABLE F.3. Distribution of daytime walleye catch and harvest totals in the New York waters of Lake Erie during 2022.

		May	Jun	Jul	Aug	Sep	Oct	Total
Barcelona	Catch	469	6,265	9,665	5,478	3,672	11	25,560
	Harvest	373	5,202	6,944	3,851	2,536	11	18,917
Dunkirk	Catch	660	2,795	8,171	10,775	2,156	-	24,558
	Harvest	561	2,199	4,552	6,335	1,804	-	15,452
Cattaraugus	Catch	36	1,244	6,029	12,802	3,417	288	24,024
	Harvest	12	985	4,397	10,804	2,871	264	19,334
Sturgeon	Catch	-	1,537	5,098	2,477	145	11	9,267
	Harvest	-	1,304	3,135	1,635	65	-	6,139
Buffalo	Catch	2,741	11,528	6,680	3,141	2,288	45	26,484
	Harvest	2,200	6,642	4,585	1,327	1,154	22	15,931
Total	Catch	3,906	23,368	35,643	34,674	11,678	355	109,624
	Harvest	3,147	16,333	23,613	23,952	8,431	298	75,774

Measures of walleye angler success can also be expressed as frequency of boat limit catches and zero catches for targeted walleye trips. Table F.4 shows that limit catches of walleye are generally uncommon across all years, while complete lack of success (zero harvest) occurs more frequently. In 2022, 11% of walleye fishing boats achieved a party limit while 29% failed to harvest walleye.

In the past, large decreases in the average size of harvested walleye have been a precursor to excellent fishing, as they are an indication of large pulses of young walleye entering the fishery. In the last seven years the average size of harvested walleye decreased by 1.9 inches to 20.4 inches in 2022 (Figure F.4), one of the lowest observations in survey history. This decrease is a result of recent production of exceptionally strong year classes in the east and west basins and is an indicator of excellent fishing quality now and in the coming years.

The age distribution of the walleye harvest was determined from otolith samples taken at fish cleaning stations and was expanded to estimate number harvested by age (Figure F.5). Walleye harvest was dominated by the 2019 (age-3) and 2016 (age-6) year classes, comprising approximately 30% and 24% of the total harvest, respectively (Figure F.5). It is likely that most age-3 fish are the result of exceptional west basin recruitment in 2019 and that most age-5 fish are the result of the exceptional east basin recruitment in 2016.

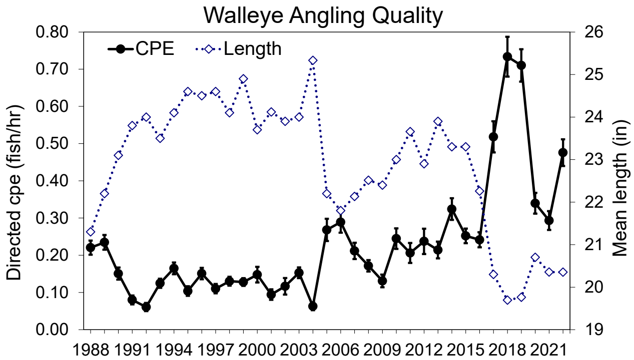

FIGURE F.4. Annual trends in walleye sport fishing quality as measured by mean length harvested (inches) and catch rate (number per hour or CPE), 1988–2022. CPE calculations are weighted by the amount of walleye effort estimated at each harbor.

TABLE F.4. Walleye boat fishing quality metrics, including harvest (HPE) and catch rates, harvest and catch per boat, percentage of boats achieving their daily limit, and percentage of boats that harvested no walleyes, 1988–2022.

Year	Walleye/ang-hr		Walleye/boat trip		Walleye boat trips		Daily limit
	HPE	CPE	harvest	catch	% Limit	% Zero	regulation
1988	0.19	0.22	2.6	3.0	4	41	5
1989	0.21	0.23	3.2	3.5	5	39	5
1990	0.13	0.15	2.0	2.3	1	42	5
1991	0.08	0.08	1.1	1.2	1	59	5
1992	0.06	0.06	0.8	0.9	1	71	5
1993	0.12	0.12	1.7	1.8	2	48	5
1994	0.15	0.16	2.1	2.2	3	45	5
1995	0.10	0.10	1.3	1.4	1	55	5
1996	0.14	0.15	1.8	2.0	3	47	5
1997	0.11	0.11	1.5	1.5	1	50	5
1998	0.12	0.13	1.7	1.8	1	47	5
1999	0.13	0.13	1.8	1.9	3	52	5
2000	0.14	0.15	2.1	2.2	5	49	5
2001	0.08	0.09	1.2	1.3	1	60	5
2002	0.11	0.12	1.4	1.6	2	52	5
2003	0.14	0.15	2.1	2.3	4	39	4
2004	0.06	0.06	0.7	0.8	0	65	4
2005	0.17	0.27	2.2	3.6	8	44	4
2006	0.24	0.29	3.1	3.8	12	32	4
2007	0.19	0.21	2.6	2.9	4	36	5
2008	0.16	0.17	2.1	2.3	2	42	5
2009	0.12	0.13	1.5	1.7	2	50	5
2010	0.21	0.24	2.9	3.3	5	36	5
2011	0.18	0.21	2.7	3.1	5	37	5
2012	0.18	0.24	2.8	3.6	5	37	5
2013	0.19	0.21	2.7	3.1	3	39	6
2014	0.27	0.32	3.7	4.4	6	28	6
2015	0.24	0.25	3.3	3.4	4	30	6
2016	0.21	0.24	2.7	3.1	4	36	6
2017	0.31	0.52	3.9	6.5	10	32	6
2018	0.50	0.73	6.4	9.4	23	20	6
2019	0.57	0.71	6.6	8.3	24	18	6
2020	0.29	0.34	3.6	4.2	7	31	6
2021	0.22	0.29	2.7	3.7	4	38	6
2022	0.34	0.48	4.5	6.4	11	29	6
Ave*	**0.19**	**0.23**	**2.5**	**3.1**	**5**	**42**	

In general, walleye condition has been trending down over the last decade. In 2022 the relative weight of the average 18–24 inch walleye was 83, slightly below the time series average of 85 (Murphy et al. 1990; Figure F.6). In 2022, round goby dominated angler-caught walleye diets while smelt contributed 16% (Figure F.7; see section C). Smelt have consistently dominated the walleye diets until recently, when goby became a more prominent diet item. 2022 was the seventh time in the last eight years that smelt did not comprise the majority (>50% by volume) of the diet.

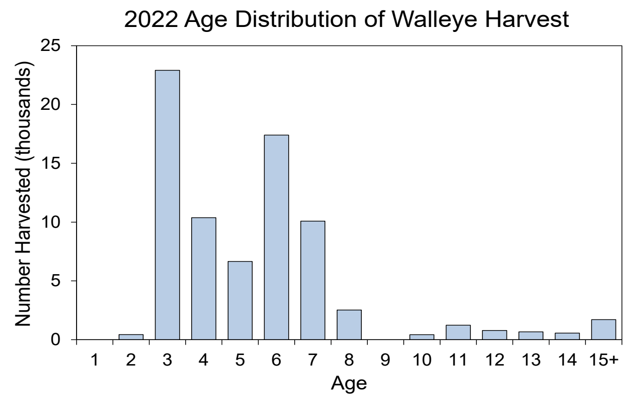

FIGURE F.5. Age distribution of the 2022 walleye harvest estimated by expanding the age distribution of samples at fish cleaning stations by the 2022 walleye harvest estimate.

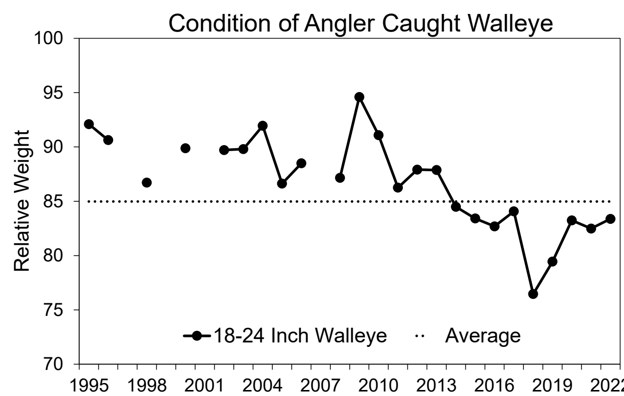

FIGURE F.6. Annual relative weight and time-series average of angler-caught walleye in the New York waters of Lake Erie at 18–24 inches, 1995–2022.

The exceptional east basin 2016 and west basin 2019 walleye year classes supported above-average fishing quality in 2022. There is also evidence of an exceptional 2017 east basin, strong 2018 west basin, and strong 2019 east basin year classes (See Section D). Overall strong walleye recruitment throughout Lake Erie in recent years should continue to result in excellent fishing quality in New York waters for years to come.

Although the quality of walleye fishing in the New York waters of Lake Erie is at above-average levels, walleye effort is nowhere near the highs recorded in the late 1980's and early 1990's (Figure F.3). This may indicate limited capacity for increased walleye effort in the NY waters of Lake Erie by the current angling population.

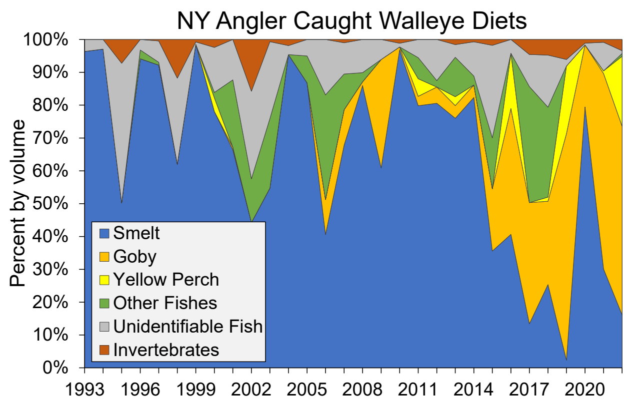

FIGURE F.7. Diet composition (percent by volume) of angler caught walleye from the New York waters of Lake Erie, collected at fish cleaning stations,1993–2022.

The most important factor contributing to walleye fishing quality in the east basin of Lake Erie is the summertime movements of walleye from the west basin of Lake Erie into the central and east basins. The proportion of west basin walleye harvested in the east basin can vary 4.5 fold annually, from 20% of the harvest in July 2016 to 90% in July 2018 (Euclide et al. 2021). However, the contribution of west basin walleye becomes less prominent as the distance from the west basin increases, declining from 75% of the July 2017 harvest in the western portion of the east basin (PA line to Dunkirk) to 25% in the far east portion of the basin (Sturgeon Point to Buffalo; Matley et al. 2020; Raby et al. 2018; Euclide et al. 2021).

The east basin walleye stocks, which are significantly smaller than the west basin stock, typically remain in the east basin year-round, making them more susceptible to harvest in the spring, near Buffalo (i.e., far east), and in years when the magnitude of migration is reduced (Dippold et al. 2020; Zhao et al. 2011; Euclide et al. 2021).

Smallmouth Bass

Estimated targeted fishing effort for smallmouth bass in 2022 was 70,032 angler hours, a 44% increase from 2021 (Figure F.8). Smallmouth bass angling quality has been quite variable over the last decade, ranging from 1.37 to 0.80 fish per hour. The amount of trip-to-trip variability has also increased. Overall catch rate by bass anglers was 1.09 bass per hour in 2022 (Figure F.9), the 10th highest in the time series. Smallmouth bass harvest was estimated at 1,154 fish in 2022, only 1.4% of the total bass catch (82,309), one of the lowest in the time series (Table F.5; Figure F.8). Approximately 81% of the catch and 77% of the harvest was reported from the Buffalo Harbor survey location in 2022.

A long-term decline in smallmouth bass harvest rates has been underway since this survey began in the 1980's. This notable trend of increasing catch-and-release fishing has caused catch rates by anglers targeting smallmouth bass to diverge from overall harvest totals. In recent years, smallmouth bass harvest totals have been the lowest observed in the time series.

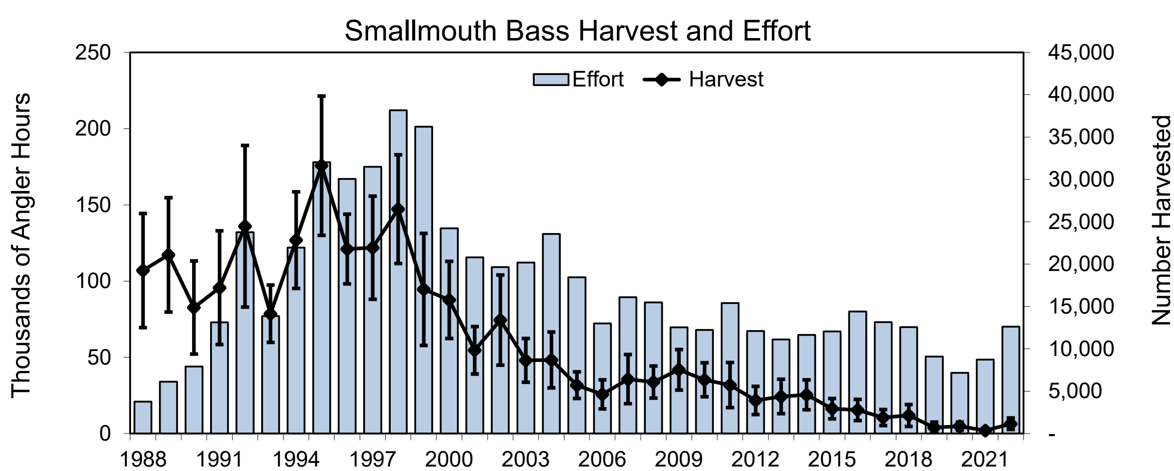

FIGURE F.8. Annual trends in smallmouth bass sport fishing effort (angler-hours) and number harvested from April through October, 1988–2022.

Anglers targeting species other than smallmouth bass can account for as much as 70% of the total smallmouth bass harvest in a given year. The quality walleye and perch fishing observed recently may also provide a more appealing alternative for catch-and-consume anglers.

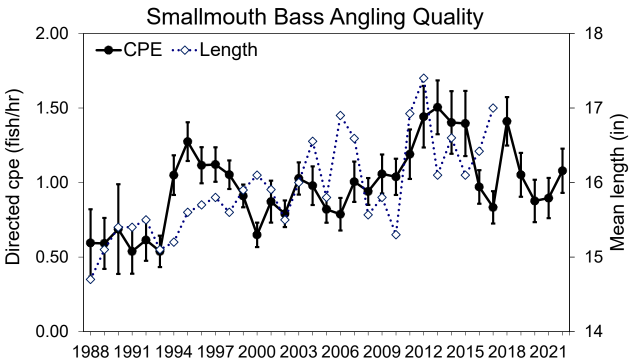

FIGURE F.9. Annual trends in smallmouth bass sport fishing quality as measured by mean length harvested (inches) and catch rate (number per hour or CPE), 1988–2022. A spring bass season was implemented in 1994 which significantly increased catch rates. Numbers of harvested smallmouth bass have not been sufficient to estimate average length in the last four years.

Measures of bass angler success can also be expressed as catch per boat and frequency of zero catches for targeted bass fishing trips. Table F.6 indicates that the 2022 catch per boat was 13.9 (average 12.6) and the percentage of boats that caught no bass was 13.3% (average 15.8%). Lake Erie's bass angling quality can still be characterized as excellent, especially relative to other bass populations.

TABLE F.5. Distribution of smallmouth bass catch and harvest totals in the New York waters of Lake Erie during 2022.

		Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Barcelona	Catch	-	813	340	219	56	126	-	1,553
	Harvest	-	-	22	52	19	-	-	93
Dunkirk	Catch	-	5,721	2,777	1,376	200	23	163	10,258
	Harvest	-	-	-	33	-	-	-	33
Cattaraugus	Catch	593	782	162	181	30	33	228	2,010
	Harvest	-	-	65	76	-	-	-	140
Sturgeon	Catch	-	-	820	327	223	51	33	1,453
	Harvest	-	-	-	-	-	-	-	-
Buffalo	Catch	11,013	16,592	18,053	5,842	5,221	5,909	4,404	67,035
	Harvest	-	-	167	140	354	60	168	888
Total	Catch	11,607	23,908	22,151	7,945	5,729	6,142	4,828	82,309
	Harvest	-	-	254	300	373	60	168	1,154

TABLE F.6. Bass boat fishing quality metrics, including harvest and catch rates, harvest and catch per boat, and percentage of boats that caught no bass, 1988–2022. *Averages only include data from 1994–present following the implementation of a spring season with a single fish 20" minimum size.

Year	Bass/ang-hr		Bass/boat trip		Boat trips
	HPE	CPE	harvest	catch	% Zero
1988	0.22	0.59	2.7	7.1	23
1989	0.18	0.59	2.0	6.5	22
1990	0.18	0.69	2.1	7.9	12
1991	0.17	0.54	2.1	6.7	22
1992	0.14	0.61	1.8	7.7	26
1993	0.09	0.54	1.0	5.8	23
1994	0.09	1.05	1.1	12.8	14
1995	0.11	1.27	1.3	14.6	11
1996	0.08	1.12	0.9	13.7	12
1997	0.09	1.12	1.1	14.3	12
1998	0.09	1.05	1.1	12.8	14
1999	0.06	0.91	0.8	10.6	17
2000	0.07	0.65	0.9	8.1	17
2001	0.07	0.87	0.9	11.7	13
2002	0.06	0.79	0.7	9.2	20
2003	0.06	1.03	0.7	11.5	17
2004	0.06	0.98	0.6	10.9	17
2005	0.04	0.82	0.4	9.9	23
2006	0.05	0.79	0.5	8.7	22
2007	0.05	1.01	0.6	12.7	16
2008	0.05	0.94	0.6	10.5	21
2009	0.06	1.06	0.7	12.4	19
2010	0.07	1.04	0.8	11.4	20
2011	0.05	1.19	0.6	13.8	18
2012	0.03	1.44	0.4	18.1	14
2013	0.04	1.50	0.6	18.5	15
2014	0.05	1.40	0.6	16.9	15
2015	0.04	1.40	0.5	17.5	14
2016	0.03	0.97	0.3	11.8	17
2017	0.02	0.83	0.2	9.4	23
2018	0.02	1.41	0.3	17.5	9
2019	0.01	1.05	0.1	11.4	12
2020	0.02	0.88	0.2	8.8	14
2021	0.00	0.90	0.1	10.8	12
2022	0.01	1.08	0.1	13.9	13
Ave*	**0.05**	**1.05**	**0.6**	**12.6**	**16**

Eighteen bass tournaments (12 three-hour, 6 eight-hour) were documented in NY waters of Lake Erie during 2022 (Table F.7). All tournaments were based out of Buffalo Harbor. An average of 16 boats (range: 10–24) participated per 8-hour, 5-fish bag tournament in 2022 and an average of 32 bass (range: 12–55) were weighed in per event. For 3-hour, 3-fish bag tournaments, an average of 13 boats (range: 9–16) participated and 27 bass (range: 6–36) were weighed in per event in 2022.

TABLE F.7. Summary results of 3-hour and 8-hour smallmouth bass tournaments held in the New York portion of Lake Erie from 2018–2022. Results include average number of participating anglers and boats, and estimated number and weight (lbs.) of bass weighed in per tournament.

Year	Format	Tournaments	Participants (range)	Boats (range)	Bass (range)	Weight (range)
2018	3 Hour	6	26 (11-43)	14 (10-17)	31 (15-39)	106 (39-159)
	8 Hour	6	81 (18-338)	45 (9-169)	308 (5-1,487)	1,074 (26-5,058)
2019	3 Hour	10	27 (16-43)	14 (8-22)	27 (12-45)	100 (51-180)
	8 Hour	8	33 (18-40)	22 (9-40)	80 (16-192)	306 (73-639)
2020	3 Hour	12	28 (11-41)	15 (6-22)	30 (12-51)	110 (49-193)
	8 Hour	6	26 (20-38)	15 (11-22)	65 (45-110)	262 (129-434)
2021	3 Hour	8	24 (8-31)	13 (4-16)	27 (12-42)	96 (40-191)
	8 Hour	6	33 (14-67)	17 (7-35)	81 (10-264)	278 (44-821)
2022	3 Hour	12	25 (18-30)	13 (9-16)	27 (6-36)	96 (30-131)
	8 Hour	6	32 (19-48)	16 (10-24)	32 (12-55)	137 (65-210)
Overall	3 Hour	48	26 (8-43)	14 (4-22)	28 (6-51)	78 (30-193)
	8 Hour	32	40 (14-338)	23 (7-169)	111 (5-1,487)	321 (26-5,058)

Yellow Perch

Yellow Perch was the most harvested species by boat anglers in 2022 (Table F.2). Estimated 2022 targeted yellow perch effort was 49,968 angler-hours, a 71% increase from 2021 and above average (34,783 angler-hours) for the 35-year time series (Figure F.10). Estimated 2022 yellow perch harvest (103,572 fish) was well above average (Figure F.10). Boats launching out of Cattaraugus Creek accounted for 73% of the catch and 75% of the harvest of yellow perch in 2022 (Table F.8). The highest monthly yellow perch harvest occurred in April (57% of total).

TABLE F.8. Distribution of yellow perch catch and harvest totals in the New York waters of Lake Erie during 2022.

		Apr	May	Jun	Jul	Aug	Sep	Oct	Total
Barcelona	Catch	-	497	559	417	140	-	-	1,612
	Harvest	-	478	219	198	121	-	-	1,016
Dunkirk	Catch	-	1,260	1,491	1,687	1,929	79	-	6,446
	Harvest	-	1,142	354	1,392	1,862	57	-	4,807
Cattaraugus	Catch	51,420	17,334	695	907	740	3,139	16,131	90,365
	Harvest	44,908	15,025	162	665	577	2,749	13,571	77,656
Sturgeon	Catch	-	-	1,639	147	358	239	1,946	4,329
	Harvest	-	-	1,546	90	213	239	1,573	3,660
Buffalo	Catch	14,424	1,641	1,322	546	1,903	438	324	20,598
	Harvest	13,853	902	318	203	973	60	123	16,432
Total	Catch	65,844	20,733	5,705	3,703	5,069	3,895	18,401	123,350
	Harvest	58,761	17,547	2,598	2,548	3,747	3,104	15,266	103,572

The overall 2022 yellow perch catch rate was 2.16 perch per hour (Figure F.11), well above the time-series average of 1.51 fish per hour. The mean length of harvested yellow perch was 11.2 inches in 2022, the 5th highest in the time series (Figure F.11). The age distribution of the yellow perch harvest was determined from anal spine samples and was expanded to estimate harvest at age. Yellow perch harvest in 2022 was dominated by the 2019 (age 3) and 2016 year classes (age 6) making up approximately 74% of the total harvest (Figure F.12).

Measures of yellow perch angler success can also be expressed as frequency of boat limit catches and frequency of zero catches for targeted yellow perch fishing trips. Table F.9 shows that boat limit catches of yellow perch remain a rare occurrence across all years, while complete lack of success (zero harvest) occurs more commonly. During 2022, only 3% (average 1.5%) of yellow perch fishing boats achieved a party limit, while 16% (average 38%) failed to harvest any perch.

TABLE F.9. Yellow perch boat fishing quality metrics, including harvest and catch rates, harvest and catch per boat, percentage of boats achieving their daily limit, and percentage of boats that harvested no yellow perch, 1988–2022.

Year	Perch/ang-hr		Perch/boat trip		Perch boat trips		Daily limit regulation
	HPE	CPE	harvest	catch	% Limit	% Zero	
1988	1.65	1.67	17.4	17.7	0	40	none
1989	2.04	2.17	24.2	25.7	0	36	none
1990	0.66	0.70	7.3	7.7	0	43	none
1991	0.56	0.59	6.0	6.3	0	46	none
1992	0.34	0.36	3.5	3.7	0	58	none
1993	0.31	0.37	3.2	3.8	0	68	none
1994	0.33	0.42	3.9	5.0	0	45	none
1995	0.53	0.76	4.4	6.4	0	38	none
1996	0.30	0.51	3.3	5.5	0	63	none
1997	0.27	0.35	2.2	2.9	0	71	50
1998	0.46	0.67	4.4	6.4	0	75	50
1999	0.44	0.78	5.7	10.2	0	70	50
2000	0.20	0.20	2.1	2.1	0	56	50
2001	1.64	1.75	18.4	19.7	2	24	50
2002	1.03	1.17	8.9	10.1	1	39	50
2003	0.79	0.97	8.2	10.1	0	45	50
2004	1.17	1.38	13.0	15.3	0	38	50
2005	1.11	1.36	11.9	14.7	0	40	50
2006	1.35	1.46	14.1	15.2	2	31	50
2007	0.99	1.08	9.7	10.6	0	43	50
2008	1.79	2.18	18.3	22.2	3	28	50
2009	1.72	2.23	18.4	23.9	3	24	50
2010	1.43	1.98	15.3	21.2	1	35	50
2011	2.00	2.59	23.1	30.0	3	27	50
2012	2.24	3.40	26.8	40.5	5	20	50
2013	2.64	3.56	30.2	40.7	6	18	50
2014	2.73	3.45	33.3	42.0	7	14	50
2015	2.15	2.67	26.1	32.3	3	27	50
2016	0.95	1.15	10.7	12.9	1	39	50
2017	1.50	1.78	17.2	20.3	2	26	50
2018	1.47	1.74	15.1	18.0	1	27	50
2019	1.82	1.96	21.5	23.2	4	26	50
2020	1.64	1.75	16.2	17.2	3	27	50
2021	2.05	2.18	24.1	25.6	3	21	50
2022	1.88	2.13	25.3	28.8	3	16	50
Ave*	**1.26**	**1.53**	**14.1**	**17.1**	**1**	**38**	

Beginning in 2001, excellent yellow perch fishing quality returned after a full decade of poor fishing. Improvements in yellow perch fishing quality were consistent with other population metrics (Sections C

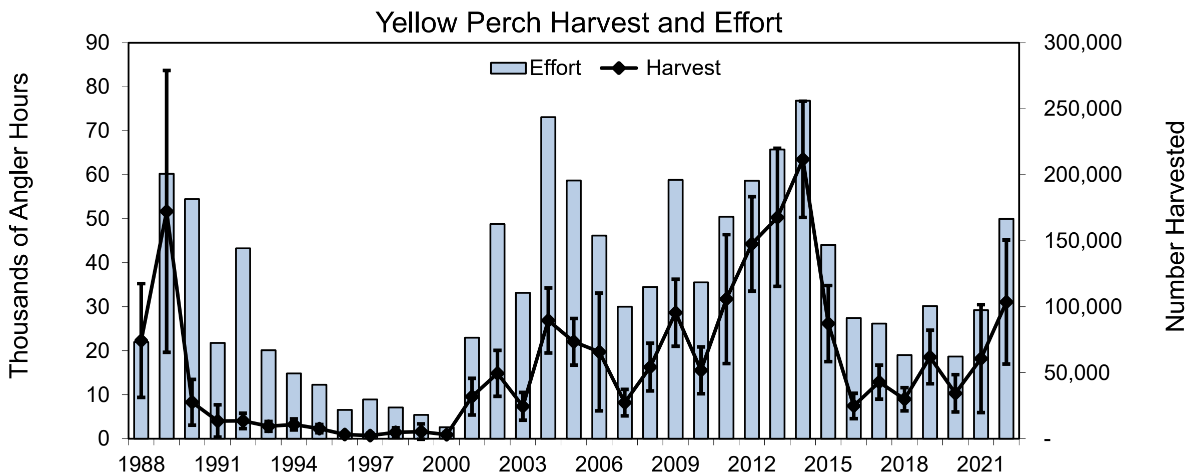

FIGURE F.10. Annual trends in yellow perch sport fishing effort (angler-hours) and number harvested from April through October, 1988–2022.

and D) indicating improved status relative to the 1990's. A major driver in the improvement in fishing quality was consistent year class production. For average to above-average fishing quality to occur regularly, there typically needs to be two or three moderate to strong year classes contributing to the fishery in a given year. Most recently, strong year classes were observed in 2019 and 2020 (Sections C and D) and are likely to account for the majority of the fish caught in 2023, which should result in average catch rates for yellow perch in 2023.

In recent years, trends in perch catch and harvest have decoupled from catch-per-effort and abundance, meaning that increases in perch abundance have not resulted in increased effort, catch, and harvest as they have in the past, even as angling quality remains high. We hypothesize that the reason for this decoupling is that exceptional walleye fishing has caused some perch anglers to shift their effort to walleye.

Perch fisheries in New York's portion of Lake Erie typically operate in deeper water (> 40 ft) and some anglers tend to release smaller, but otherwise harvestable-sized yellow perch. Yellow perch that are retrieved from depths greater than 30 ft. are known to experience barotrauma resulting in high mortality for released fish (Knight et al. 2019). Ongoing outreach efforts are conveying this message to the angling community with recommendations to harvest all perch with barotrauma or count them towards your limit.

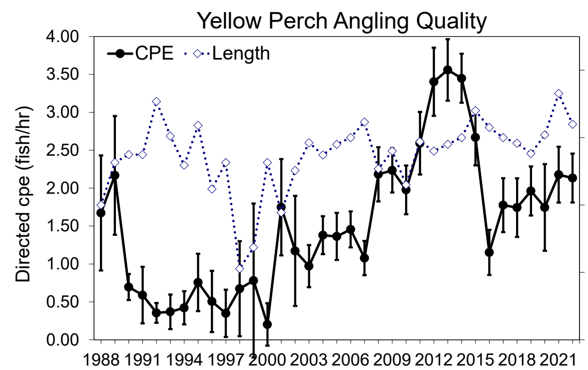

FIGURE F.11. Annual trends in yellow perch sport fishing quality as measured by mean length harvested (inches) and catch rate (number per hour or cpe), 1988–2022.

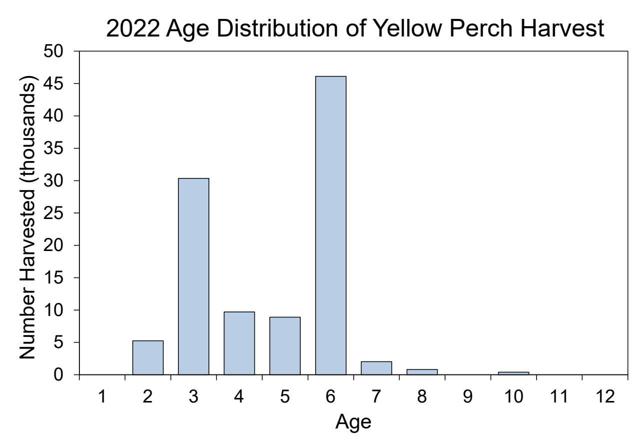

FIGURE F.12. Age distribution of the 2022 yellow perch harvest estimated by expanding the age distribution of samples collected during the angler survey by the 2022 harvest estimate.

Other Species

Catch and harvest estimates for other prominent species are presented in Table F.2. Freshwater drum (45,387; 11%) and white bass (8,455; 2%) were routinely caught by anglers in 2022. Round goby (14,784) also remained a commonly encountered nuisance species. Lake trout (1,151), steelhead (698), brown trout (95) were the salmonids identified in the 2022 angler catch. Lake trout (216) and steelhead (251) were the most commonly harvested of the salmonid species.

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G. COLDWATER GILL NET ASSESSMENT

James L. Markham

Introduction

The annual coldwater fish community gill net assessment program has been performed by New York's Lake Erie Fisheries Research Unit since 1986. The principal objective of this August survey is to produce standardized indices of relative abundance and sea lamprey wounding rates (see Section H) for coldwater fish species in the New York waters of Lake Erie. In addition, the survey produces age and strain composition data for lake trout. Data from this survey are also contributed to the Lake Erie Committee's (LEC) interagency Coldwater Task Group for annual lake wide assessments (Coldwater Task Group 2023). Long-term index netting remains invaluable as a tool for assessing the health of the coldwater fish community, assessing progress towards sea lamprey control, and measuring the success of lake trout rehabilitation efforts.

Rehabilitation of a self-sustaining lake trout population in the eastern basin of Lake Erie continues to be a major objective of New York's Great Lakes coldwater fisheries management program. This objective is pursued in cooperation with member agencies of the Great Lakes Fishery Commission's LEC, the U.S. Fish and Wildlife Service (USFWS), and the US Geological Survey's Lake Erie Biological Station at Sandusky, Ohio. An updated lake trout management plan (LEC 2021) was approved by the LEC in 2021 and serves as a guide for ongoing rehabilitation efforts.

Methods

A new survey design to assess lake trout and other coldwater species was implemented in 2020 following five years of sampling which identified substantial differences in species abundance between standard survey sites (net locations adjacent to the thermocline) and experimental sites in offshore waters (Markham 2020). The previous survey design resulted in over sampling of the area directly adjacent to the 50°F isotherm and a complete lack of sampling in offshore waters. The new survey was designed to provide better coverage of the entire coldwater habitat, decrease the number of required samples, and maintain comparable metrics between new and old survey methodologies. See Markham (2021) for details of the previous survey design and comparability to the current survey design.

Survey Design

The survey occurs in August each year and covers the area from Dunkirk west to the New York/Pennsylvania boundary, which is the approximate summertime coldwater habitat in the New York waters of Lake Erie. The standard survey net consists of a gang of 10 randomly ordered, 8 ft deep by 50 ft long monofilament gill net panels (500 ft total length per net gang), ranging from 1.5 to 6.0 inch in 0.5 inch increments, set overnight on bottom. Netting locations are randomly selected from a 2.5 minute lat/long grid system (Markham 2021).

Survey locations are divided into two strata—standard assessment nets and offshore assessment nets (Figure G.1). Standard assessment nets are set in similar areas to the previous assessment survey—adjacent to the thermocline—to maintain comparability to long-term abundance metrics (see Markham 2021). Two net gangs in each of eight randomly chosen grids containing the 50°F isotherm (16 net gangs total) are set with the first net 8–10 ft. deeper than the 50°F isotherm and the second net 10 ft. deeper than the first net. The specific grid that the nets are set in depends on the depth of the 50°F isotherm; if the depth and temperature criteria fall outside of the standard assessment grid (i.e. shallower or deeper), then nets are moved to the adjacent grid to the north or south following the temperature protocols. Nets are set parallel to the shoreline but otherwise can be placed anywhere within the grid following the protocol for temperature and depth. An additional 16 net gangs (offshore assessment nets) are set in randomly selected offshore grids. Nets in these areas are set in any location within the selected grid in a direction parallel to the bottom contour. A total of 32 net gangs are targeted for a complete survey each year.

Total length, weight, sex, maturity, stomach contents, fin clips, and sea lamprey wounding are recorded for every lake trout. Burbot, whitefish, and other salmonids are examined using the same protocol. Snouts are retained from all tagged lake trout for coded-wire tag (CWT) retrieval. Otoliths and a fin-clip sample are also collected from any lake trout without a clip and CWT for future determination of age and origin. Otoliths and/or scales are collected from other species as needed.

The number of potentially wild lake trout in the sampled population is approximated by subtracting the estimated number of fish that are unmarked due to clipping and tagging error from the total number of unmarked (i.e., no clip or CWT) fish. The joint probability of a fish not having a clip or tag due to tagging or clipping error (i.e., number of lake trout with an adipose clip but no CWT; number with a CWT and an adipose) was determined using the gill net catch data. Numbers of fish that were unmarked due to error was calculated by multiplying the aforementioned joint probability by the total number of fish caught. The index of wild reproduction is represented as a proportional five-year running average to overcome low sample sizes associated with unmarked fish.

Strain-specific and total annual survival (S) for individual cohorts were calculated using a catch curve approach which employed a 3-year running average of catch per unit effort at ages 4 through 11. A running average was used due to the high year-to-year variability in catches, particularly of the Finger Lakes strain fish.

Results and Discussion

A total of 32 unbiased lifts were completed during the August 2022 assessment (Figure G.1). Half of the net lifts (16) sampled the standard assessment stratum at depths between 70 and 100 feet while the remaining 16 nets sampled the offshore stratum at depths between 95 and 155 feet. Target coldwater species caught during the survey (all nets) included 198 lake trout, 71 lake whitefish, 5 burbot, 1 brown trout, and 1 steelhead. Other non-target species included 8 white suckers, 4 white bass, 8 yellow perch, and 60 walleye.

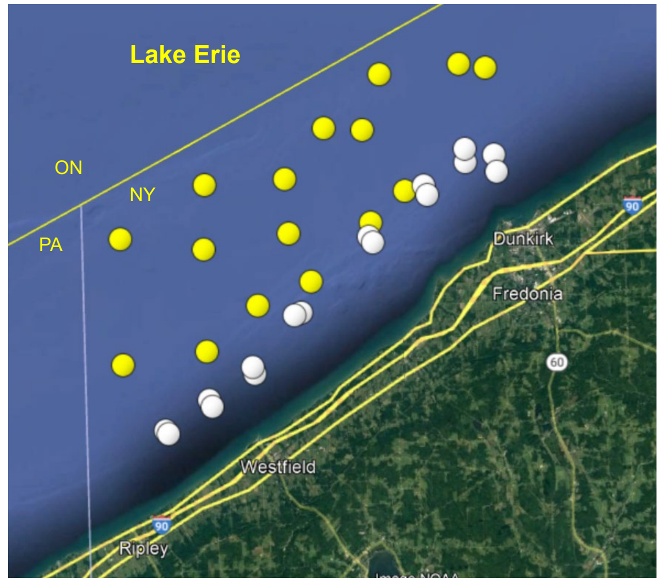

FIGURE G.1. Gill net locations for assessment of coldwater species in the NY waters of Lake Erie, August 2022. White circles represent standard assessment net locations; yellow circles indicate offshore net locations randomly selected from a 2.5 minute lat/long grid system.

Natural Reproduction of Lake Trout

Three potentially wild lake trout (no clips or CWT) were sampled in 2022 (Table G.1). Altogether, 69 potentially wild fish have been caught since 2000, representing 2.2% or less of the annual lake trout sample. The joint probability of a stocked fish not having a CWT or adipose fin clip is about 0.1% and is fairly consistent over time. This is substantially lower than the percentage of untagged and unclipped lake trout caught in our survey in most years, indicating that some portion of the lake trout population is likely naturally produced. Our analysis estimated 0.55% of the lake trout captured between 2000–2022 were likely wild (Figure G.2). A higher proportion of wild fish appear to have been present in the early 2000s with a more consistent proportion over the past 15 years of around 0.4%, or about 1 in every 250 lake trout sampled. An increasing trend is evident in recent years. These results coupled with the confirmed presence of viable eggs and wild fry in the vicinity of Shorehaven, NY in 2021 and 2022 (Markham et al. 2022) indicate that lake trout are having some limited reproductive success. To further explore this, otoliths and fin clip samples from potentially wild lake trout are removed and saved and will be used in future otolith chemistry and/or genetic analyses to determine if these fish were of wild or hatchery origin.

TABLE G.1. Number and percentage of potentially wild lake trout, and total sample size of lake trout caught in coldwater assessment gill nets in the New York waters of Lake Erie, 2000–2022. A potentially wild fish has no fin clips and no coded-wire tag (CWT).

Year	Number of Fish without Tags/Clips	Number of Lake Trout Sampled	Percent without Tags/Clips
2000	3	134	2.2
2001	5	249	2.0
2002	2	226	0.9
2003	11	550	2.0
2004	2	248	0.8
2005	1	281	0.4
2006	1	353	0.3
2007	1	355	0.3
2008	5	603	0.8
2009	3	466	0.6
2010	6	365	1.6
2011	5	659	0.8
2012	3	498	0.6
2013	2	528	0.4
2014	2	837	0.2
2015	5	782	0.6
2016	0	363	0.0
2017	2	361	0.6
2018	1	356	0.3
2019	5	359	1.4
2020	0	201	0.0
2021	1	107	0.9
2022	3	198	1.5

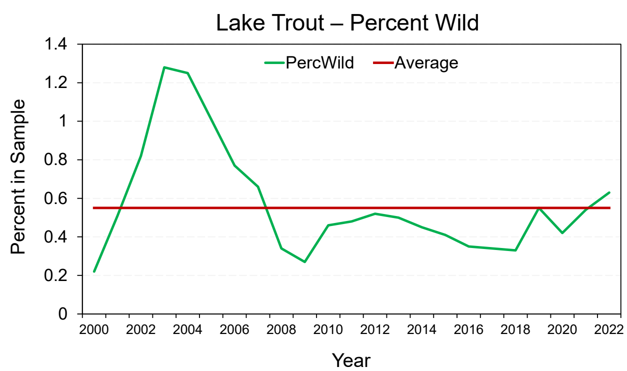

FIGURE G.2 Percentage of potentially wild lake trout caught in coldwater assessment gill nets in the New York waters of Lake Erie for 5-year running average time blocks, 2000–2022. A potentially wild fish has no fin clips and no coded-wire tag (CWT).

Lake Trout Age Structure

In 2022, 19 age classes ranging from age-1 to 32 were represented in the sample of 177 known-age fish as determined by CWT or fin clip examination (Table G.2). Ages 7, 12, and 13 were the most abundant cohorts (Figure G.3). Abundance of lake trout older than age-10 continues to increase and now represents the majority (61%) of the population. The oldest lake trout sampled in 2022 was a 32 year-old male that measured nearly 37 inches and weighed 20 pounds.

TABLE G.2. Number, mean total length (inches TL), mean weight (lbs.), and percent maturity of known age and sex lake trout by age class collected in gill nets (all nets) from New York waters of Lake Erie, August 2022.

AGE	SEX	NUMBER	MEAN LENGTH (inches TL)	MEAN WEIGHT (pounds)	PERCENT MATURE
1	Male	1	8.8	0.2	0
	Female	1	7.3	0.1	0
2	Male	1	16.6	1.8	0
	Female	1	15.9	1.5	0
3	Male	9	22.4	4.7	100
	Female	1	22.2	4.2	0
4	Male	1	24.9	6.8	100
	Female	0	-----	-----	-----
5	Male	5	25.9	7.8	100
	Female	4	28.1	10.3	100
6	Male	9	27.9	9.6	100
	Female	5	28.0	10.2	100
7	Male	13	29.4	11.1	100
	Female	10	29.9	12.2	100
8	Male	0	-----	-----	-----
	Female	4	29.7	12.7	100
9	Male	1	30.0	13.0	100
	Female	3	31.1	14.9	100
10	Male	10	30.7	14.1	100
	Female	5	30.6	13.5	100
12	Male	18	33.2	17.0	100
	Female	13	31.6	15.6	100
13	Male	12	32.8	16.6	100
	Female	11	31.3	14.5	100
14	Male	10	32.9	16.4	100
	Female	4	31.8	15.0	100
15	Male	5	33.2	15.5	100
	Female	3	31.8	15.7	100
16	Male	2	32.4	16.4	100
	Female	3	31.6	15.1	100
19	Male	1	33.5	18.1	100
	Female	0	-----	-----	----
20	Male	3	33.5	17.2	100
	Female	2	33.3	18.3	100
21	Male	2	36.2	21.1	100
	Female	3	34.4	18.3	100
32	Male	1	36.6	20.0	100
	Female	0	-----	-----	-----

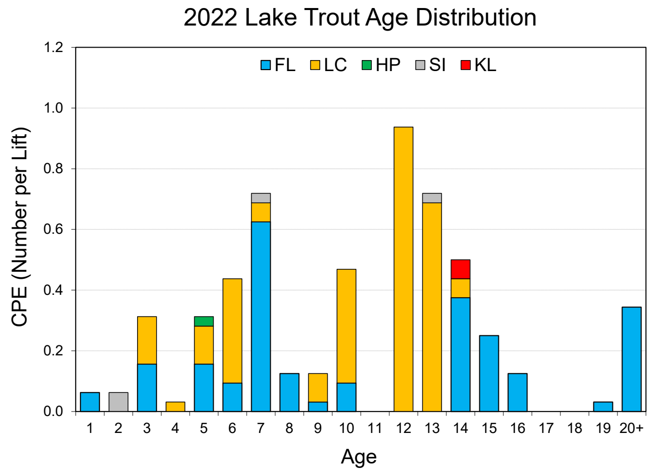

FIGURE G.3. Relative abundance by age and strain of lake trout collected in gill nets (all nets) fished in New York waters of Lake Erie, August 2022. Stocking strain codes: FL = Finger Lakes, LC = Lake Champlain, HP = Huron/Perry Sound, SI = Slate Island, and KL = Klondike.

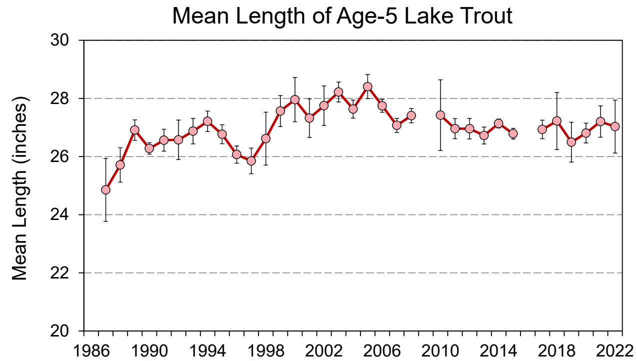

FIGURE G.4. Mean length-at-age with 95% confidence limits (approximated as 2 SE's) for age-5 lake trout collected in gill nets from New York waters of Lake Erie, August 1986-2022.

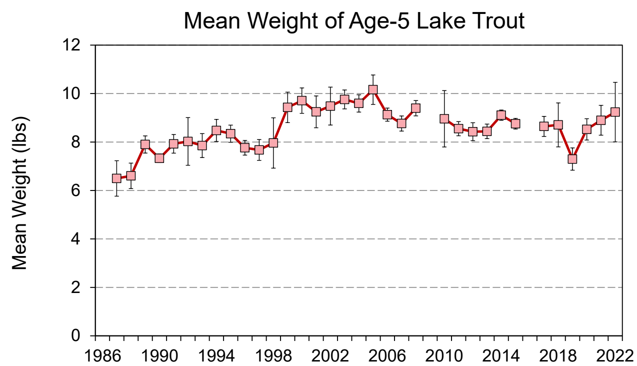

FIGURE G.5. Mean weight-at-age with 95% confidence limits (approximated as 2 SE's) for age-5 lake trout collected in gill nets from New York waters of Lake Erie, August 1986-2022.

Lake Trout Strains

Five lake trout strains were detected among the 177 fish with hatchery-implanted CWT's or fin-clips (Figure G.3). Lake Champlain, Finger Lakes, and Slate Island have been the most commonly stocked lake trout strains in Lake Erie over the past thirteen years (see Section I, Figure I.2). Lake Champlain and Finger Lakes strains were the most numerous strains caught in Lake Erie in 2022, comprising 87% of the catch. Of note was the catch of two age-14 Klondike strain lake trout, which are the oldest lake trout of this strain ever sampled in the survey.

Lake Trout Growth and Maturity

Mean length-at-age and weight-at-age of age-5 lake trout have remained relatively consistent for the past 15 years (Figures G.4 and G.5). However, a decline in length and weight was evident in 2019 and is consistent with recent changes in the forage community, especially adult rainbow smelt abundance (see Section C). Both metrics increased in 2020 to more typical values and remained steady in both 2021 and 2022. Male lake trout are typically 100% mature by age-4 and females by age-5 (Table G.2). Maturity schedules are consistent with previous surveys and remain unchanged throughout the time series.

Lake Trout Abundance

Relative abundance of lake trout sampled in standard assessment nets (all ages combined) in 2022 was 5.9 lake trout/lift (Figure G.6). This is an increase from 2021 and consistent with values between 2016–2020. This is slightly above the time-series average of 5.4 fish/lift. Very few immature lake trout (generally ≤ age 4) were sampled in standard assessment nets in 2022 (CPE = 0.25 fish/lift), continuing a declining trend in their relative abundance (Figure G.6). However, lake trout are not fully recruited to the gill nets until at least age-4, so relative abundance measures of cohorts less than age-4 typically increase at older ages. The abundance of lake trout in all nets (standard and offshore) was 6.1 fish/lift, which was an increase from 2021 but equal to 2020 indices (Figure G.6). Lake trout are typically less abundant in offshore nets compared to standard netting locations (see Markham 2020) but were more abundant in offshore nets in both 2021 and 2022.

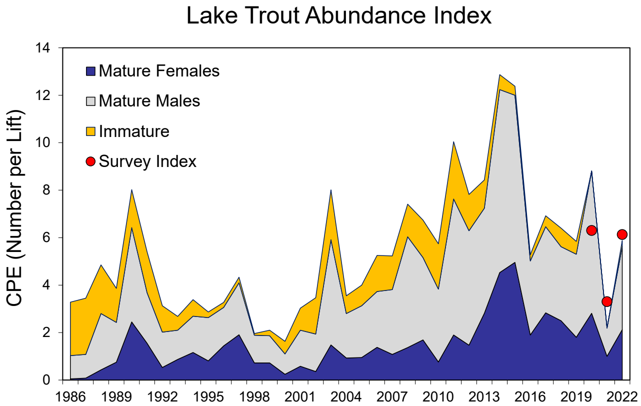

FIGURE G.6. Catch per lift (CPE) of immature and mature (by sex) lake trout caught in standard assessment gill nets from NY waters of Lake Erie, August 1986–2022. The red circles represent the CPE for all survey nets (standard plus offshore), 2020–2022.

Lake Trout Survival

Between 1983 and 2001, the Superior and Finger Lakes strains were the most consistently stocked lake trout strains in Lake Erie (see Section I) and provided the best timeline of changes in lake trout survival across a range of conditions. Prior to 1986, combined survival estimates for both strains were near or below the 60% target survival rate (Lake Trout Task Group 1985; Markham et al. 2008) due to excessive mortality from a large, untreated sea lamprey population (Table G.3). Substantial increases in survival occurred following the initial sea lamprey treatments in Lake Erie in 1986. While survival estimates have generally remained above targets for the Finger Lakes strain since 1986, the Superior strain experienced very low survival for the 1997–2001 cohorts, presumably due to increased sea lamprey predation (see Section H). Estimated Klondike strain survival was very low and was comparable to the Superior strain for the 1997–2001 year classes. Survival of the more recently stocked Lake Champlain strain (predominately Finger Lakes origin) has been above target and comparable to the Finger Lakes strain. Overall survival since 2006 has been very high and is reflected in the current age structure of the lake trout population (see Figure G.3).

Given Lake Erie's continuing sea lamprey control issues, stocking lake trout strains that survive sea lamprey attacks and consistently have above target survival rates (i.e., Finger Lakes and Lake Champlain strains) will produce a more stable adult population and provide the best opportunity for rehabilitation. The continued importance of the sea lamprey control program to lake trout rehabilitation efforts in Lake Erie cannot be overstated.

TABLE G.3. Catch curve analysis estimates of annual survival (S) by strain and year class for lake trout caught in standard assessment nets in the New York waters of Lake Erie, 1985–2022. Three-year running averages of CPE from ages 4–11 were used due to year-to-year variability in catches. Cells in red indicate survival estimates that fall below the 0.60 target rate. Asterisk (*) indicates years where only partial age ranges were available.

	STRAIN				
Year Class	**LC**	**SUP**	**FL**	**KL**	**ALL**
1983		0.687			0.454
1984		0.619	0.502		0.533
1985		0.543	0.594		0.578
1986		0.678			0.634
1987		0.712	0.928		0.655
1988		0.726	0.818		0.679
1989		0.914	0.945		0.766
1990		0.789	0.634		0.709
1991					0.615
1992					0.599
1993			0.850		0.646
1994					0.649
1995					0.489
1996			0.780		0.667
1997		0.404	0.850		0.549
1998		0.414			0.364
1999		0.323	0.760		0.431
2000		0.438	0.769		0.655
2001		0.225	0.696		0.522
2002			0.693		0.633
2003			0.667	0.242	0.585
2004				0.485	0.420
2005			0.450		0.629
2006			0.827	0.58	0.770
2007			0.835	0.619	0.791
2008	0.850		0.807	0.579	0.728
2009	0.782				0.763
2010	0.868				0.863
2011					
2012*	0.922		0.751		0.846
2013*	0.880		0.754		0.812
2014*	0.733		0.952		0.832
2015*	0.863		0.828		0.832
MEAN	**0.843**	**0.575**	**0.759**	**0.501**	**0.647**

Lake Trout Diet

Stomach content analysis of lake trout revealed a diet almost entirely comprised of fish in 2022 (Figure G.7). Rainbow smelt were the dominant prey item, occurring in 73% of the non-empty stomachs, followed by round goby (46%). Rainbow smelt remain the main prey item for lake trout, but round goby have become more common, especially in years with lower smelt abundance.

Rainbow smelt were more numerically abundant in lake trout diets compared to other fish species, averaging just over four per stomach (Figure G.8). Decreased numbers of rainbow smelt in lake trout stomachs coincided with observed lower abundances of yearling and older rainbow smelt in the 2022 fall trawling survey (see Section C). Round goby averaged 2.8 fish per stomach in 2022, which was higher than the previous two years and concurs with reduced numbers of rainbow smelt. While the presence of fish species other than rainbow smelt and round goby in lake trout diets was low in both 2021 (3%) and 2022 (3%), it is worth noting the increased presence in recent years. The majority of fish

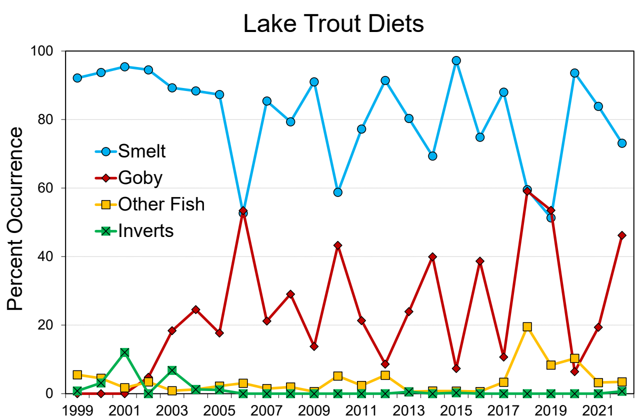

FIGURE G.7. Percent occurrence in diet of rainbow smelt, round goby, all other fish species, and invertebrates from non-empty stomachs of lake trout collected in gill nets from New York waters of Lake Erie, August 1999–2022.

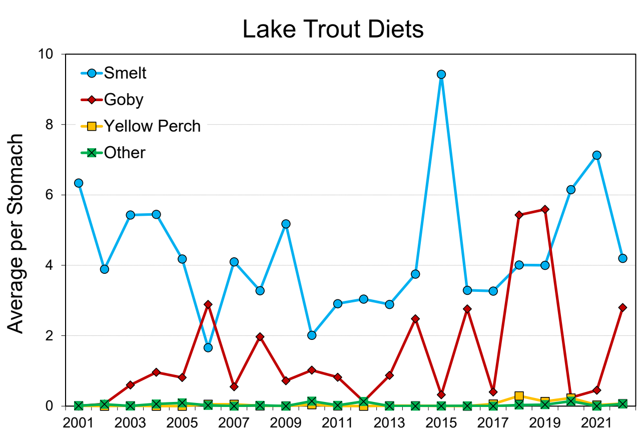

FIGURE G.8. Average number per stomach of rainbow smelt, round goby, yellow perch, and all other fish species, from non-empty stomachs of lake trout collected in gill nets from New York waters of Lake Erie, August 2001–2022.

in this category include yellow perch, gizzard shad, white perch, and white sucker.

Burbot Abundance

The burbot abundance index in the 2022 standard assessment nets was 0.19 fish/lift, which tied the lowest estimate observed in the time-series (Figure G.9). Burbot abundance has declined over 95% from a peak in 2004 and shows no signs of recovery. The abundance of burbot in all nets (standard and offshore) was 0.15 fish/lift. Previous surveys indicated similar abundances of burbot in both standard and offshore netting locations (Markham 2020). While the exact reasons for the decline of burbot in Lake Erie are unclear, it is likely related to a combination of recruitment failure (Stapanian et al. 2010; Coldwater Task Group 2016), sea lamprey predation, and competition with adult lake trout (Coldwater Task Group 2016).

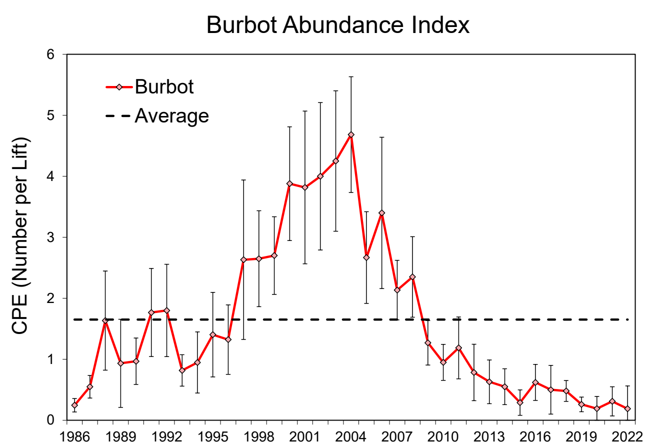

FIGURE G.9. Catch per effort (number fish/lift) and 95% confidence limits (approximated as 2 SE's) of burbot caught in standard assessment gill nets from New York waters of Lake Erie, August 1986–2022. Dashed line indicates time series average.

Lake Whitefish Abundance

Lake whitefish have exhibited highly variable catches in this survey (as depicted by large confidence limits), both within and among years. A total of 50 lake whitefish were caught in the 16 standard assessment nets in 2022, resulting in a CPE of 3.1 fish/lift (Figure G.10). This was a large decline from the previous years' time-series high abundance estimate but still above the average of 2.8 fish/lift. The lake whitefish abundance index has increased since 2015 due to several above average year classes produced since 2014 (see Section C).

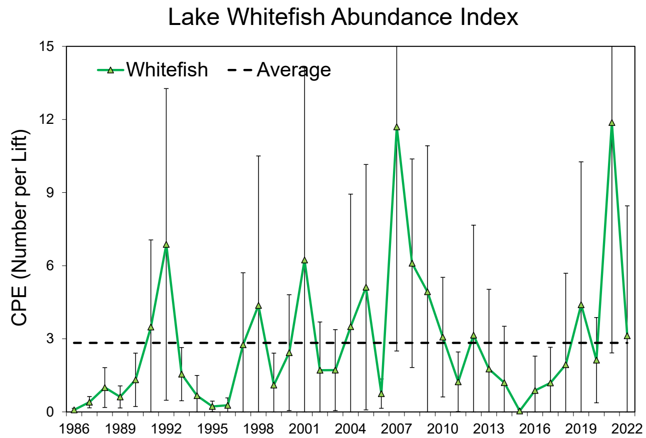

FIGURE G.10. Catch per effort (number fish/lift) and 95% confidence limits (approximated as 2 SE's) of lake whitefish caught in standard assessment gill nets from New York waters of Lake Erie, August 1986–2022. Dashed line indicates time series average.

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H. Sea Lamprey Assessment

James L. Markham

Sea lamprey invaded Lake Erie and the upper Great Lakes in the 1920's with the opening of the Welland Canal connecting lakes Erie and Ontario. While not the exclusive cause, sea lamprey predation played a major role in the eventual demise of Lake Erie's lake trout population. The initial Strategic Plan for Lake Trout Restoration in Eastern Lake Erie (Lake Trout Task Group 1985) pointed to the lack of lamprey control as an impediment to re-establishing lake trout. The Sea Lamprey Management Plan for Lake Erie (Lake Trout Task Group 1985a) followed with a set of goals to achieve sea lamprey control. Since 1986, Great Lakes Fishery Commission (GLFC) agents have conducted regular lampricide treatments of key Lake Erie tributaries to control sea lamprey populations and mitigate the damage they inflict on the lake's coldwater fish community.

This report updates long-term sea lamprey wounding rate indices on lake trout and other species through data collected by the New York State Department of Environmental Conservation's (DEC) Lake Erie Fisheries Research Unit during the annual coldwater assessment survey (see Section G). Previous monitoring of adult sea lamprey populations also included nest counts on standard stream sections; this survey was discontinued in 2019 because it was not routinely incorporated in management decisions. Other lake wide adult and larval sea lamprey assessments, and all Lake Erie sea lamprey control efforts, are performed by the United States Fish and Wildlife Service (Service) and the Department of Fisheries and Oceans Canada (DFO) as agents of the GLFC. A summary of these activities can be found in the Lake Erie Coldwater Task Group Report (Coldwater Task Group 2023).

Methods

Wounding Rate Assessment

Lake trout are the only Lake Erie fish species used for sea lamprey wounding assessments due to their availability throughout the Great Lakes and vulnerability to sea lamprey attacks. Fish are examined for wounds during August gill net assessments targeting lake trout, burbot and other coldwater species in New York's portion of Lake Erie (see Section G).

Sea lamprey wounds on lake trout are classified as A1–A4 for evidence of active feeding, and as B1–B4 wounds for non-active feeding, according to King and Edsall (1979). Standard wounding rates on lake trout are reported as the number of fresh (A1–A3) wounds per 100 fish > 21 inches. A1 and A4 wounds, specifically, are also reported as evidence of the current and previous year's wounding, respectively. Data are tabulated using lake trout total length (TL) categories: 17–21 inches, 21–25 inches, 25–29 inches, and >29 inches.

Beginning in 2013, angler survey technicians began recording wounds (fresh or healed) observed on harvested fish examined during the Open Lake Sport Fishing Survey (see Section F). These observations identify the broader list of sport fish species attacked by sea lamprey, and perhaps over time will also generate useful information to establish a wounding index for other species in the fish community.

Results and Discussion

Lake Trout Wounding Rate Assessment

Lake trout collected in coldwater assessment netting had a total of 11 A1–A3 wounds observed on 192 lake trout greater than 21 inches in 2022, resulting in a wounding rate of 5.7 wounds per 100 fish (Figure H.1; Table H.1). This represents a slight increase compared to the previous year and just above the target rate of 5.0 wounds per 100 fish (Lake Trout Task Group 1985a; Markham et al. 2008; LEC 2021). A1–A3 wounding rates in 2021 and 2022 were the lowest since 2002 and the first time since the mid-1990s that rates less than 6.0 wounds/100 fish occurred in consecutive years.

For the second consecutive year, the only A1–A3 wounds recorded occurred on lake trout >29 inches (7.7 wounds/100 fish; Table H.1). Sea lamprey will typically target larger lake trout (>24 inches) when available (Swink 2003) and the current Lake Erie lake trout

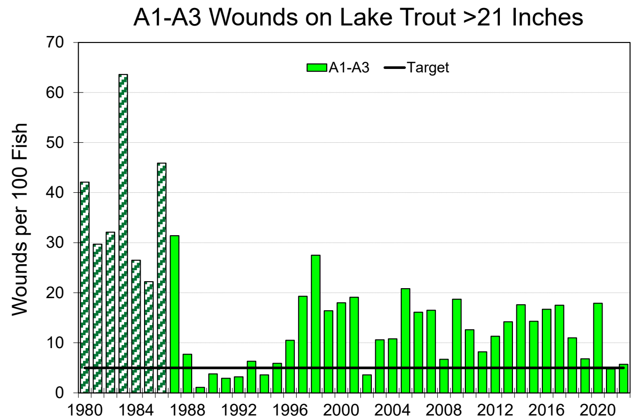

FIGURE H.1. Number of fresh (A1–A3) sea lamprey wounds per 100 adult lake trout >21 inches sampled in gill nets from New York waters of Lake Erie, August 1980–2022. The target wounding rate is ≤ 5 wounds per 100 lake trout (solid black line). Patterned bars indicate the pre-treatment period.

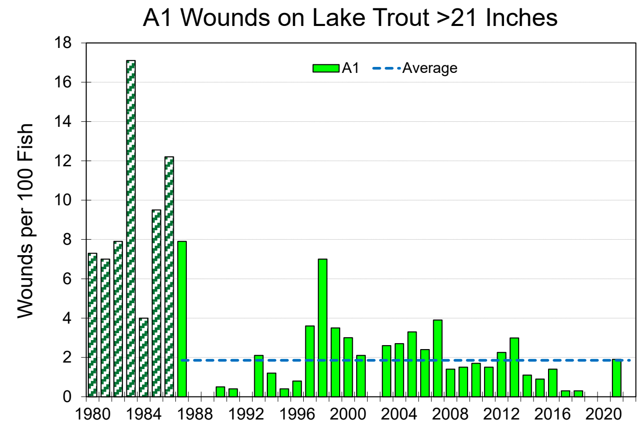

FIGURE H.2. Number of A1 sea lamprey wounds per 100 adult lake trout >21 inches sampled in gill nets from New York waters of Lake Erie, August 1980–2022. The post-treatment average includes 1987–2021 (dashed blue line). Patterned bars indicate the pre-treatment period.

TABLE H.1. Frequency of sea lamprey wounds and wounding rates observed on standard length groups of lake trout collected from gill nets in New York waters of Lake Erie, August 2022.

Size Class Total Length (inches)	Sample Size	Wound Classification A1	A2	A3	A4	No. A1-A3 Wounds Per 100 Fish	No. A4 Wounds Per 100 Fish
17-21	1	0	0	0	0	0.0	0.0
21-25	10	0	0	0	0	0.0	0.0
25-29	39	0	0	0	10	0.0	25.6
>29	143	0	3	8	121	7.7	84.6
>21	192	0	3	8	131	5.7	68.2

population is mainly comprised of large, mature fish (see Section G). Only one lake trout 17–21 inches was captured during the 2022 survey; lake trout in this size category rarely show signs of sea lamprey attacks.

Fresh A1 wounds are considered indicators of the attack rate for the current year at the time of sampling (August). No A1 wounds were found on lake trout in 2022 (Table H.1; Figure H.2). This was the third time in the past four years that no A1 wounds were detected during this survey. A1 wounding rates have been at or below the post-treatment series average of 1.9 wounds/100 fish for the past nine years.

Cumulative attacks from previous years are indicated by A4 wounds (healed). Altogether 131 A4 wounds were found on 192 lake trout >21 inches in 2022, resulting in an A4 wounding rate of 68.2 wounds/100 fish (Table H.1). This was equal to the A4 wounding rate in 2021 and the lowest measure since 2014. A4

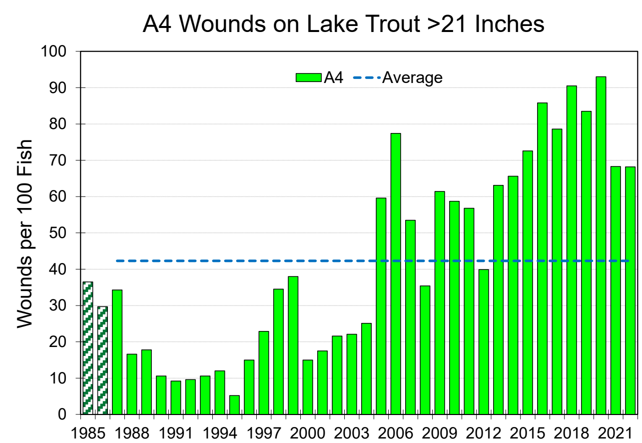

FIGURE H.3. Number of healed (A4) sea lamprey wounds observed per 100 adult lake trout >21 inches sampled in gill nets from New York waters of Lake Erie, August 1985–2022. The post-treatment average (dashed blue line) includes 1987–2021. Patterned bars indicate the pre-treatment period.

wounding rates remain above the time series average (42.3 wounds/100 fish) for the 16th time in the past 18 years (Figure H.3). All A4 wounds were found on lake trout greater than 25 inches (Table H.1). A4 wounding rates on lake trout >29 inches remain very high (84.6 wounds/100 fish) with many fish having multiple healed wounds.

Over the past decade numbers of observed healed wounds (A4) on lake trout have increased without an observed increase in fresh wounds (A1–A3). Reasons for the decoupling of the fresh and healed wounding trends are not well understood. Changes in the areas where sea lamprey are mainly produced in Lake Erie (from east basin streams to the St. Clair River in the west basin) may be a contributing factor. Increased sea lamprey production in western Lake Erie may delay predation on eastern basin lake trout until after our August survey. A delay in timing of predation could cause an increase in healed wounding without observed increases in fresh wounds. Another possible explanation is the change in lake trout strain composition. Since 2002 there has been a gradual transition away from stocking Lake Superior strain lake trout, which are highly susceptible to sea lamprey induced mortality in Lake Erie, towards lake trout strains (i.e., Finger Lakes, Lake Champlain strains) that are better able to survive sea lamprey attacks (Schneider et al. 1996; see Section G). A decrease in mortality due to sea lamprey attacks could cause increases in the prevalence of healed wounds without concomitant increases in fresh wounds.

Lake Champlain (LC) and Finger Lakes (FL) were the most prevalent lake trout strains sampled in 2022 (Table H.2). Consistent with results from the previous four years, both A1–A3 and A4 wounding rates were similar between these strains. The FL and LC strains are genetically very similar to each other (T. Copeland, USFWS, personal communication) and appear to survive sea lamprey attacks at similar rates. Sample sizes on other captured lake trout strains were too low ($N \leq 2$) to provide meaningful measures of wounding. However, previous survey results have shown that, in general, Superior lake trout strains such as Klondike, Slate Island and Traverse Island have higher wounding rates compared to the Finger Lakes strain (Markham 2011; Markham 2014; Rogers et al. 2019). Interestingly the highest A1–A3 wounding rate (27.8 wounds/100 fish) occurred from the 18 lake trout that could not be identified to a strain, mainly due to missing coded-wire tags.

TABLE H.2. Frequency of sea lamprey wounds observed on lake trout >21 inches, by strain, in New York waters of Lake Erie, August 2022.

Lake Trout Strain	Sample Size	Wound Classification A1	A2	A3	A4	No. A1-A3 Wounds Per 100 Fish	No. A4 Wounds Per 100 Fish
Finger Lakes	78	0	0	2	53	2.6	67.9
Huron-Parry Sound	1	0	0	0	0	-----	-----
Lake Champlain	91	0	2	2	54	4.4	59.3
Klondike	2	0	0	0	5	-----	-----
Slate Island	2	0	0	0	1	-----	-----
Unidentified	18	0	1	4	18	27.8	100.0

Trends in recent years have shown an improvement in wounding rates towards the benchmarks recommended in the Lake Erie Lake Trout Rehabilitation Plan (Markham et al. 2008; LEC 2021). Strains better able to survive sea lamprey attacks, such as the Lake Champlain and Finger Lakes strains, should continue to be used exclusively to achieve rehabilitation goals. These strains are also well suited to take advantage of the nearshore spawning habitat historically available in Lake Erie.

Open Lake Sport Fishing Survey

Only one healed sea lamprey wound was observed by creel survey technicians examining 1,798 angler kept sport fish during the 2022 Open Lake Sport Fishing Survey (Table H.3). The majority (1,403; 78%) of the examined fish were walleye and yellow perch (364; 20%). The observed wound was on a channel catfish. Observations from this survey over the past ten years have shown that sea lamprey attack warm and cool-water species such as smallmouth bass, walleye, and northern pike, and confirm that sea lamprey have the potential to affect Lake Erie's entire fish community.

TABLE H.3. Number of recorded wounds (fresh or healed) on fish examined during the Open Lake Sport Fishing Survey, May–October 2022.

Species	Wounds Observed: Fresh	Wounds Observed: Healed	Number of Fish Examined
Channel Catfish	0	1	3
Smallmouth Bass	0	0	7
Steelhead	0	0	8
Brown Trout	0	0	3
White Bass	0	0	2
Yellow Perch	0	0	364
Walleye	0	0	1403
Lake Trout	0	0	8

Future Control Efforts

Sea lamprey control continues to be an integral part of the management and rehabilitation goals for coldwater fish species in the Lake Erie Fish Community Goals and Objectives (Francis et al. 2020). Despite lake trout wounding rates near target levels, continued suppression of sea lamprey is essential for lake trout rehabilitation and for maintaining the coldwater fish community as a functioning part of the Lake Erie food web.

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I. SALMONINE STOCKING SUMMARY

James L. Markham and Michael T. Todd

New York has maintained a robust annual stocking program for salmonines (trout and salmon) into Lake Erie and its tributaries at least since 1968 when the first coho salmon were introduced. Initial introductions were made to create a recreational fishery and to utilize the lake's sparsely inhabited hypolimnion (below the thermocline). One exception is lake trout, which have been stocked by the US Fish and Wildlife Service (USFWS) since the mid-1970's to re-establish this native species. Coho and Chinook salmon are no longer stocked into Lake Erie by any jurisdiction and most of the lake wide stocking effort focuses on steelhead and lake trout.

The number of fish stocked is expressed as yearling equivalents; the majority of the salmonines stocked in Lake Erie are stocked at the yearling (one year old) life stage. However, in some years surplus fish become available and are typically stocked as fall fingerlings (~ 6 months old). In this instance, fall fingerlings are converted to yearling equivalents based on a lake wide standard of 0.03527 yearlings per fall fingerling for steelhead and brown trout (unpublished data), and 0.41 yearlings per fall fingerling for lake trout (B. Lantry, USGS, unpublished data).

Results and Discussion

A total of 308,935 salmonines were stocked into the New York waters of Lake Erie in 2022 (Table I.1). The majority (263,935; 85%) were stocked as yearlings with the remainder being fall fingerlings. Stocking was near targets for all species in 2022. However, the overall combined stocking of salmonines in yearling equivalents in 2022 was below average compared to the previous 33 years of the time-series due to stocking policy changes over time.

<u>Steelhead/Rainbow Trout</u>

A total of 139,835 yearling steelhead/rainbow trout were stocked into the Lake Erie tributaries from the Salmon River State Fish Hatchery (SRSFH; Tables I.1 and I.2; Figure I.1). This was slightly below the stocking target of 142,500 yearlings. It should be noted that the stocking target for steelhead declined from 255,000 to 142,500 (44%) yearlings in 2020. The reduction was necessary to accommodate an experimental approach initiated by SRSFH staff with guidance from Vermont's Ed Weed Fish Culture Station to determine if improvements in average length and overall length distribution of spring yearling steelhead could be achieved (Markham et al. 2023). This experimental approach followed the management recommendations of Markham and Robinson (2021) with the goal of improving adult returns and providing increased stability to New York's tributary steelhead fishery. Following three years of experimental rearing techniques, significant increases in both average length and weight of yearling stocked fish were achieved, resulting in a more consistent (i.e., less variation in size) stocked product which equaled or surpassed the effective stocking number (i.e., fish > 6.0 inches) despite stocking nearly half the number of fish (Markham et al. 2023). Hatchery staff determined that grading, growing the fish as large as possible inside, and supplementing the outdoor raceways with warmer inside water during the colder winter months were the most important changes. However, length ranges and length frequency distributions indicated a maximum growth ceiling, most likely due to limitations in water quality and quantity at the hatchery. Unless improvements can be made, these limitations will continue to hinder the growth potential of the steelhead and limit the effectiveness of the revised hatchery techniques.

A total of 45,000 fall fingerling domestic rainbow trout raised at the Bath State Fish Hatchery were stocked in 2022, which equaled the stocking target (Table I.1; Figure I.1). This was the fifth year of stocking fall fingerling domestic rainbow trout into the Lake Erie tributaries as replacements for yearling brown trout. Brown trout stocking was terminated because the most recent 16-year brown trout stocking effort failed to produce a reliable lake, harbor, or tributary fishery based on angler surveys (Markham and Todd 2018).

The domestic rainbow trout were stocked into New York's four largest streams (Cattaraugus, Eighteen Mile, Canadaway, and Chautauqua Creeks) near the end of October. Due to their large size at stocking (average = 7.0 inches), the fall fingerling domestic rainbow trout were considered yearlings in Figure I.1. In addition to the fall fingerlings, 5,000 yearling domestic rainbow trout from Caledonia State Fish Hatchery were stocked into Eighteen Mile Creek in early April (Table I.1).

Lake Trout

A total of 119,100 yearling lake trout were stocked into the New York waters of Lake Erie in 2022 (Table I.1). Most of the lake trout were stocked offshore of Dunkirk in 70 feet of water from the R/V Argo, however 9,900 fish were shore stocked in Barcelona Harbor due to a boat malfunction. Lake trout were also stocked into the Ohio (79,800 yearlings) and Ontario (74,866 yearlings) waters of Lake Erie in 2022. No lake trout were stocked into the Pennsylvania waters of Lake Erie in 2022 due to a new rotational stocking plan outlined in the revised Lake Trout Rehabilitation Plan (LEC 2021). Pennsylvania is scheduled to receive approximately 120,000 yearling lake trout in 2023. The combined total of 273,766 yearlings was near Lake Erie's Lake Trout Rehabilitation Plan (LEC 2021) annual stocking target of 280,000 yearlings (Figure I.2). Lake trout stocking targets on Lake Erie have been approached or exceeded in 13 of the past 15 years.

Cooperative Net Pen Project

A cooperative pen-rearing project pursued in partnership with the Bison City Rod and Gun Club in the lower Buffalo River continued in 2022. A total of 7,500 unmarked yearling steelhead were stocked into two floating net pens on April 1st and released on April 23rd. Steelhead weights during the 22-day pen period began at 16.7 fish/lb and ended at 13.2 fish/lb—a 21% increase. Average size of the steelhead increased from 5.5 to 6.0 inches. Water temperature at release was 52 °F. Club members reported that fish mortality in the pens was negligible (~25 fish; 0.3%). This was the 16th year of the project, which is scheduled to continue in 2023.

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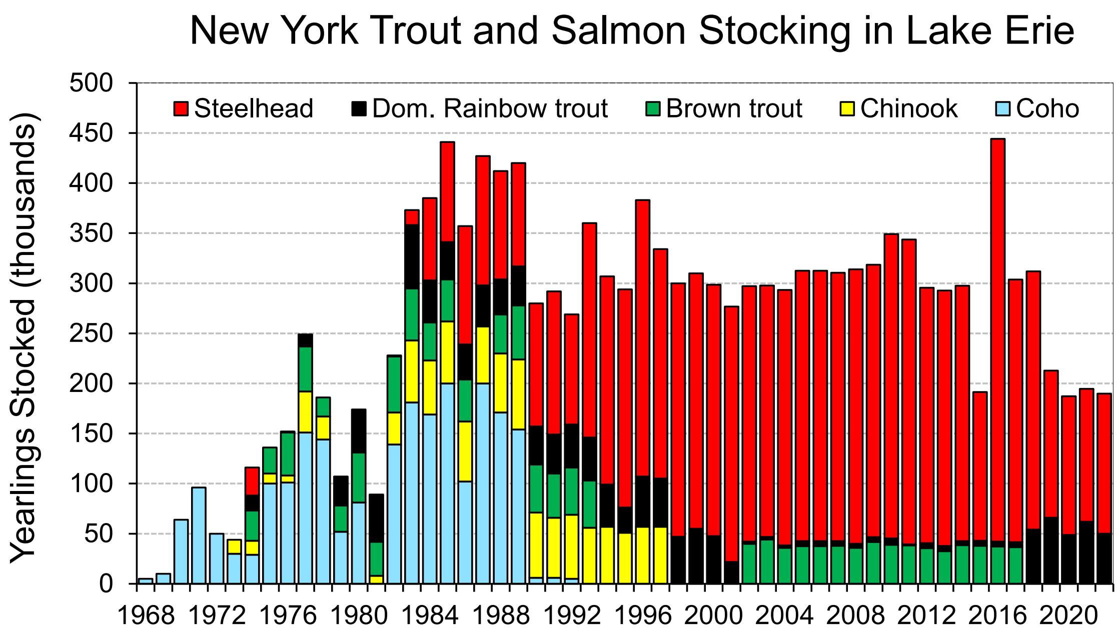

FIGURE I.1. Number (in yearling equivalents) of coho and Chinook salmon, brown trout, and rainbow trout (domestic and steelhead) stocked in New York waters of Lake Erie, 1968–2022. 1 fall fingerling = 0.035 yearling equivalents. Fall fingerling domestic rainbow trout stocked in 2018–2022 were considered yearlings due to their relatively large size at stocking.

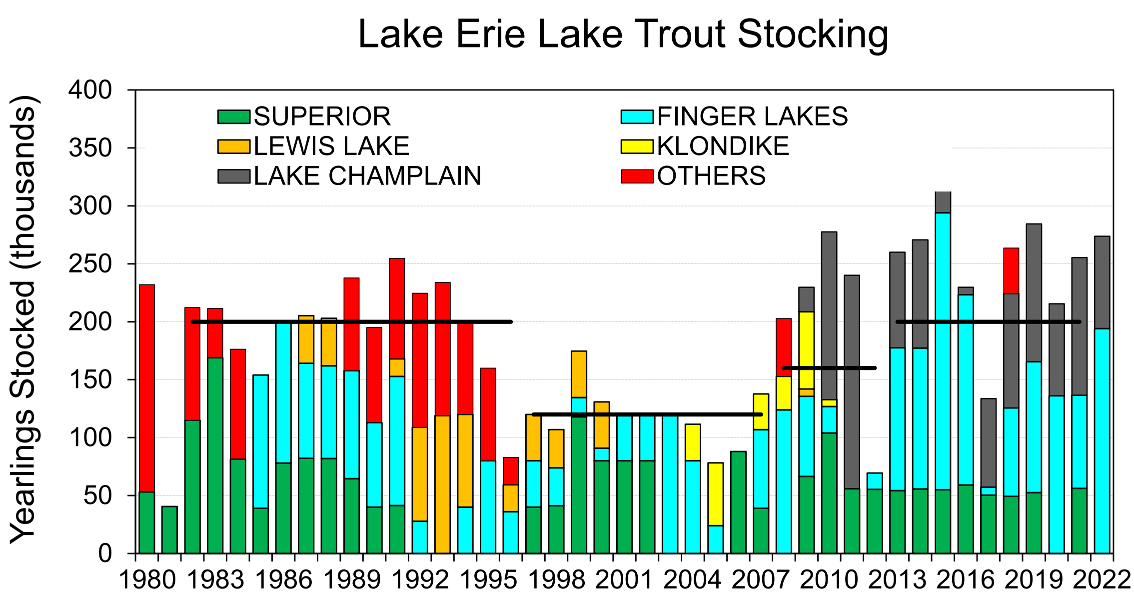

FIGURE I.2. Number (in yearling equivalents) of lake trout stocked by all jurisdictions in Lake Erie, 1980–2022, by strain. Stocking targets through time are shown by black lines; the current annual stocking target is 280,000 yearlings. "Superior" includes Superior, Apostle Island, Traverse Island, Michipicoten, and Slate Island strains; "Others" include Clearwater Lake, Lake Ontario, Lake Erie, Lake Manitou, and Huron-Perry strains. 1 fall fingerling = 0.41 yearling equivalents.

TABLE I.1. Summary of trout stocking in New York waters of Lake Erie in 2022. Months indicates the number of months fish spent in the hatchery prior to stocking.

Species	Location	Date	Year Class	Hatchery	Strain	Months	Stage	#/lb.	Clip/Mark	Number	Target
Lake Trout	Dunkirk Harbor	5/2/2022	2021	ANFH	SLW	16	Ylg	15.8	640991	39,900	40,000
Lake Trout	Dunkirk Harbor	5/3/2022	2021	ANFH	SLW	16	Ylg	14.1	640989	29,700	40,000
Lake Trout	Barcelona Harbor	5/3/2022	2021	ANFH	SLW	16	Ylg	14.1	640989	9,900	-----
Lake Trout	Dunkirk Harbor	5/4/2022	2021	ANFH	LCD	16	Ylg	12.7	640999	39,600	40,000
Lake Trout Totals										**119,100**	**120,000**
Rainbow Trout	Canadaway Creek	3/22/2022	2021	SRSFH	Washington	12	Ylg	16.2	None	10,000	10,000
Rainbow Trout	Chautauqua Creek	3/22/2022	2021	SRSFH	Washington	12	Ylg	16.2	None	20,000	25,000
Rainbow Trout	Silver Creek	3/22/2022	2021	SRSFH	Washington	12	Ylg	16.2	None	5,000	5,000
Rainbow Trout	Walnut Creek	3/22/2022	2021	SRSFH	Washington	12	Ylg	16.2	None	5,000	5,000
Rainbow Trout	Cattaraugus Creek	4/1/2022	2021	SRSFH	Washington	12	Ylg	16.8	None	37,635	60,000
Rainbow Trout	Eighteen Mile Creek	3/23/2022	2021	SRSFH	Washington	12	Ylg	16.2	None	20,000	20,000
Rainbow Trout	Buffalo Creek	4/1/2022	2021	SRSFH	Washington	12	Ylg	16.7	None	5,000	5,000
Rainbow Trout	Cayuga Creek	4/1/2022	2021	SRSFH	Washington	12	Ylg	16.7	None	5,000	5,000
Rainbow Trout	Buffalo River Net Pens	4/23/2022	2021	SRSFH	Washington	13	Ylg	13.8	None	7,500	7,500
Rainbow Trout	Cattaraugus Creek	5/9/2022	2021	SRSFH	Washington	12	Ylg	24.6	None	24,700	-----
Rainbow Trout	Eighteen Mile Creek	4/4/2022	2021	CSFH	Domestic	16	Ylg	3.3	None	5,000	5,000
Rainbow Trout	Canadaway Creek	10/26/2022	2022	BSFH	Domestic	10	FF	8.3	None	10,000	10,000
Rainbow Trout	Chautauqua Creek	10/26/2022	2022	BSFH	Domestic	10	FF	8.3	None	10,000	10,000
Rainbow Trout	Cattaraugus Creek	10/27/2022	2022	BSFH	Domestic	10	FF	7.5	None	15,000	15,000
Rainbow Trout	Eighteen Mile Creek	10/27/2022	2022	BSFH	Domestic	10	FF	7.5	None	10,000	10,000
Rainbow Trout Totals											
	Steelhead Yearlings (Washington Strain)									**139,835**	**142,500**
	Domestic Rainbow Trout Fall Fingerlings (Randolph Strain)									**45,000**	**45,000**
	Domestic Rainbow Trout Spring Yearlings (Randolph Strain)									**5,000**	**5,000**
TOTAL ALL SPECIES			**Yearlings**							**263,935**	**267,500**
			Fall Fingerlings							**45,000**	**45,000**

Hatchery Codes: RSFH - Randolph State Fish Hatchery; CSFH - Caledonia State Fish Hatchery; SRSFH - Salmon River State Fish Hatchery
ANFH - Allegheny National Fishery Hatchery; BSFH - Bath State Fish Hatchery

TABLE I.2. Approximate numbers (in thousands of fish) of salmon and trout planted in New York waters of Lake Erie,1970-2022. Lake trout numbers include those stocked in Pennsylvania, Ontario, and Ohio waters. Totals do not include spring fingerling or fry stockings.

	YEAR																										
Species/ Type	**1970**	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**	**1977**	**1978**	**1979**	**1980**	**1981**	**1982**	**1983**	**1984**	**1985**	**1986**	**1987**	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**
Coho Y	64	96	50	30	29	100	87	149	144	50	81	0	139	181	169	200	102	200	169	148	0	0	0	0	0	0	0
Coho F	0	0	0	0	0	0	390	50	0	50	0	0	0	0	0	0	0	0	38	180	163	161	76	0	0	0	0
Coho f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	80	0	0	0	200	0	0	0	0
Chin f	0	0	0	125	125	85	65	362	206	0	0	71	280	550	478	547	529	500	520	620	574	525	565	497	500	500	500
Lake Y	0	0	0	0	0	0	0	0	236	201	41	41	196	205	176	154	199	205	203	213	195	206	225	217	200	160	82.9
Lake F	0	0	0	0	0	150	186	125	0	508	474	0	39	17	0	0	0	0	0	60	0	127	0	42	0	82	0
Lake fry	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	150	0	0	150	200	0	0
Lake adt	0	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0.1	0	0	0	0	0	0	0	0	0	0	2.7	1
Brown Y	0	0	0	0	28	0	42	42	0	26	50	34	53	50	38	42	40	0	38	53	47	44	47	47	0	0	0
Brown F	0	0	0	0	60	26	25	81	0	0	0	0	85	50	0	0	50	0	22	42	37	0	0	0	0	0	0
Brown f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0
Rbow Y	0	0	0	0	15	0	0	12	19	29	43	46	0	61	39	34	32	41	34	38	37	39	43	43	42	2.5	42.5
Rbow F	0	0	0	0	0	0	25	0	0	0	0	40	0	50	28	32	49	0	22	25	38	0	0	0	0	21	0
Rbow f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	110	120	148	0	0	0	0	0	0	0	0	0	90.6
Rbow adt	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Sthd Y	0	0	0	0	28	0	0	0	0	0	0	0	0	15	81	100	118	270	107	103	121	143	105	214	208	218	274.8
Sthd F	0	0	0	0	0	0	0	0	0	0	0	0	37	0	38	0	0	0	0	13	48	0	130	0	0	0	20
TOTAL	**64**	**96**	**50**	**155**	**285**	**361**	**820**	**821**	**605.1**	**864**	**689**	**232**	**829**	**1179**	**1157.1**	**1229**	**1267**	**1216**	**1253**	**1495**	**1260**	**1245**	**1391**	**1060**	**951**	**986.2**	**1011.8**

	YEAR																									
Species/ Type	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
Coho Y	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coho F	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Coho f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chin f	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake Y	120	107	158	128	120	120	120	111.6	54.2	88	137.6	202.8	223.3	277.7	234.3	55.3	260	230.1	246.6	218.7	126.7	247.3	251.5	198.6	255.3	273.8
Lake F	0	0	40.5	7	0	0	0	0	58.4	0	0	0	0	0	0	123.7	0	99.1	81.7	26.9	17	40	40	41	0	0
Lake fry	301	81	0	262.7	130.2	283.5	109.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake adt	0	0	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown Y	0	0	0	0	0	38.7	43.4	36	37.4	37.5	37.9	36	37.6	37.5	38.1	35.5	32.6	38.5	37.8	38.1	36.5	0	0	0	0	0
Brown F	0	0	0	0	0	33.6	39.5	0	0	0	0	0	25	0	7.4	0	0	5	0	0	0	0	0	0	0	0
Brown f	0	0	0	0	35	0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0
Rbow Y	46.9	47	55.3	47.5	21.3	2.2	2.5	2.4	5	5	4.5	5	4.7	4.9	1	5	5	4	5	5	5	4.4	5	3.8	17	5
Rbow F	0	0	0	0	0	0	0	0	0	0	0	0	0	46	15	0	0	0	0	0	0	49.8	61	45	45	45
Rbow f	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rbow adt	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sthd Y	228	253	255	250.8	255	255	251.3	255	270	270	268	265	272	303.7	304.3	255	255	255	147.5	401.2	255	255	146.8	138.5	132.6	139.8
Sthd F	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30	25	203	76.3	0	0	0	0
TOTAL	**1019.1**	**407**	**509.8**	**433.5**	**431.3**	**449.5**	**456.7**	**405**	**425**	**400.5**	**448**	**508.8**	**562.6**	**709.8**	**600.1**	**474.5**	**552.6**	**631.7**	**548.6**	**714.9**	**643.2**	**672.8**	**504.3**	**426.9**	**449.9**	**463.6**

Legend: Y=Standard stocked yearling; F=Fall fingerling; f=Spring fingerling; fry=Advanced yolk-sac/swim-up fry; adt=Surplus broodstock

J. Lower Trophic Level Monitoring Program

James L. Markham and Kristen T. Holeck (Cornell University)

In 1983, the Lake Erie Fisheries Research Unit began a lower trophic level monitoring program as part of a broader statewide effort. Three nearshore sites were initially sampled (Barcelona, Dunkirk, and Buffalo) once a month from May through September for water transparency (Secchi depth), water temperature, and zooplankton. In 1988, sampling efforts shifted to two sites off Dunkirk—one nearshore and one offshore—with sampling frequency increased to two-week intervals (Figure J.1).

In 1999, a lakewide lower trophic level assessment program was initiated (Forage Task Group 2023). A total of 18 stations in Lake Erie, three offshore and three inshore in each of three basins, were established to gain an understanding of lakewide ecosystem trends and monitor lake productivity. Standard measurements included water temperature, dissolved oxygen, water transparency, total phosphorus, chlorophyll *a*, and zooplankton size, density, and species composition. Results from New York's stations are merged with those from other jurisdictions and reported in the inter-agency Forage Task Group annual report (Forage Task Group 2023).

Lake Erie's bi-national fish community goals and objectives for the nearshore eastern basin target mesotrophic conditions consistent with maintaining a stable cool-water percid (walleye and yellow perch) community (Francis et al. 2020). Within this mesotrophic state, summer water transparencies should range between 3–6 m (10–20 feet), total phosphorus between 9 and 18 µg/L, and chlorophyll *a* between 2.5 and 5.0 µg/L (Leach et al. 1977). Fish community objectives for the offshore waters of the eastern basin target oligotrophic conditions consistent with maintaining a stable salmonid fish community: transparency > 6 m (20 feet); total phosphorus < 9 µg/L; chlorophyll *a* < 2.5 µg/L. Ongoing monitoring of these parameters in nearshore and offshore habitats is used to assess whether these key trophic state indicators remain consistent with Lake Erie's fish community Goals and Objectives.

FIGURE J.1. Location of nearshore (36 ft) and offshore (90 ft) lower trophic sampling sites monitored by the NYSDEC's Lake Erie Unit between May and September annually.

Methods

Samples are collected at fixed shallow (36 ft) and deep (90 ft) sites adjacent to Dunkirk (Figure J.1) every two weeks from May through September, totaling 11 to 12 sampling events annually. In 2021 the location of the deep site was moved from the 70 ft to the 90 ft depth contour to ensure more consistent sampling of the thermocline during the summer months. Paired sampling used to evaluate this change in 2018 and 2019 did not identify major differences between sites. During each site visit, water depth, date, and time of day are recorded along with weather conditions such as cloud cover and wind speed. Water transparency is measured to the nearest 0.5 meter (1.6 ft) using a Secchi disk. A YSI Pro DSS meter is used to measure temperature and dissolved oxygen at one meter depth increments and to determine the thermocline depth. Composite water samples are collected above the thermocline for chlorophyll *a* and phosphorus. A zooplankton sample is obtained by vertically retrieving a 0.5 m (1.6 ft), 64 µm conical plankton net starting above the thermocline (epilimnion) or from one meter off the bottom if no thermocline is detected. Zooplankton, chlorophyll *a*, and phosphorus sample processing is outsourced.

To produce a single metric of trophic condition, a trophic state index (TSI; Carlson 1977) is calculated which merges three independent variables. This index uses algal biomass as the basis for trophic state classification, independently estimated using measures of chlorophyll *a*, transparency, and total phosphorus. Each independent measure is combined and the average of the three indices reflects a trophic state value for that site and sampling event. The median value of the combined daily indices is used to determine an annual index for each site. Because the number generated is only a relative measure of the trophic conditions and does not define trophic status, this index was calibrated to accepted Lake Erie ranges for values of total phosphorus, chlorophyll *a*, and transparency (Leach et al. 1977) that have long been used to assess trophic conditions. In these terms, oligotrophic was determined to have a TSI < 36.5, mesotrophic between 36.5–45.5, eutrophic between 45.5–59.2, and hyper-eutrophic >59.2.

Results and Discussion

A total of 9 scheduled sampling dates were completed between May 6th and September 30th, 2022. One scheduled sampling date in August and one in September were missed due to conflict with an ongoing survey.

Surface Water Temperature

The average summer (June–August) surface water temperature with each month equally weighted was calculated for the offshore station by year (Figure J.2). Summer surface temperature should provide an index of relative system production and growth rate potential for warm water fishes, assuming prey resources are not limiting. Average summer surface water temperatures ranged from 66.9 °F in 2000 to 72.8 °F in 2010. The average summer surface water temperature in 2022 was 71.5 °F, which was the fourth highest in the time series and above the average (69.8 °F).

More robust long-term measures of water temperature are also available for the east basin of Lake Erie. Average daily water temperatures have been recorded at the Buffalo Water Treatment Plant (BWTP) since 1927 (NOAA 2023). Water temperatures at this site are taken at the entrance to the upper Niagara River at 30 ft. A continuous water temperature series is also available from the Dunkirk Water Treatment Plant (DWTP) since 1980. Water temperatures from this site are taken from Lake Erie at 29 ft. At both locations, daily water temperatures are the average of four separate measurements over a 24-hour period.

In 2022, average summer water temperature (June–August) at the DWTP was 71.7 °F, the fourth highest summer temperature in the 43-year time series (Figure J.2). Long term trends show increasing summer water temperatures at the DWTP intake. With a few exceptions, water temperatures and general trends are similar between NYSDEC surface temperature observations and near bottom temperature measurements taken at the DWTP between 1999 and 2022. At the BWTP intake, average summer water temperature in 2022 was 71.0 °F, the 11th highest (89th percentile) in the 96-year series and above the series

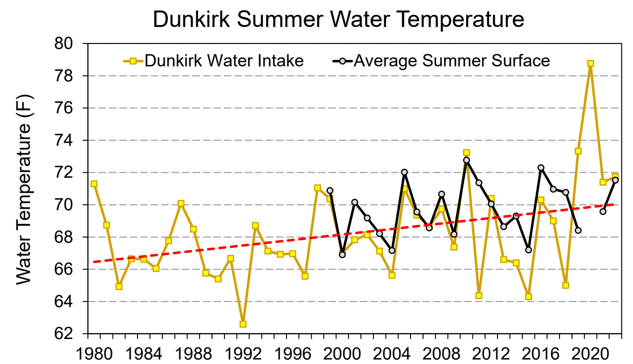

FIGURE J.2. Average summer (June–August) Lake Erie surface water temperature (°F), weighted by month, at an offshore (90 ft) site at Dunkirk, NY, 1999–2022 and at an intake pipe (29 ft) for the Dunkirk Water Treatment Plant, 1980–2022. The time series trend for the Dunkirk Water Intake is also shown (dashed red line).

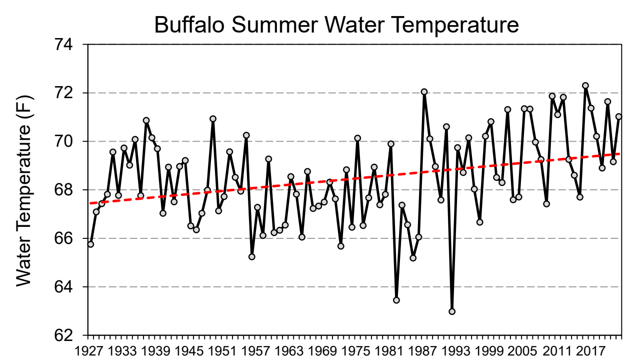

FIGURE J.3. Average summer (June–August) water temperature (°F) recorded at the Buffalo Water Treatment Plant, 1927–2022. The intake pipe is located at a depth of 30 feet at the entrance to the Upper Niagara River. The time series trend is also shown (dashed red line).

summer average of 68.4 °F (Figure J.3). Long term trends at the BWTP also show gradually increasing summer water temperatures.

Bottom Dissolved Oxygen

Dissolved oxygen (DO) levels less than 2 mg/L are considered stressful to fish and other aquatic biota (Craig 2012; Eby and Crowder 2002). Hypolimnetic DO can become low when the water column becomes stratified, which can begin as early as June and continue through September in the eastern basin. However, hypolimnetic DO is rarely limiting in Lake Erie's eastern basin due to a deep hypolimnion layer, relatively low productivity, and cooler water temperatures (Forage Task Group 2023).

DO measurements have only been collected since 2007 at the Dunkirk site and some of those years have few or no observations due to equipment malfunctions (Figure J.4). Bottom summertime measurements taken in 2022 ranged from 5.6–9.2 mg/L oxygen, well above the 2.0 mg/L threshold (Figure J.4). DO measures below the 2.0 mg/L level at New York's offshore sampling site have never been observed. The 5.6 mg/L measurement taken on August 24th was the third lowest DO recorded in the time series (lowest was 4.3 mg/L in 2009).

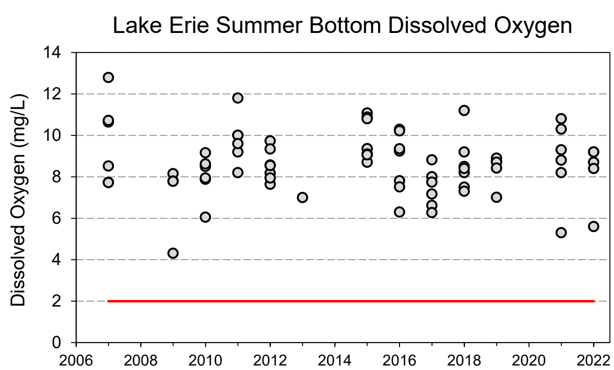

FIGURE J.4. Summer (June–August) Lake Erie bottom dissolved oxygen (mg/L) readings at an offshore (90 ft) site at Dunkirk, NY, 2007–2022. 2.0 mg/L line represents the level at which oxygen becomes limiting for many temperate fishes. No readings were taken in 2008, 2014, or 2020.

Phosphorus

Total phosphorus (TP) levels throughout Lake Erie have generally stabilized over the past decade (Forage Task Group 2023). Modest increases have been evident at New York's nearshore and offshore sites over this time series, and similar patterns have been evident between sites (Figure J.5). However, in 2022 a divergent pattern existed between the nearshore and offshore sites with average TP levels increasing at the nearshore site (12.2 µg/L; 2nd highest in time series) but sharply decreasing at the offshore site (5.5 µg/L; 3rd lowest in time series). The increase at the nearshore site was influenced by a particularly high TP reading (39.1 µg/L) recorded on August 24th.

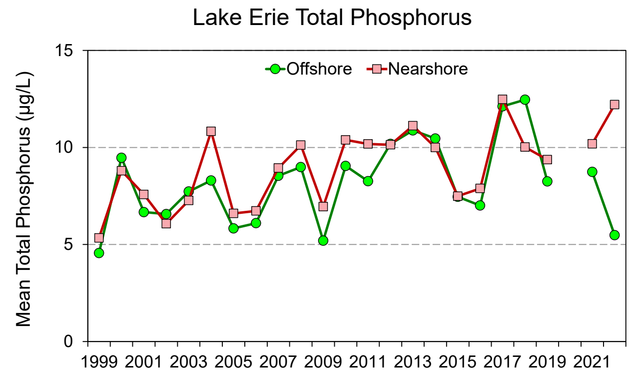

FIGURE J.5. Average total phosphorus (µg/L), weighted by month, at nearshore (36 ft) and offshore (90 ft) Lake Erie sites at Dunkirk, NY, 1999–2022. No data were recorded in 2020.

Water Transparency

Transparency has been measured annually since the 1983 in nearshore waters, and since 1988 in offshore waters. This long-term data series documents changes in water transparency that accompanied the invasion of dreissenid mussels into eastern Lake Erie in 1990. By 1992, summer water transparency increased in both nearshore and offshore sites to over 25 feet (Figure J.6). Transparency in the nearshore waters began to decrease by the late-1990s, perhaps in response to the invasion of round goby, a prolific consumer of dreissenids (e.g., zebra mussels), into eastern Lake Erie. Water transparency has been generally stable for the past fifteen years but has remained consistently higher in the offshore waters.

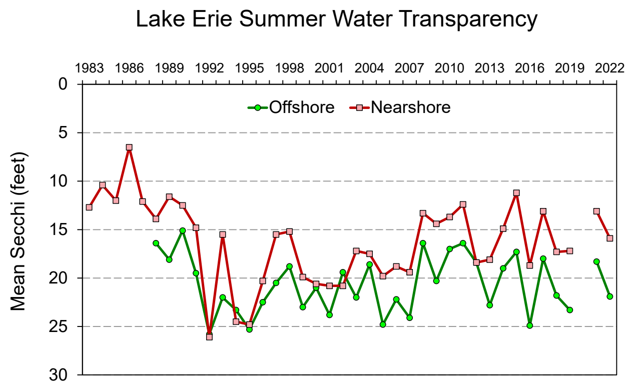

FIGURE J.6. Average summer (June–August) Lake Erie transparency (feet), weighted by month, at nearshore (36 ft) and offshore (90 ft) sites at Dunkirk, NY, 1983–2022. Note that the shallowest depths are at the top of the y-axis and deepest at the bottom. No data were recorded in 2020.

Chlorophyll a

Chlorophyll *a* concentration is an indicator of phytoplankton biomass, ultimately representing primary production. Trends in chlorophyll *a* have been similar between nearshore and offshore sites throughout this time series (Figure J.7). Chlorophyll *a* concentration decreased in 2007 and exhibited an increasing trend beginning in 2013. Measures in both 2018 and 2019 declined from a peak observed at both sites in 2017 but increased again in 2021. In 2022, chlorophyll *a* measures decreased slightly from the previous years' time series high at the offshore site (2.24 µg/L; 3rd highest in time series) but increased sharply at the nearshore site to a time series high of 3.07 µg/L. Similar to TP, an unusually high chlorophyll *a* measure was recorded on August 24th at the nearshore site that influenced the average.

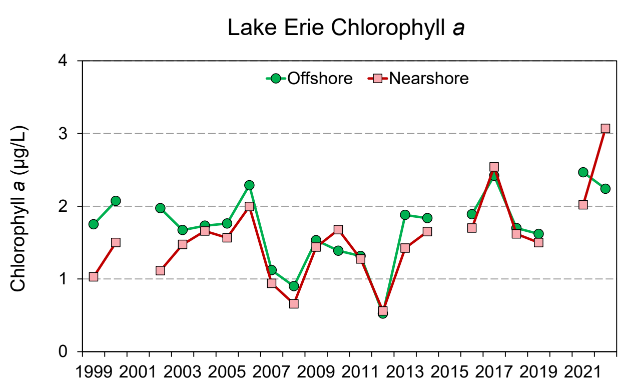

FIGURE J.7. Average chlorophyll *a* (µg/L), weighted by month, at nearshore (36 ft) and offshore (90 ft) Lake Erie sites at Dunkirk, NY, 1999–2022. Measures are not available in 2001, 2015, and 2020.

Trophic State Index (TSI)

Trophic state index (TSI) trends at the nearshore site indicate that median TSI values were mostly below the targeted mesotrophic range in the early years of the time series but have generally increased into the targeted mesotrophic zone since the late-2000s (Figure J.8). The median nearshore TSI value in 2022 was 36.0, which was just below the targeted mesotrophic range. At the offshore site, TSI values have been slightly more consistent and have largely remained within the targeted oligotrophic range. The median offshore TSI value in 2022 was 33.6, falling within the targeted oligotrophic range. Worth noting is the large range of values in 2022, especially at the nearshore site. Functionally there remains little difference between the nearshore and offshore TSI values and both have exhibited gradual increases over time as indicators of productivity have increased in the New York portion of Lake Erie.

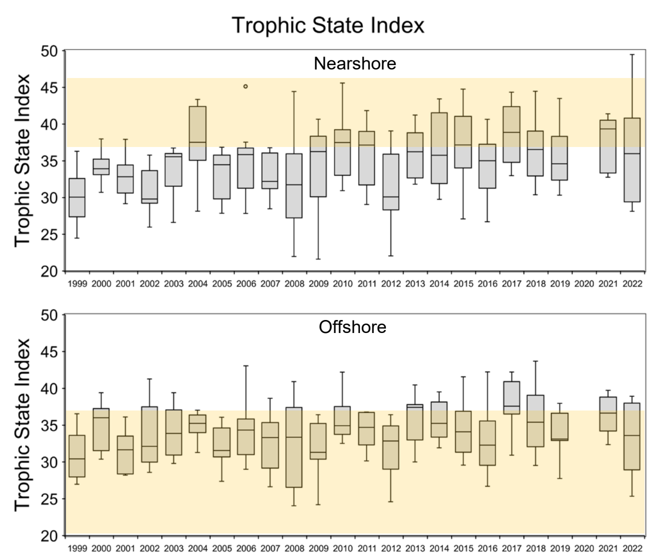

FIGURE J.8. Box and whisker plot of trophic state indices (TSI) at nearshore (36 ft; top panel) and offshore (90 ft; bottom panel) Lake Erie sites at Dunkirk, NY, 1999–2022. Boxes indicate 25th and 75th quartiles of the values with the median value as the horizontal line. Vertical whiskers show the range of values. Outlier values are shown as single data points; one outlier (2004 nearshore) falls outside the upper scale. Shaded area represents trophic state target. No data was collected in 2020.

A gradual increase in productivity in the eastern basin, especially in the nearshore waters, has occurred over the past nearly two decades. Oligotrophic conditions that were present nearshore in the 1990s and early 2000s have gradually shifted toward targeted mesotrophic conditions, and an apparent increase in lower trophic productivity is perhaps resulted in a response in the eastern basin percid community. Yellow perch and walleye status have both improved from their low ebbs observed in the 1990s. Trends in offshore lower trophic measures also indicate a gradual increase in productivity. However, these recent trends have not compromised thermal or DO habitat required for salmonid species.

Zooplankton Density and Biomass

In 2022, May–September zooplankton density was 13,300 ind/m^3 at the nearshore site, well below the long-term (2000–2021) average of 23,300 ind/m^3 (Figure J.9, top panel). At the offshore site, density was 9,000 ind/m^3, also below long-term average of 21,200 ind/m^3. The offshore density is in stark contrast to 2019, when the highest observed density (43,800 ind/m^3) occurred. Densities were driven by high numbers of nauplii at both nearshore and offshore sites. Biomass was below average at both nearshore (40 mg/m^3) and offshore (24 mg/m^3) sites (Figure J.9, bottom panel). Long-term average biomass was 60 mg/m^3 and 49 mg/m^3 at the nearshore and offshore sites, respectively. The decrease in biomass compared to the previous year was due primarily to lower biomass of cyclopoids in the nearshore and daphnia and cyclopoids in the offshore. Combined nearshore and offshore biomass of calanoids, cyclopoids, nauplii, and cladocerans decreased compared to 2021 and was below average for the time series (Figure J.10).

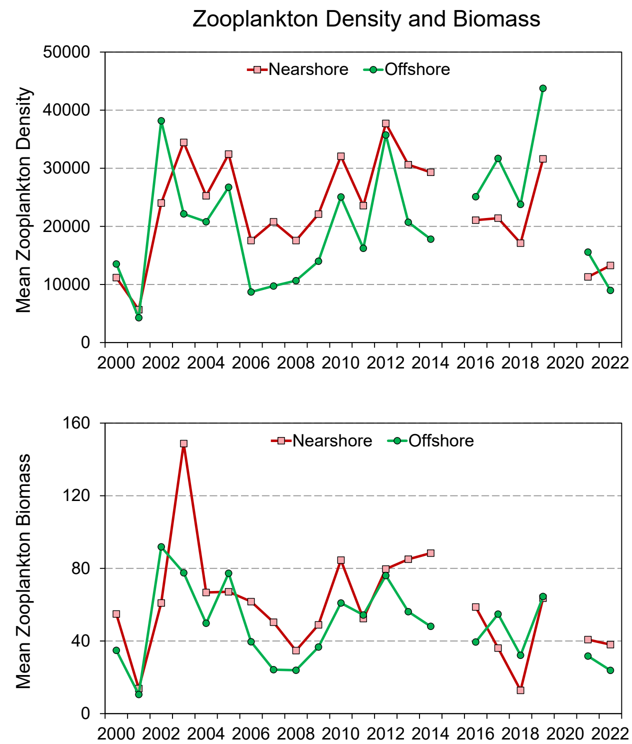

FIGURE J.9. May–September average zooplankton density (#/m^3 • 10^3) (top panel) and biomass (mg/m^3) (bottom panel) in the epilimnion at nearshore (Station 17) and offshore (Station 18) Lake Erie sites at Dunkirk, NY, 2000–2022. 2015 data are not available, and no data was collected in 2020.

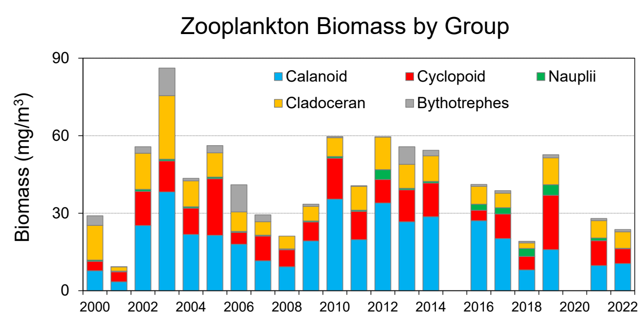

FIGURE J.10. May–September average zooplankton biomass (mg/m^3) by major taxonomic group for combined nearshore and offshore Lake Erie sampling stations at Dunkirk, NY, 2000–2022. 2015 data are not available, and no data was collected in 2020.

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K. Summary of the 2021–2022 Tributary Angler Survey

James L. Markham

The 2021–2022 angler survey was conducted to monitor and obtain current information on New York's Lake Erie tributary salmonid fishery, including estimates of fishing quality, angler effort, catch, harvest, and angler demographics. Information gained during this survey directly informs fisheries management decisions. The results of this survey will also determine progress toward meeting the goals and objectives in the Management Plan for Lake Erie Steelhead (Markham et al. 2016). This was the seventh angler survey conducted on New York's Lake Erie tributaries since 2003 (Markham 2006; 2008; 2012; 2016; 2019). The only prior survey was the benchmark Great Lakes angler survey conducted in 1984 (NYSDEC 1984). The 1984 survey found spring tributary effort was mainly directed at steelhead while fall fishing was distributed among a variety of salmonid species. Segments of the 1984 survey have continued in recent surveys including estimates of catch and harvest for Chautauqua, Canadaway, Cattaraugus, and Eighteen Mile Creeks as well as the winter fishery in Dunkirk Harbor.

Many changes have occurred since the 1984 survey that have altered the salmonid fishery. Stocking of Pacific salmon species ceased in 2003 across all Lake Erie jurisdictions due to poor returns, and agencies focused on steelhead almost exclusively. As such, recent angler surveys revealed high steelhead angler effort and success from fall through spring with far less contribution from other species. Another important change that affected the Dunkirk Harbor fishery was the closure of the Dunkirk Power Plant in 2015. The Power Plant discharged warm water into the harbor that attracted baitfish as well as predators, especially during the winter months. Except for rare occasions, this fishery is no longer as popular as it once was.

Study Area

This survey covered the eight Lake Erie tributaries in New York stocked with steelhead and two winter harbor fisheries (Dunkirk and Barcelona) (Figure K.1). The tributaries include: Chautauqua Creek, Canadaway Creek, Cattaraugus Creek, Eighteen Mile Creek, Silver

Angler Survey Tributaries

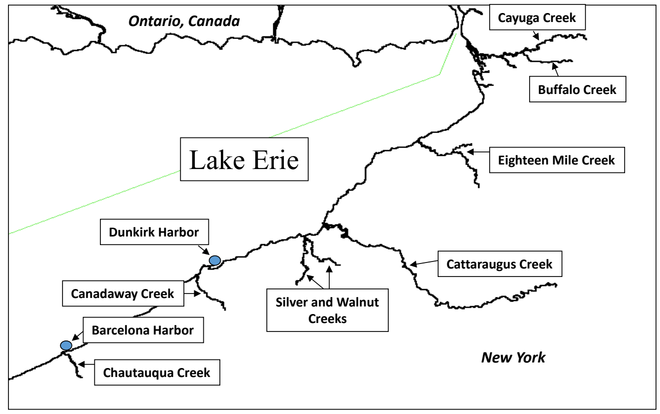

FIGURE K.1. Map of New York water of Lake Erie showing locations of tributaries and harbors sampled during a salmonid angler survey conducted from 1 October 2021 – 30 April 2022.

Creek and Walnut Creeks (combined), Buffalo Creek, and Cayuga Creek. Although anglers fish in other non-stocked tributaries, the 2003 Lake Erie angler diary data show 93% of angler cooperator effort was directed to these eight tributaries (Markham 2005). The area surveyed on each tributary varied, but generally covered from the mouth upstream to the first barrier impassable to fish.

The survey also covers the portion of Cattaraugus Creek on the Seneca Nation of Indians (SNI) Reservation which encompasses approximately 14 of the creek's 34 miles downstream of the first impassable barrier (Springville Dam). Anglers fishing on SNI territory are subject to a separate fishing license and regulations. SNI granted permission to conduct the angler survey on their lands.

Methods

Standard survey methods have been employed throughout the survey's history. Major access sites along each creek were selected for both car counts and angler interviews. However, in each ensuing survey year a few sites have been added or deleted based on changing patterns in available access and angler use to obtain the most accurate estimates of angler effort. Silver and Walnut Creeks were treated as a single system for survey design purposes because of their proximity and small size. Conversely, Cattaraugus Creek was split into two sections for efficient sampling but combined as one system for reporting results, including the 14 stream miles on the SNI Reservation.

The survey employs a roving-roving methodology described by Pollock et al. (1994). The design requires two survey technicians to conduct both angler counts and interviews, which were conducted separately to provide the best estimate of instantaneous effort (Malvestuto 1983). Previous surveys covered the period from 15 September through 15 May, but due to personnel issues this survey was conducted from 1 October 2021 through 30 April 2022. Effort data was not collected in April 2022. The survey still encompassed the majority of the tributary fishing season. All weekends and holidays were sampled as well as three weekdays (on average) by each creel agent per week. Each day was further separated into secondary AM or PM sampling shifts (divided into two equal, non-overlapping segments). Daily hours encompassed sunrise to sunset, which approximated legal fishing hours. The specific methods for this creel survey are described in detail in a previous report (Markham 2016).

Estimates of fishing effort, catch, and harvest were calculated following the methods described for the roving-roving creel design in Pollock et al. (1994) and Lockwood et al. (1999); estimated measures of error were calculated from Schmidt (1975). Directed catch rate and angler preference results include only anglers targeting salmonids, although total angler effort and catch rates were used to determine total catch and harvest estimates. Demographics information was determined via a series of interview questions with the exception of age and gender, which was estimated by the survey technician. Further details of survey methodology and calculations are described in Markham (2016).

Results and Discussion

Survey technicians conducted a total of 1,450 interviews at 71 sites along Lake Erie tributaries and harbors between 1 October 2021 and 30 April 2022 (Table K.1). The majority of the interviews occurred in the tributaries (1,413; 97%) and were from anglers targeting salmonids (1,400; 99%). The non-salmonid effort was mainly anglers fishing for smallmouth bass or any fish species.

TABLE K.1. Total number of angler interviews conducted between 1 October 2021 – 30 April 2022 on New York's Lake Erie tributaries and harbors.

	Interviews	
Tributaries	**Total**	**Targeting Salmonids**
Chautauqua	249	249
Canadaway	192	192
Silver/Walnut	72	72
Cattaraugus	262	255
Eighteen Mile	453	450
Buffalo	130	128
Cayuga	55	54
Tributary Total	**1,413**	**1,400**
Harbors		
Dunkirk Harbor	31	26
Barcelona Harbor	6	6
Harbor Total	**37**	**32**
GRAND TOTAL	**1,450**	**1,432**

Eighteen Mile Creek yielded the highest number of angler interviews in the 2021–2022 survey, followed by Cattaraugus and Chautauqua Creeks (Table K.1). In previous surveys Cattaraugus Creek had the highest number of interviews, but poor fall stream conditions affected angler usage during this survey. Cayuga Creek continued to produce the fewest tributary angler interviews. Only 37 total interviews were conducted at Dunkirk and Barcelona Harbors with 32 (86%) of the anglers targeting salmonids (Table K.1).

Angler Demographics

Angler demographics were very similar to those of previous surveys (Markham 2006; 2008; 2012; 2016; 2019). The "typical" Lake Erie tributary angler was a male between 25 and 60 years old (Table K.2). Spinning gear remains the most popular (45%) followed by fly (30%) and noodle/drift rods (25%). Noodle/drift rods have become more common in recent surveys. Artificials (flies, lures; 43%) and natural baits (eggs, shiners, worms; 42%) were found to be equally used by anglers.

Consistent with previous surveys, most tributary anglers (89%) were New York residents (Table K.3). Non-resident anglers resided in 23 other states and two countries (Canada, Bosnia). Of the non-resident anglers, the majority were from Pennsylvania (36%), Ontario, Canada (4%), and Ohio (11%). Border restrictions associated with COVID 19 likely reduced participation by Canadian anglers who are typically encountered more frequently during this survey. Of the NY anglers, 92% resided in the three counties encompassing the Lake Erie tributaries (Erie (68%), Chautauqua (22%), Cattaraugus (3%); Table K.4). Only 3% of anglers resided in four other neighboring counties (Niagara, Wyoming, Genesee, Allegany) with the remainder (5%) originating from other counties across the state.

TABLE K.2. Age, gender, gear, and lure preferences of interviewed salmonid anglers fishing New York's Lake Erie tributaries and harbors, October 2021 – April 2022.

	Number of Anglers
Gender	**2021 – 22**
Male	1,405 (98.1%)
Female	27 (1.9%)

	Number of Anglers
Age Group	**2021 – 22**
<25	131 (9.2%)
25-40	563 (39.4%)
40-60	505 (35.4%)
>60	229 (16.0%)

	Number of Anglers
Gear	**2021 – 22**
Fly	423 (29.6%)
Noodle/Drift	362 (25.3%)
Spinning	646 (45.1%)

	Number of Anglers
Lure	**2021 – 22**
Artificial	609 (42.6%)
Bait	595 (41.6%)
Combination	225 (15.7%)

TABLE K.3. State residency of interviewed anglers fishing New York's Lake Erie tributaries and harbors, October 2021 – April 2022.

State	Number of Anglers
New York	1,270 (88.9%)
Pennsylvania	58 (4.1%)
Ontario, Canada	6 (0.4%)
Ohio	18 (1.3%)
Others (CA, CO, CT, DE, FL, GA, IL, IA, ME, MD, MA, MI, NH, NJ, NC, OR, SC, TX, VT, VA, WV, Bosnia)	77 (5.4%)

TABLE K.4. County residency of interviewed New York resident anglers fishing New York's Lake Erie tributaries and harbors, October 2021 – April 2022.

New York County	Number of Anglers
Chautauqua	276 (22.0%)
Cattaraugus	31 (2.5%)
Erie	849 (67.6%)
Niagara	31 (2.5%)
Wyoming	3 (0.2%)
Genesee	4 (0.3%)
Allegany	1 (<0.1%)
Other	60 (4.8%)

<u>*Angler Effort*</u>

Tributaries – Total tributary salmonid angling effort was estimated at 101,148 angler-hours from October 2021 through March 2022 (Table K.5). An estimated total of 41,557 directed individual stream trips for salmonids occurred during this period based on a mean trip length of 2.67 hours calculated from 433 complete trip interviews. A complete trip only applies to a single stream—if an angler fished more than one steam, or stream section in a day, that would constitute multiple trips.

Eighteen Mile (38,692 angler-hours), Chautauqua (22,346 angler-hours), Cattaraugus (17,628 angler-hours), and Canadaway Creeks (12,111 angler-hours) received the majority (90%) of angler effort (Table K.5; Figure K.2). Silver/Walnut and Cayuga Creeks received the least angler effort (2,040 and 2,422 angler-hours, respectively). Angler effort on Cattaraugus Creek was less than half that of previous surveys due to poor stream conditions during October and November.

TABLE K.5. Monthly angler effort (angler-hours) directed at salmonids from New York's tributaries and harbors, 1 October 2021 – 31 March 2022. NS indicates typically sampled months that were not surveyed in 2021–2022.

Tributary	September	October	November	December	January	February	March	April	May	TOTAL
Chautauqua	NS	7,010	8,041	4,861	574	526	1,334	NS	NS	22,346
Canadaway	NS	2,719	3,768	3,214	493	513	1,404	NS	NS	12,111
Silver/Walnut	NS	1,175	308	395	0	0	162	NS	NS	2,040
Cattaraugus	NS	6,294	3,731	2,319	1,266	474	3,544	NS	NS	17,628
Eighteen Mile	NS	7,635	13,787	7,996	1,408	259	7,607	NS	NS	38,692
Buffalo	NS	1,865	2,866	1,071	0	107	0	NS	NS	5,909
Cayuga	NS	175	312	390	95	158	1,292	NS	NS	2,422
Tributary Total	**-----**	**26,873**	**32,813**	**20,246**	**3,836**	**2,037**	**15,343**	**-----**	**-----**	**101,148**
Harbor										
Barcelona	NS	0	0	0	0	67	132	NS	NS	199
Dunkirk	NS	190	120	0	0	0	780	NS	NS	1,090
Harbor Total	**-----**	**190**	**120**	**0**	**0**	**67**	**912**	**-----**	**-----**	**1,289**
GRAND TOTAL	**-----**	**27,063**	**32,933**	**20,246**	**3,836**	**2,104**	**16,255**	**-----**	**-----**	**102,437**

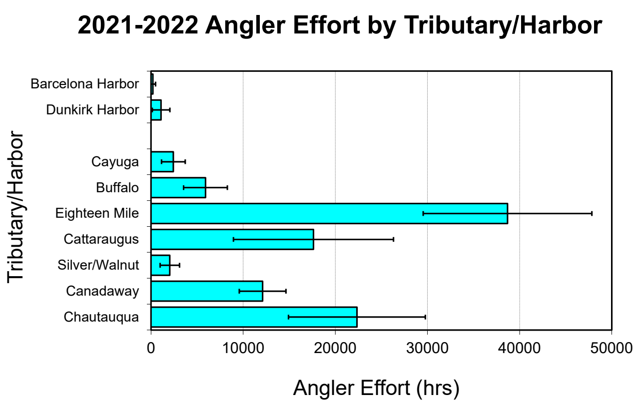

FIGURE K.2. Total angler effort (angler-hours) targeting salmonids in tributaries and harbors of New York waters of Lake Erie, 1 October 2021 – 31 March 2022. Error bars show 2 standard errors of the total effort.

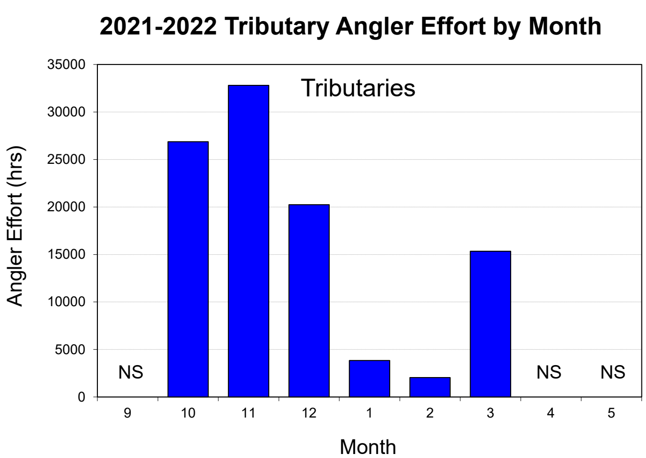

FIGURE K.3. Total angler effort (angler-hours) targeting salmonids by month in the New York tributaries of Lake Erie, 1 October 2021 – 31 March 2022. NS indicates typically sampled months that were not surveyed in 2021–2022.

The months of October, November, and December combined for 79% of the directed tributary angling effort (Table K.5; Figure K.3). Angling effort was the least in January and February (6%), which is typical due to winter stream and weather conditions.

Harbors – Combined shore, ice and boat effort in the harbor fishery was estimated at only 1,605 angler-hours in 2021–2022, accounting for less than 2% of the combined harbor and tributary fishing effort (Table K.5). A total of 401 trips occurred based on a mean trip length of 4.73 hours as calculated from three complete trip interviews. The majority (88%) of the angler effort occurred in Dunkirk Harbor (Figure K.2). March, specifically in Dunkirk Harbor, was the most popular month for the harbor fishery, accounting for 71% of the total harbor effort (Table K.5; Figure K.4). Low amounts of effort were detected during the rest of the survey period.

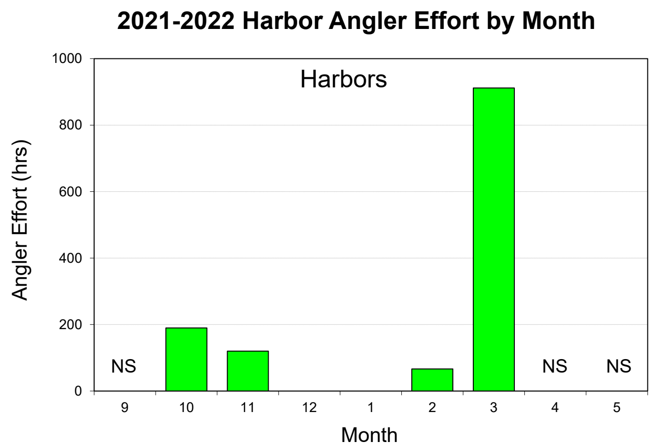

FIGURE K.4. Total angler effort (angler-hours) targeting salmonids by month in selected New York harbors of Lake Erie, 1 October 2021 – 31 March 2022. NS indicates typically sampled months that were not surveyed in 2021–2022.

Catch and Harvest Rates

Tributaries – Steelhead accounted for nearly 100% of the salmonids caught in the tributaries although a small number of brown trout and two coho salmon were encountered by interviewed anglers. The overall tributary catch rate for anglers targeting salmonids averaged 0.44 fish per angler-hour and the accompanying targeted harvest rate was 0.03 fish/hr (Table K.6). Based on these rates, a trout angler caught a salmonid, on average, every 2.3 hours. The overall catch rate for steelhead was 0.43 fish/hr, well above the target rate of 0.33 fish/hr listed in the Lake Erie Steelhead Management Plan (Markham et al. 2016).

Like the previous survey in 2017–2018, catch rates were similar (range: 0.34 – 0.61 fish/hr) among the sampled streams in 2021–2022 (Table K.6; Figure K.5). Chautauqua Creek anglers experienced the greatest overall catch rate at 0.62 fish/hr. Eighteen Mile Creek, which was the most-fished tributary, produced the lowest overall catch rate of 0.34 fish/hr.

Harvest rates were consistently low across the tributaries during 2021–2022 (Table K.6; Figure K.5). Steelhead comprised nearly all of the salmonids harvested in the survey. The overall tributary harvest rate was 0.03 fish per angler-hour, which equates to 7.0% of the steelhead caught. The greatest harvest rate was from Canadaway Creek (0.08 fish/hr).

TABLE K.6. Targeted catch and harvest rates (fish/hr) for steelhead and all salmonids from New York's Lake Erie tributaries and harbors, 1 October 2021 – 30 April 2022.

Tributary	Catch Rate by Species		Harvest Rate by Species	
	Steelhead	All Salmonids	Steelhead	All Salmonids
Chautauqua	0.61	0.62	0.05	0.05
Canadaway	0.47	0.47	0.08	0.08
Silver/Walnut	0.42	0.43	0.03	0.03
Cattaraugus	0.39	0.40	0.02	0.02
Eighteen Mile	0.33	0.34	0.01	0.01
Buffalo	0.47	0.48	0.01	0.01
Cayuga	0.41	0.41	0.02	0.02
Tributary Total	**0.43**	**0.44**	**0.03**	**0.03**
Harbor				
Barcelona	0.32	0.32	0.00	0.00
Dunkirk	0.18	0.20	0.09	0.09
Harbor Total	**0.20**	**0.22**	**0.08**	**0.08**

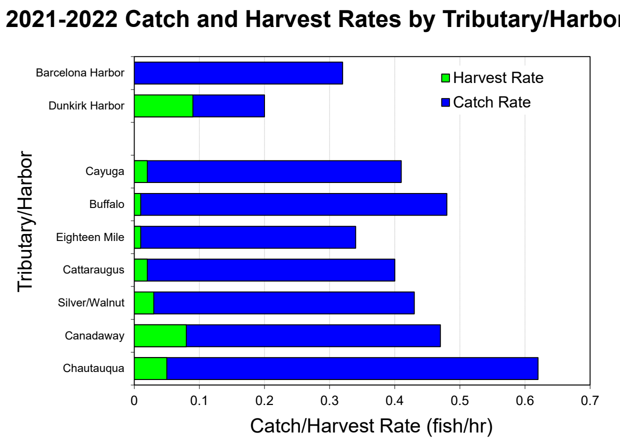

FIGURE K.5. Targeted catch and harvest rates (fish/hr) of salmonids by anglers fishing the New York tributaries and harbors of Lake Erie, 1 October 2021 – 30 April 2022.

The highest cates rates occurred in April (0.64 fish/hr) while the lowest occurred in October (0.27 fish/hr; Table K.7; Figure K.6). Catch rates were generally consistent between all other sampled months in 2021–2022. Harvest rates were also relatively consistent between sampling months (Table K.7; Figure K.6). Peak harvest rates occurred in October and March (0.04 fish/hr) and the lowest rates were observed in January and February (0.01 fish/hr).

TABLE K.7. Targeted catch and harvest rates (fish/hr) for all salmonids by month from New York's Lake Erie tributaries and harbors, 1 October 2021 – 30 April 2022.

Month	Catch Rates		Harvest Rates	
	Tributaries	Harbors	Tributaries	Harbors
September	-----	-----	-----	-----
October	0.27	0.05	0.04	0
November	0.52	0	0.03	0
December	0.49	0	0.04	0
January	0.47	0	0.01	0
February	0.41	0.08	0.01	0
March	0.28	0.30	0.04	0.12
April	0.64	0.29	0.02	0
May	-----	-----	-----	-----

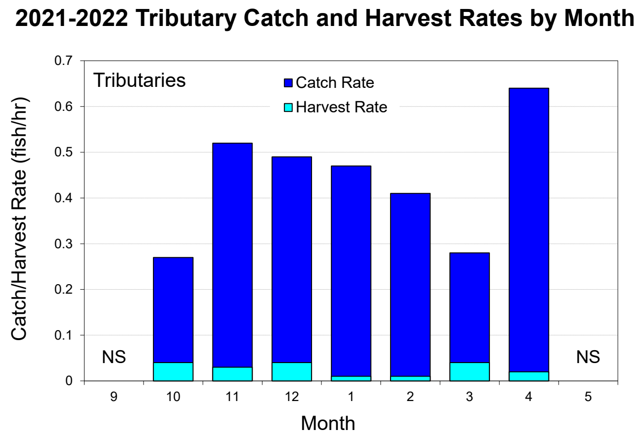

FIGURE K.6. Targeted monthly catch and harvest rates (fish/hr) of salmonids by anglers fishing the New York tributaries of Lake Erie, 1 October 2021 – 30 April 2022. NS indicates typically sampled months that were not surveyed in 2021–2022.

Harbors – The overall harbor catch rate for anglers targeting salmonids was 0.22 fish per angler-hour (Table K.6; Figure K.5); the accompanying harvest rate was 0.08 fish/hr. Higher catch rates occurred in Barcelona Harbor (0.32 fish/hr) compared to Dunkirk Harbor (0.20 fish/hr). Harvest rates at Dunkirk Harbor were high relative to the tributaries with 36% of the salmonids harvested; no harvest was detected at Barcelona Harbor. Steelhead comprised the entire salmonid harvest in the harbors.

Angler catches of salmonids were only recorded in October and between February and April in the harbors (Table K.7; Figure K.7). Peak catch rates occurred in March (0.30 fish/hr) and April (0.29 fish/hr). March was the only month that harvest (0.12 fish/hr) was recorded in the harbor fishery.

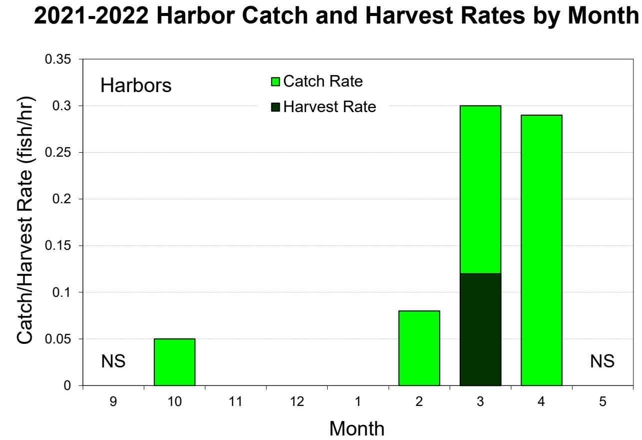

FIGURE K.7. Targeted monthly catch and harvest rates (fish/hr) of salmonids by anglers fishing in selected New York harbors of Lake Erie, 1 October 2021 – 30 April 2022. NS indicates typically sampled months that were not surveyed in 2021–2022.

Overall Catch

Tributaries – Lake Erie tributary anglers caught an estimated 40,613 salmonids during the 2021–2022 survey period (Table K.8). Steelhead continued to be the most caught species (39,840 fish; 98%) while brown trout (723 fish; 2%) and Pacific salmon (50 fish; <1%) remain minor contributors. Eighteen Mile (12,050 fish; 30%) and Chautauqua (13,281 fish; 33%) Creeks accounted for nearly two-thirds of the total catch (Figure K.8).

TABLE K.8. Total catch of salmonids from New York's tributaries and harbors, 1 October 2021 – 31 March 2022.

Tributary	Catch by Species			Total Catch
	Steelhead	Brown Trout	Salmon	
Chautauqua	12,872	409	0	13,281
Canadaway	5,724	0	0	5,724
Silver/Walnut	871	20	0	891
Cattaraugus	4,622	108	0	4,730
Eighteen Mile	11,834	186	30	12,050
Buffalo	3,034	0	20	3,054
Cayuga	883	0	0	883
Tributary Total	**39,840**	**723**	**50**	**40,613**
Harbor				
Barcelona	71	0	0	71
Dunkirk	188	26	0	214
Harbor Total	**259**	**26**	**0**	**285**
GRAND TOTAL	**40,099**	**749**	**50**	**40,898**

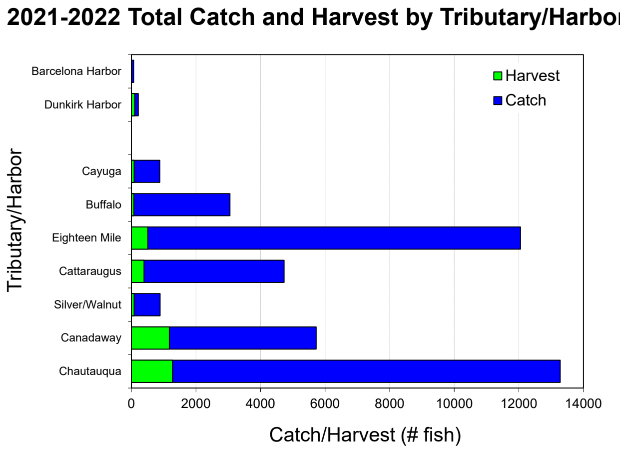

FIGURE K.8. Total catch and harvest of salmonids by anglers fishing the New York tributaries and harbors of Lake Erie, 1 October 2021 – 31 March 2022.

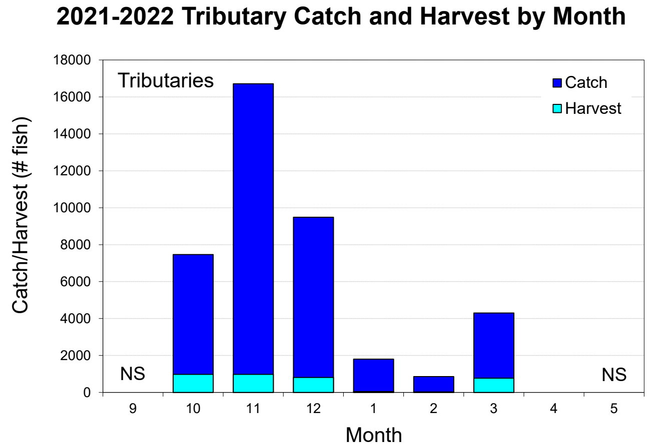

FIGURE K.9. Monthly catch and harvest of salmonids by anglers fishing the New York tributaries of Lake Erie, 1 October 2021 – 31 March 2022. NS indicates typically sampled months that were not surveyed in 2021–2022.

Overall tributary catch by month generally followed the same trend as angling effort. The months with the highest angler effort (October, November, and December) were those with the highest catch despite sometimes having lower catch rates than other months (Table K.9; Figure K.9). Nearly 83% of the total catch was recorded during these three months. As seen in previous angler surveys, lower catches occurred during the winter months when cold weather conditions limit angling effort.

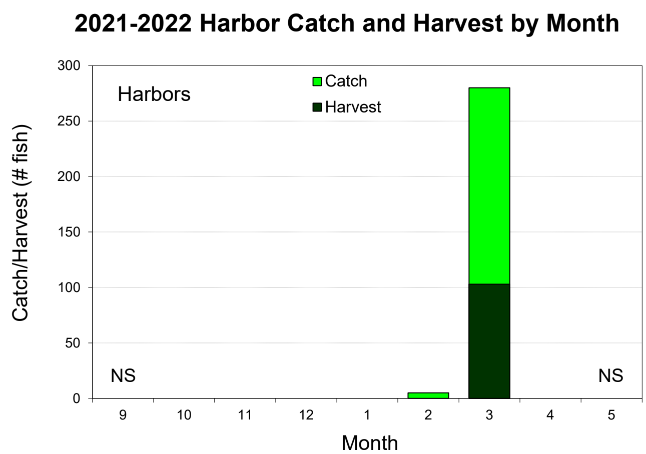

FIGURE K.10. Monthly catch and harvest of salmonids by anglers fishing in selected New York harbors of Lake Erie, 1 October 2021 – 31 March 2022. NS indicates typically sampled months that were not surveyed in 2021–2022.

Harbors – Anglers fishing Dunkirk and Barcelona Harbors caught an estimated 285 salmonids during the 2021–2022 survey period (Table K.8; Figure K.8). With the exception of 26 brown trout, the entire catch was comprised of steelhead; no Pacific salmon were reported by anglers fishing in the harbors. Most of the catch (75%) in the harbor fishery occurred in Dunkirk Harbor, with 98% occurring during April (Table K.9; Figure K.10).

TABLE K.9. Total catch and harvest of salmonids by month from New York's tributaries and harbors from 1 October 2021 – 31 March 2022.

Month	Tributary		Harbor	
	Catch	Harvest	Catch	Harvest
September	-----	-----	-----	-----
October	7,464	974	0	0
November	16,710	976	0	0
December	9,483	808	0	0
January	1,799	49	0	0
February	855	26	5	0
March	4,303	768	280	103
April	-----	-----	-----	-----
May	-----	-----	-----	-----

Overall Harvest

Tributaries – Overall harvest from the tributary fishery was estimated at 3,602 steelhead, which was 9% of the total estimated catch (Table K.10). Cattaraugus, Chautauqua, Eighteen Mile and Canadaway Creeks accounted for 93% of the tributary harvest (Table K.10; Figure K.8). Only minor harvests were recorded at all other surveyed streams. October, November, December, and March accounted for 98% of the tributary harvest (Table K.9; Figure K.9).

TABLE K.10. Total harvest of salmonids from New York's tributaries and harbors, 1 October 2021 – 31 March 2022.

Tributary	Harvest by Species			Total Harvest
	Steelhead	Brown Trout	Salmon	
Chautauqua	1,197	79	0	1,276
Canadaway	1,175	0	0	1,175
Silver/Walnut	84	0	0	84
Cattaraugus	392	0	0	392
Eighteen Mile	511	0	0	511
Buffalo	78	0	0	78
Cayuga	86	0	0	86
Tributary Total	**3,523**	**79**	**0**	**3,602**
Harbor				
Barcelona	0	0	0	0
Dunkirk	103	0	0	103
Harbor Total	**103**	**0**	**0**	**103**
GRAND TOTAL	**3,626**	**79**	**0**	**3,705**

Harbors – Overall harvest from the harbor fishery was estimated at 103 steelhead in 2021–2022, which was 37% of the total harbor catch (Table K.10; Figure K.8). Steelhead accounted for all of the harvest in the harbor fishery, and all of the harvest occurred in March in Dunkirk Harbor (Table K.9; Figure K.10).

Trends in the Fishery

Tributaries – Direct comparisons of the 2021–2022 survey to previous surveys should be made with caution due to missing months of angler effort (September, April, May) and catch rate information (September, May). Estimated angler effort from the 2021–2022 survey decreased by nearly 25% relative to the 2017–2018 survey and was about half of the estimated angler effort (~200,000 angler-hours) from the initial angler surveys in 2003–2004, 2004–2005, and 2007–2008 (Figure K.11). However, April typically accounts for the third highest angler effort behind October and November. If we assume angler effort in the missing months was similar to the 2017–2018 survey, we can approximate what the total tributary effort would have been in 2021–2022. Adding in the September, April, and May effort from the previous survey would account for an additional 27,267 angler-hours, resulting in a total approximated 2021–2022 angler effort of 128,415 angler-hours, which is nearly equal to the 2017–2018 survey results (134,499 angler-hours).

2021–2022 salmonid catch rates (0.44 fish/hr) decreased from the 2017–2018 survey (0.56 fish/hr) but were well above the Management Plan target of 0.33 fish/hr (Markham et al. 2016; Figure K.12). Most tributaries show general declining trends in catch rates from the 2003–2004 survey through the 2014–2015 survey with Chautauqua and Canadaway Creeks showing the steepest declines (Figure K.13). However, all tributaries showed an increase in angler catch rates in the 2017–2018 survey, and with the exception of Chautauqua Creek a slight decline in 2021–2022. Recent surveys (2017–2018 and 2021–2022) have also shown more consistent catch rates between the tributaries (i.e., nearly all equal) compared to earlier surveys which had much greater differences between individual tributaries. The reasons for this are unclear but may be related to changes in stocking locations and recent improvements to stocking size that resulted in more consistent adult returns to the fishery. Overall tributary catch of salmonids in 2021–2022 (40,613 fish) was equal to estimates from the 2014–2015 survey (Figure K.14). However, this does not include September, April, and May due to missing effort and/or catch rate data, which would increase the overall catch estimates to levels similar to the 2011–2012 survey.

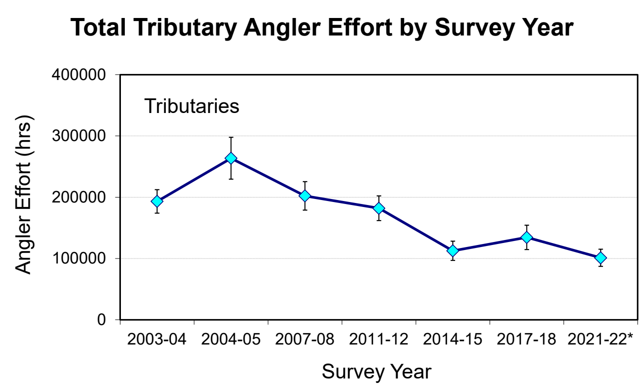

FIGURE K.11. Total salmonid angler effort (angler-hours) from New York's Lake Erie tributaries estimated from creel surveys in 2003–2004, 2004–2005, 2007–2008, 2011–2012, 2014–2015, 2017–2018, and 2021–2022. Error bars show 2 standard errors of the total effort. Effort estimates in 2021–2022 do not include September, April, and May.

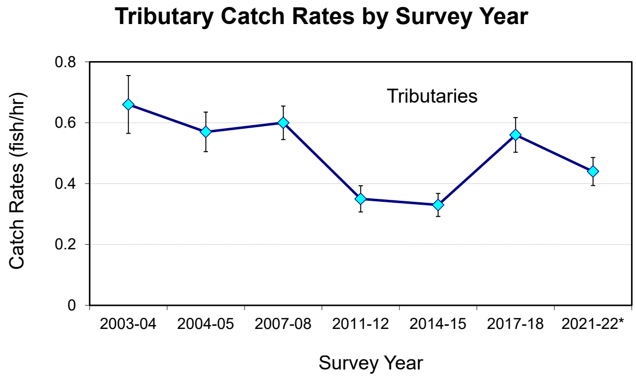

FIGURE K.12. Targeted catch rates (fish/hr) of salmonids from New York's Lake Erie tributaries estimated from creel surveys in 2003–2004, 2004–2005, 2007–2008, 2011–2012, 2014–2015, 2017–2018, and 2021–2022. Error bars show 2 standard errors of the catch rate. Catch rates in 2021–2022 do not include September and May.

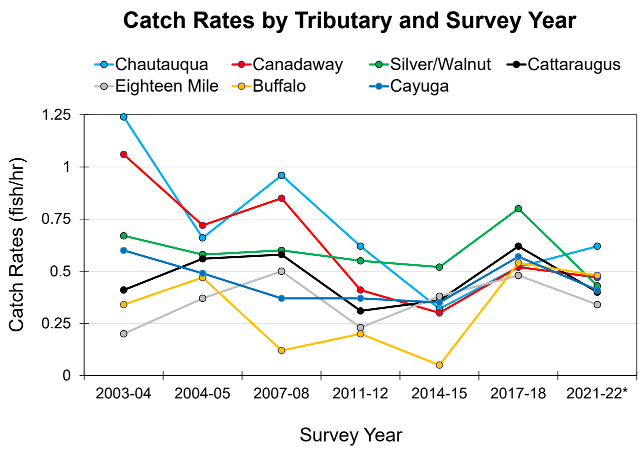

FIGURE K.13. Targeted catch rates (fish/hr) of salmonids by tributary and survey year estimated from creel surveys conducted in New York's tributaries of Lake Erie in 2003–2004, 2004–2005, 2007–2008, 2011–2012, 2014–2015, 2017–2018, and 2021–2022. Catch rates in 2021–2022 do not include September and May.

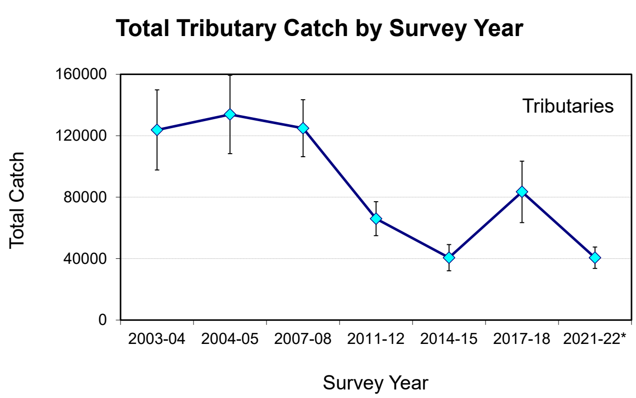

FIGURE K.14. Total catch of salmonids from New York's Lake Erie tributaries estimated from creel surveys in 2003–2004, 2004–2005, 2007–2008, 2011–2012, 2014–2015, 2017–2018, and 2021–2022. Error bars show 2 standard errors of the total catch. Catch estimates in 2021–2022 do not include September, April, and May.

Harbors – Trends in the harbor fishery indicate more variable fishing quality when compared to the tributaries, but with some similar trends. Declines in both angler effort and catch rates occurred between the 2007–2008 and 2011–2012 angler surveys and remained stable between 2011–2012 and 2014–2015 (Figures K.15 and K.16). Like the tributaries, slight increases in angler effort and large increases in catch rates were observed in 2017–2018 followed by declines in both in 2021–2022. Low harbor angler effort resulted in an overall estimated catch of just 285 fish in 2021–2022, which was similar to estimates in 2011–12 and 2014–15 (Figure K.17).

Summary – The reasons for the annual variability in the fishing quality in both the Lake Erie tributaries and harbors during the time period this survey has been conducted (2003–2022) are unclear. Overall stocking policies in terms of numbers, stocking methods, and fish quality have remained relatively consistent in New York and all other Lake Erie jurisdictions for over two decades, and harvest both in the open lake and tributaries remains at low levels. Fluctuation in both walleye and sea lamprey populations have occurred, but the extent of their influence on the Lake Erie steelhead population remains unknown. Likely a combination of factors has contributed to the declines observed in the early part of this decade and subsequent improvement observed since 2017.

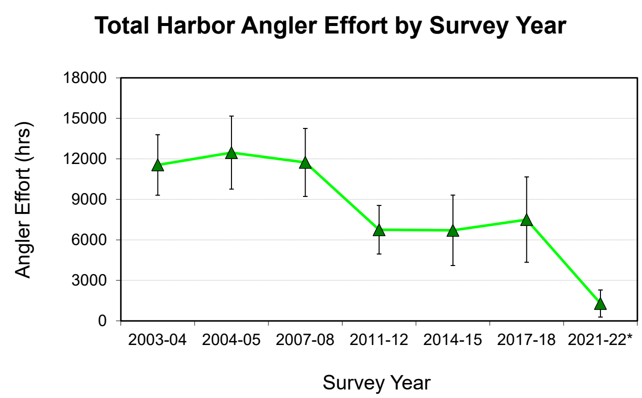

FIGURE K.15. Total salmonid angler effort (angler-hrs) from New York's Lake Erie harbors estimated from creel surveys in 2003–2004, 2004–2005, 2007–2008, 2011–2012, 2014–2015, 2017–2018 and 2021–2022. Error bars show 2 standard errors of the total effort. Effort estimates in 2021–2022 do not include September, April, and May.

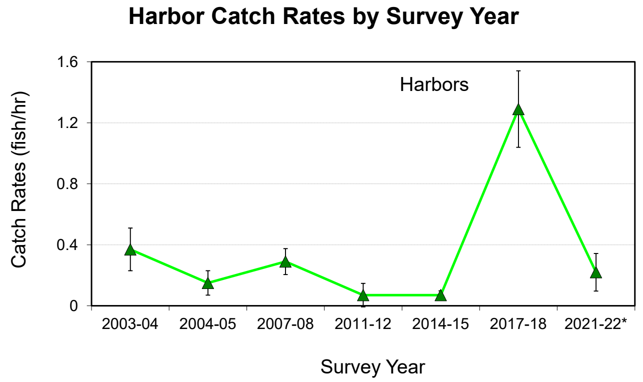

FIGURE K.16. Targeted catch rates (fish/hr) of salmonids from New York's Lake Erie harbors estimated from creel surveys in 2003–2004, 2004–2005, 2007–2008, 2011–2012, 2014–2015, 2017–2018, and 2021–2022. Error bars show 2 standard errors of the catch rate. Catch rates in 2021–2022 do not include September and May.

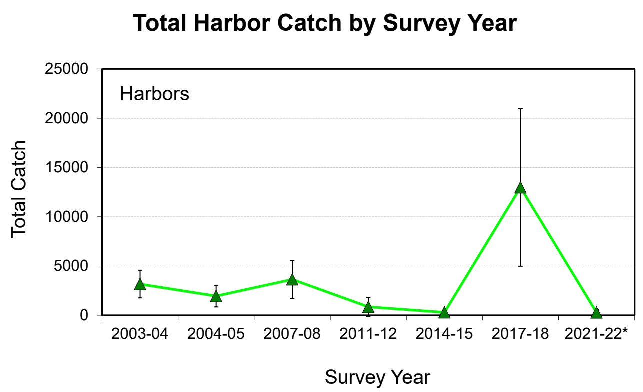

FIGURE K.17. Total catch of salmonids from New York's Lake Erie harbors estimated from creel surveys in 2003–2004, 2004–2005, 2007–2008, 2011–2012, 2014–2015, 2017–2018, and 2021–2022. Error bars show 2 standard errors of the total catch. Catch estimates in 2021–2022 do not include September, April, and May.

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APPENDIX I

Common and scientific names of fish potentially mentioned in text, tables, and/or figures.

Common Name	Scientific name
Alewife	*Alosa pseudoharengus*
Banded Killifish	*Fundulus diapphanus*
Blacknose Shiner	*Notropis heterolepis*
Bluntnose Minnow	*Pimephalesnotatus*
Bridle Shiner	*Notropis bifrenatus*
Brook Silverside	*Labidesthes sicculus*
Brown Trout	*Salmo trutta*
Bullheads	*Ictaluridae spp.*
Burbot	*Lota lota*
Carp	*Cyprinus carpio*
Channel Cat	*Ictalurus punctatus*
Chinook Salmon	*Oncorhynchus tshawytscha*
Coho Salmon	*Oncorhynchus kisutch*
Darter spp.	*Percidae spp.*
Emerald Shiner	*Notropis atherinoides*
Freshwater Drum	*Aplodinotus grunniens*
Gizzard Shad	*Dorosoma cepedianum*
Goldfish	*Carassius auratus*
Lake Sturgeon	*Acipenser fulvescens*
Lake Trout	*Salvelinus namaycush*
Lake Whitefish	*Coregonus clupeaformis*
Largemouth Bass	*Micropterus salmoides*
Muskellunge	*Esox masquinongy*
Northern Hog Sucker	*Hypentelium nigricans*
Northern Pike	*Esox lucius*
Quillback	*Carpiodes cyprinus*
Rainbow Smelt	*Osmerus mordax*
Rainbow Trout/Steelhead	*Oncorhynchus mykiss*
Redhorse Sucker spp.	*Moxostoma spp.*
Rock Bass	*Ambloplites rupestris*
Round Goby	*Neogobius melanostomus*
Rudd	*Scardinius crythrophthalmus*
Sea Lamprey	*Petromyzon marinus*
Smallmouth Bass	*Micropterus dolomieui*
Spottail Shiner	*Notropis hudsonius*
Sticklebacks	*Gasterosteidae spp.*
Stonecat	*Noturus flavus*
Trout-perch	*Percopsis omiscomaycus*
Walleye	*Sander vitreus*
White Bass	*Morone chrysops*
White Perch	*Morone americana*
White Sucker	*Catastomus commersoni*
Yellow Perch	*Perca flavescens*