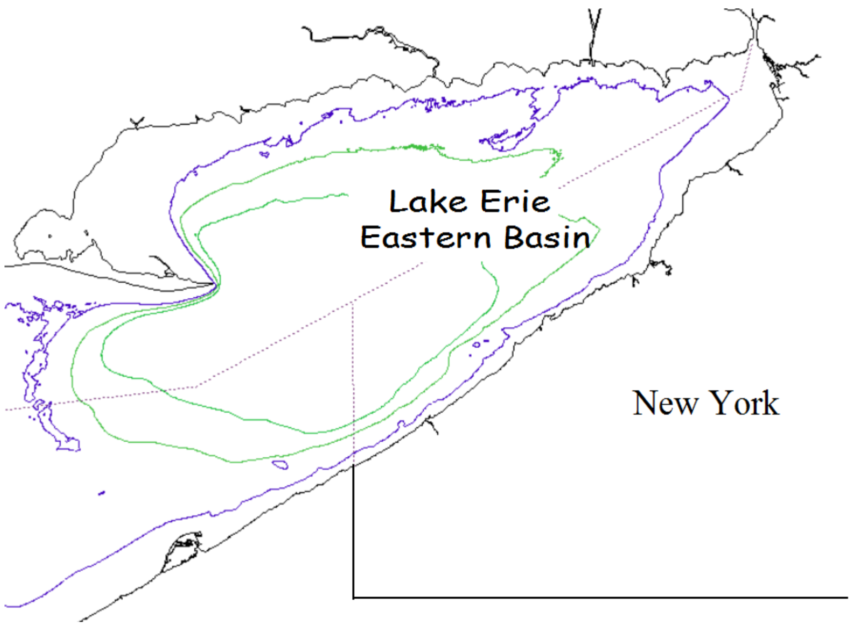
NYS DEC LAKE ERIE
2014 ANNUAL REPORT

to the Lake Erie Committee
and the Great Lakes Fishery Commission



March 2015

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

Andrew M. Cuomo, *Governor*

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NYS DEC LAKE ERIE 2014 ANNUAL REPORT
to the
Great Lakes Fishery Commission's
Lake Erie Committee

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Acknowledgments

The Lake Erie Fisheries Unit recognizes the contributions of seasonal staff essential to completing an ambitious field schedule. During the 2014 field year these individuals included Fish and Wildlife Technicians Carrie Babcock, Jonathon Draves, Ann Wilcox-Swanson, Kyle Keys and Robert Lichorat. We also acknowledge contributions of DEC's Region 9 Fisheries Office, and Buffalo State College's Great Lakes Center in support of various Lake Erie field activities.

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Preface

The Lake Erie Annual Report is prepared by 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 last report. In this regard, the Buffalo River Walleye Rehabilitation Summary, the Fisheries Acoustic Survey and the Wild Steelhead Assessment Program are not reported in this year's edition. New and proposed initiatives included in this report include the Steelhead Smolt Study (Section J) and the Acoustic Telemetry Study (Section L).

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

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Lake Erie 2014 Annual Report

Presented at the Lake Erie Committee Meeting
Ypsilanti, Michigan USA
March 23, 2015

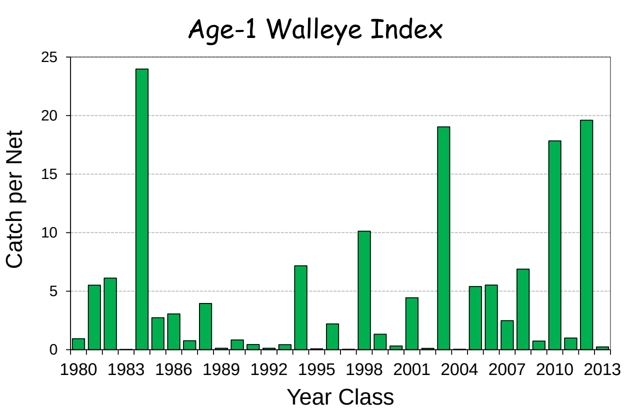
NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

NYSDEC Lake Erie Fisheries Research Unit
2014 Program Highlights

The New York State Department of Environmental Conservation's Lake Erie Fisheries Research Unit is responsible for fishery research and assessment activities for one of New York's largest and most diverse freshwater fishery resources. A variety of annual programs are designed to improve our understanding of the Lake Erie fish community to guide fisheries management, and safeguard this valuable resource for current and future generations. This document shares just a few of the highlights from the 2014 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 Lake Erie Unit office (contact information below).

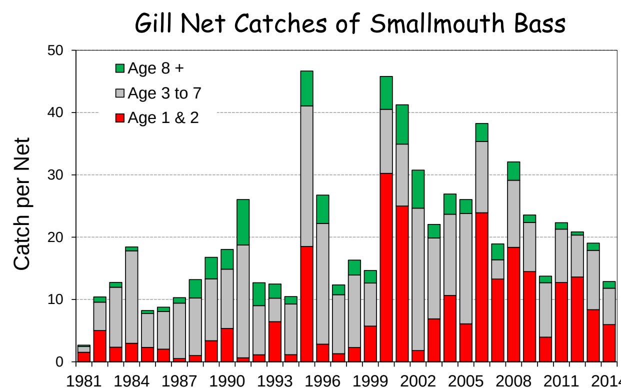
Walleye

Lake Erie's eastern basin walleye resource is composed of local spawning stocks as well as contributions from summertime movements of western basin spawning stocks. Walleye fishing quality in recent years has generally been very good and largely attributable to excellent spawning success observed in 2003 and again in 2010. Measures of walleye fishing quality in 2014 were the highest recorded in 27 years. New York's most recent juvenile walleye survey indicates a poor spawning year in 2013. However, the abundant 2012 year class will start recruiting to the sport fishery in summer 2014. Overall good recruitment through recent years, especially from 2010 and 2012, suggests adult walleye abundance in the eastern basin will remain satisfactory the next few years. A new research initiative beginning in 2015 will use acoustic telemetry to study walleye movement and assess the contribution of western basin migrants to the New York walleye fishery. A $100 reward will be associated with the return of each tagged fish along with the internal acoustic tag.



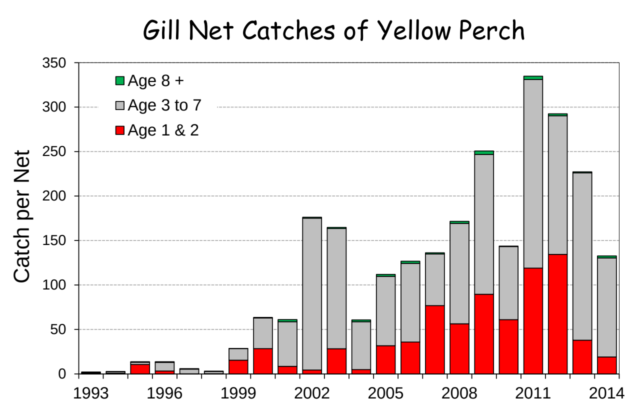
Smallmouth Bass

Lake Erie supports New York's, and perhaps the country's, finest smallmouth bass fishery. Bass fishing quality in 2014 was the second highest observed in the 27 year series of monitoring, with the peak observed in 2013. Generally stable spawning success, coupled with very high growth rates and acceptable survival, produce high angler catch rates and frequent encounters with trophy-sized fish. Most recent data indicate a very gradual decline of abundance to near long term average measures. Juvenile abundance measures suggest 2012 produced a moderately abundant smallmouth 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's now lasted well more than a decade. A large adult population continues to produce good angler catch rates, especially during spring and fall. Declining levels of juvenile yellow perch have resulted in an overall decline in the population over the past three years. Spawning success from 2011 through 2013 was average to poor. This decrease has yet to influence yellow perch angler quality which was the highest in the 27 year series in 2014.



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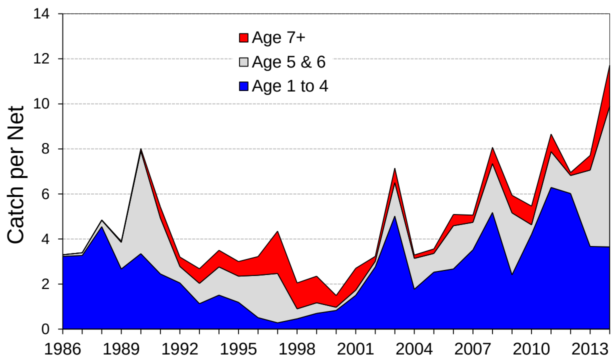
Lake Trout Restoration

Re-establishing a self-sustaining lake trout population in Lake Erie continues to be a major goal of Lake Erie's coldwater program. Lake trout have been stocked since 1978 and annual assessments monitor progress towards restoration objectives. A revised lake trout rehabilitation plan was completed in 2008 and guides current recovery efforts. The overall index of abundance of lake trout in the New York waters of Lake Erie continues to increase and was at its highest level in 29 years of monitoring in 2014. The majority of the catch was young adult lake trout ages 4-6. Adult fish (age 5 and older) were also at their highest abundance in 2014; lake trout age 10 and older remain scarce. Basinwide estimates surpassed targets for adult abundance for the first time. However, adult survival for some lake trout strains remains low, mainly due to high sea lamprey predation. Natural reproduction has not yet been detected in Lake Erie, and continued high stocking levels and sea lamprey control are needed to build adult lake trout populations to levels where natural production is viable.

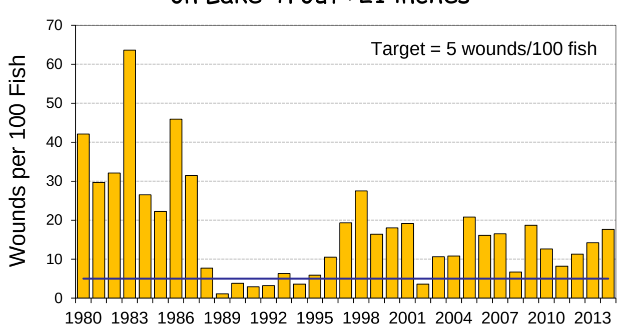
Gill Net Catches of Lake Trout



Sea Lamprey

Sea lamprey invaded Lake Erie and the Upper Great Lakes in the 1920s and have played an integral role in the failure of many native coldwater fish populations. Great Lakes Fishery Commission 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 NYSDEC includes observations of sea lamprey wounds on lake trout and other fish species, and lamprey nest counts on stream sections. Wounding rates on lake trout increased in 2014, indicative of a high sea lamprey population in Lake Erie. Inspections of sportfish species documented sea lamprey wounding on warmwater species as well. Surveys conducted over the past four years indicate the largest source of Lake Erie's sea lamprey production may be the St. Clair River rather than traditionally monitored and treated Lake Erie streams.

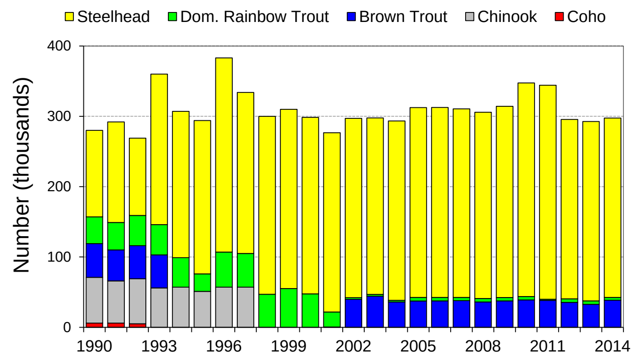
Sea Lamprey Wounding Rate
on Lake Trout >21 inches



Salmonid Management

New York annually stocks approximately 255,000 steelhead and 35,000 brown trout into Lake Erie and its tributaries to provide recreational opportunities for both lake and stream anglers. Wild reproduction of steelhead also contributes to the fishery. Fall juvenile assessments conducted since 2001 confirmed substantial numbers of young-of-year steelhead present in many tributaries. A long term annual angler diary program continues to monitor characteristics of the tributary steelhead fishery. In addition, a tributary angler survey is being conducted in 2014-15 to determine the current status of the steelhead fishery. A pilot study to investigate emigration of stocked steelhead suggests stocking size may be influencing adult returns of stocked fish. An expanded investigation is planned for 2015-16 which should provide insights on the influence of stocking size and location on adult returns.

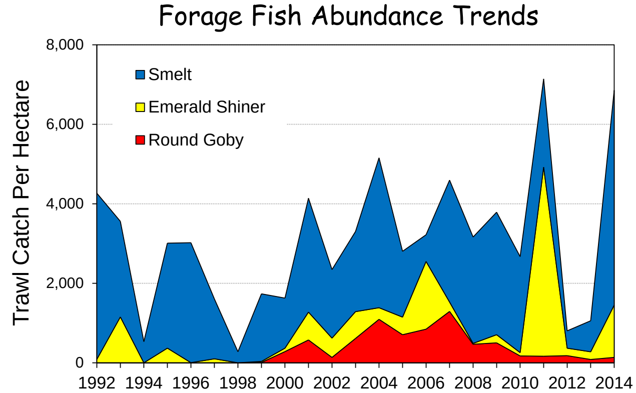
NYSDEC Trout & Salmon Stocking



Prey Fish

The Lake Erie Unit conducts a number of surveys to assess forage fishes and components of the lake's lower trophic levels. These programs have included trawling, sonar surveys of prey fishes, predator diet studies, and lower food web monitoring. A variety of prey fish surveys beginning approximately 20 years ago identified rainbow smelt as the dominant component of the open lake forage fish community. Beginning in 2000, there has been a notable increase in prey species diversity accompanied by somewhat lower smelt abundance, and in some years especially high abundances of round gobies and emerald shiners were encountered in both prey fish surveys and predator diets. In recent years, overall prey fish abundance trended slightly downward, with notable declines of goby abundance in trawl surveys. Overall abundance of forage-sized fishes was the second highest in the series in 2014, mainly due to especially high abundance of young-of-the-year rainbow smelt and emerald shiners (all life-stages). Round gobies appear to have stabilized at low levels of abundance. Lower trophic monitoring indicated nearshore eastern basin waters are currently best described as a mesotrophic environment favorable for percid production. Over time we expect these investigations to be useful in furthering our understanding of factors shaping the fish community.

Forage Fish Abundance Trends



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B. RESEARCH PARTNERSHIPS

The Lake Erie Unit collaborates with investigators from other government and academic institutions to pursue a broad array of initiatives (Table B.1). The Lake Erie Unit's contribution to these partnerships typically includes vessel and staff time for making field collections, and/or sharing archived data series spanning many years of standard sampling programs**.** The Lake Erie Unit remains willing to pursue additional partnerships to the extent such collaborations are consistent with our mission, and practical for integrating any additional efforts with our ongoing programs.

TABLE B.1. 2014 list of active research partnerships with NYS DEC Lake Erie Unit.

Principal Investigator	**Affiliation**	**Project Description**
Adelman, D.	U of Rhode Island	Assessment of sources and fates of toxic organic chemicals in Lake Superior, Erie, and Ontario
Clapsadl, M.	SUNY Buffalo	Long term Lake Erie limnology survey
Coll, J.	USGS	Long term pathogen surveillance of Lake Erie fishes
Crane, D.	ESF Syracuse	Trends in body conditions of native piscivores following round goby invasion in Lakes Erie and Ontario
Gorsky, D. and G. Jacobs	USFWS	Lake Sturgeon movement and distribution in the vicinity of Lake Erie's Buffalo Harbor and upper Niagara River
Keir, M.	DFO	Long term contaminant monitoring of Lake Erie lake trout
Mason, S.	SUNY Fredonia	Assessment of Plastic Pollution Migration into the Great Lakes Food Web
Miner, J. and R. Budnik	BGSU	Performance of stocked steelhead in Lake Erie tributaries
Murphy, E.	EPA	US EPA GLNPO Great Lakes Fish Monitoring Program
Riley, S.	USGS	Great Lakes lake trout thiamine monitoring program
Rogers, M.	USGS	Lake Erie 2014 Coordinated Science and Monitoring Initiative (CSMI)
Vandergoot, C.	ODNR	Lake Erie Walleye Acoustic Telemetry Study
Zischke, M.T.	Purdue University	Assessment of recruitment synchrony of lake whitefish across the Great Lakes.

C. FORAGE AND JUVENILE YELLOW PERCH SURVEY

James L. Markham and Jason M. Robinson

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 assessing trends in abundance of juvenile yellow perch and monitoring the status of the forage fish community. Data from this program are also merged with those from other jurisdictions to generate lake wide estimates of yellow perch and forage fish populations, and are reported by the inter-agency Forage Task Group (Forage Task Group 2014) and Yellow Perch Task Group (Yellow Perch Task Group 2014).

Methods

This trawling program is annually conducted during October at selected locations with trawlable substrate between the 50- 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 2014).

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 inches
Twine diameter:	21 thread
Cod-end webbing:	0.4 inches

Reported measures conform to a lake wide standard measurement of trawl densities as mean number per hectare (Forage Task Group 1998). A hectare is 2.471 acres. The area density is computed from known trawl fishing dimensions measured from a trawl calibration exercise conducted during the late 1990's and individual tow distances estimated from navigation equipment. The analyses in this report continue to apply those standard fishing dimensions.

Results

A total of 33 usable trawl tows were completed in the New York waters of Lake Erie in 2014 (Figure C.1). Five sample days, from October 1 to 16, completed the 2014 assessment. Overall standard daytime trawling effort totaled 330 minutes (5.5 hours). Summary statistics for 14 frequently encountered species are presented in Table C.1, and time series abundance trends for select forage species are presented in Figure C.2. Young-of-the-year (YOY) rainbow smelt were the most abundant species sampled in 2014. Abundance estimates for YOY rainbow smelt were the highest in the time series. Other species that made significant contributions to the catch included yellow perch, white perch, trout-perch, emerald shiners, and round gobies.

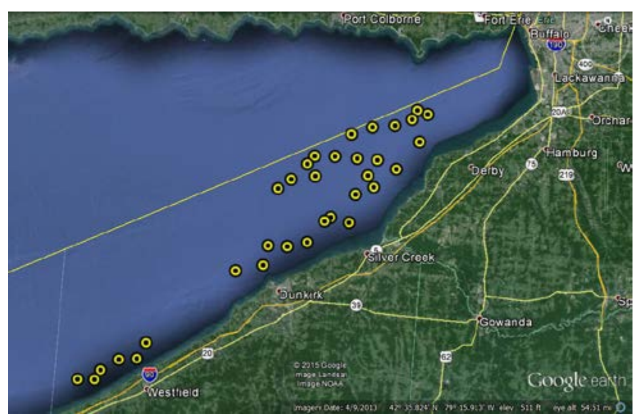


FIGURE C.1. Locations of individual 10-m trawls between the 50 to 100 ft. depth contours used to assess the abundance of age-0 yellow perch and forage fish species in the New York waters of Lake Erie, October 2014.

TABLE C.1. Catch per effort (number per hectare (2.471 acres)) of selected species collected with a 32.8 ft (10-m) bottom trawl from approximately 30 sites between the 50 to 100 ft. depth contours in New York waters of Lake Erie, October, 1992-2014.

Species	Index (#/ha) (1992 to 2013) Min	Max	Mean	Trawl (#/ha) 2014
Yellow Perch				
Age 0	0.2	1088.3	150.8	267.2
Age 1	0.3	138.2	23.0	2.8
Age 2+	0.3	85.0	28.6	102.7
Walleye				
Age 0	0.0	5.8	0.6	0.3
White Perch				
Age 0	0.0	431.5	54.3	35.2
White Bass				
Age 0	0.0	128.7	18.4	0.3
Rainbow Smelt				
Age 0	71.5	4154.1	1402.4	5379.7
Age 1+	22.2	3010.0	626.4	24.2
Alewife				
Age 0	0.0	617.6	81.3	0.0
Gizzard Shad				
Age 0	0.0	40.9	9.9	0.6
Trout-Perch				
All ages	22.5	1392.7	595.9	63.3
Sm. Bass				
Age 0	0.0	1.1	0.2	0.0
Age 1+	0.1	2.4	1.0	0.3
Emerald Shiner				
Age 0	0.0	2930.1	270.3	512.9
Age 1+	0.0	1826.2	266.5	801.8
Spottail Shiner				
Age 0	0.0	137.5	10.5	0.1
Age 1+	0.0	33.7	6.3	0.2
Round Goby				
Age 0	0.0	1059.5	227.8	105.4
Age 1+	0.0	313.2	97.4	31.4
Burbot				
Age 0	0.0	0.2	0.0	0.0
Age 1+	0.0	3.1	0.8	0.5
Whitefish				
Age 0	0.0	6.2	0.4	0.1
# of Samples	26	39	33	33

Juvenile Yellow Perch Assessment

The 2014 mean density estimate for age-0 yellow perch (267.2/ha) was above average and ranked as the 6th highest index in the 23-year series (Table C.2). This is the sixth time in the past nine years that age-0 yellow perch densities have been above average. Age-1 yellow perch (2013 year class) density estimates were low and confirm last year's observation that this is one of the weakest year class's in the series (ranked 19th of 23). Throughout the history of this survey, a relatively weak relationship has existed between age-0 yellow perch abundance and subsequent age-1 abundance (r^2 = 0.21). However, low abundance indices at age-0 rarely translate to stronger year classes at age-1. Adult (age 2+) abundance was the highest in the trawl time series, bolstered by a particularly strong age-4 cohort (2010 year class) and a moderate age-2 cohort (2012 year class).

TABLE C.2. CPE (number per hectare) of yellow perch collected with a 32.8 ft (10-m) bottom trawl from approximately 30 sites between 50 to 100 ft depth contours in New York waters of Lake Erie, October, 1992-2014.

Year	Density (yellow perch per ha) Age-0	Age-1	Age-2+
1992	10.5	2.3	9.2
1993	110.1	3.0	5.9
1994	47.7	8.4	1.0
1995	5.7	13.3	14.2
1996	103.1	0.3	6.8
1997	0.2	5.5	2.6
1998	1.3	0.4	0.3
1999	35.0	32.4	10.9
2000	23.3	6.8	27.7
2001	97.8	11.4	22.9
2002	9.3	15.6	37.0
2003	472.5	1.9	21.4
2004	1.5	28.6	60.1
2005	57.8	5.5	33.6
2006	283.2	39.9	29.0
2007	401.5	41.2	85.0
2008	1088.3	44.3	54.9
2009	11.6	62.5	43.0
2010	192.7	4.0	38.9
2011	87.2	138.2	25.0
2012	272.9	16.3	61.0
2013	4.2	23.8	39.6
2014	267.2	2.8	102.7
1992 - 2013			
min	0.2	0.3	0.3
max	1088.3	138.2	85.0
ave	150.8	23.0	28.6

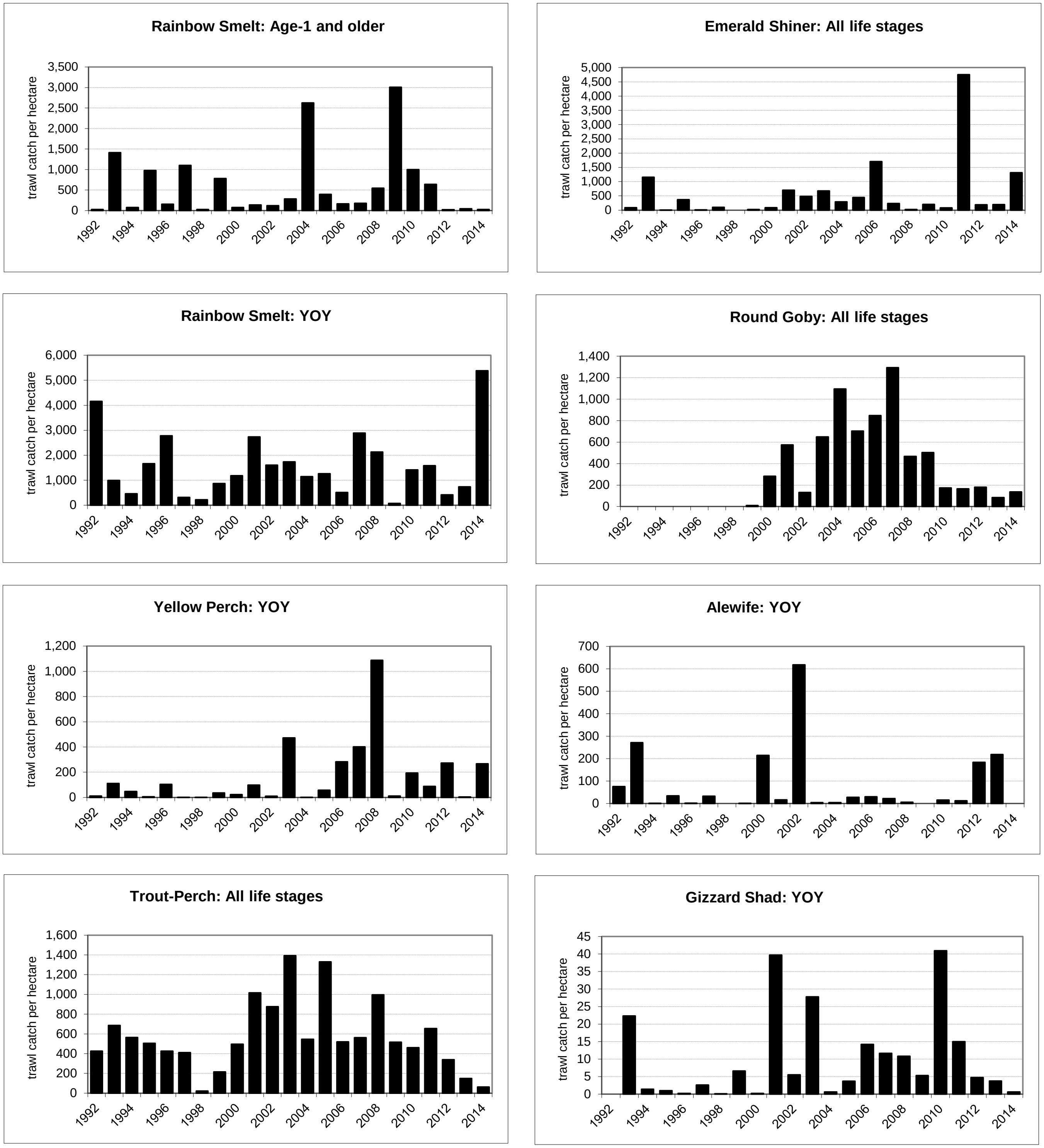


FIGURE C.2. Catch per hectare (2.471 acres) of selected forage species collected with a 10-m bottom trawl from approximately 30 sites between the 50 and 100 ft. depth contours in the New York waters of Lake Erie, October, 1992-2014.

Trends in juvenile yellow perch growth rates are presented in Figure C.3. Mean total lengths for age-0 yellow perch were below average in 2014 and the lowest observed since 1998; age-1 mean lengths were slightly above average. Generally large samples and stable growth rates for both age groups have been observed over the last nine years.

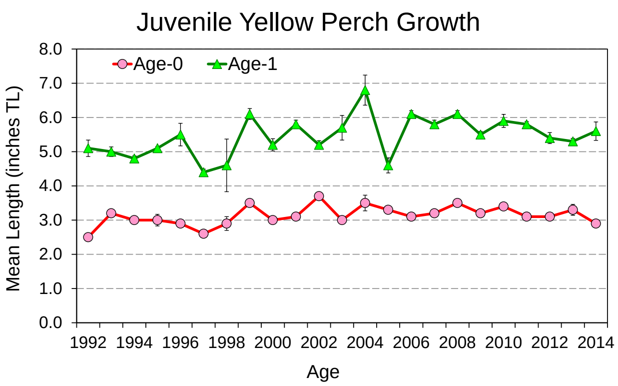


Figure C.3. Mean total length of age-0 and age-1 yellow perch collected by bottom trawl in New York waters of Lake Erie, October 1992-2014. Error Bars are 95 % confidence intervals. During 1997 only one age-0 yellow perch was collected and error bars could not be computed.

Status of Forage Fish

Each year, including 2014, soft-rayed fishes dominated trawl catches in the New York waters of Lake Erie (Figure C.4). This group includes rainbow smelt, emerald shiners, spottail shiners, trout-perch and round goby. Spiny-rayed forage fishes (YOY yellow perch, YOY white perch, and YOY white bass) increased in abundance during the mid-2000s, but have declined during the past five years. Clupeids (YOY gizzard shad, YOY alewife) remain minor contributors to the New York forage fish assessment in most years. Estimated abundance of forage-sized fish was 7,222 fish/ha (2,923 fish/ac) in 2014, which was a sizeable increase compared to the previous two years and the second highest abundance estimate in the 23-year series. The majority of this increase was due to a particularly high abundance estimate of YOY rainbow smelt.

Rainbow smelt are typically the numerically most abundant species within the soft-rayed forage group. From 1992 through 2000, an alternating yearly cycle of high and low yearling and older (YAO) smelt abundance was a predictable dynamic for this population (Figure C.2). During these years,

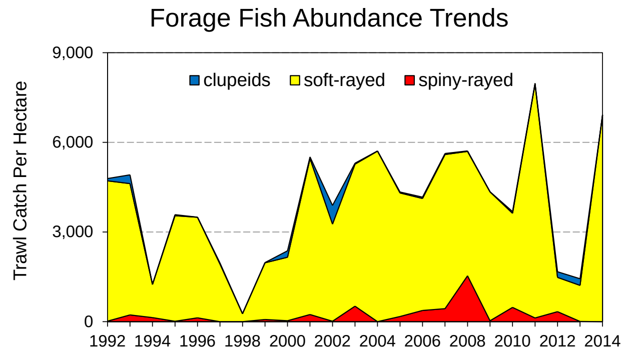


Figure C.4. Catch-per-hectare (2.471 acres) of functional groups of forage fishes collected with a standard trawl from approx. 30 sites in the New York waters of Lake Erie, October, 1992 to 2014.

yearling smelt (age-1) comprised the majority of this age group; older smelt were scarce. YOY smelt typically were the most abundant forage fish component in the absence of an abundant yearling cohort of smelt (Figure C.2).

From 2000 through 2003, YAO smelt abundance remained lower, along with the absence of the previously notable alternate-year abundance cycle (Figure C.2). The YAO age group also began to expand into a wider range of ages. During 2004, YAO smelt abundance increased dramatically, and then subsided to lower abundances from 2005 to 2008. However, in 2009 YAO smelt again emerged as a dominant component of the forage fish community, only to subside again in 2010. YAO smelt abundance measures have been consistently low since 2012; 2014 represented the second lowest value. With a few exceptions, YOY smelt abundance remained consistently high throughout this period with the highest measure in the series occurring in 2014.

Beginning in 1999, several other species also began to make significant contributions to the soft-rayed segment of the forage fish community, including emerald shiners, trout-perch and round goby (Figures C.2 and C.5). Round goby were first collected in the late 1990's and generally increased in abundance, peaking in 2007. Round goby abundance has since declined and has remained at a stable and lower abundance since 2010.

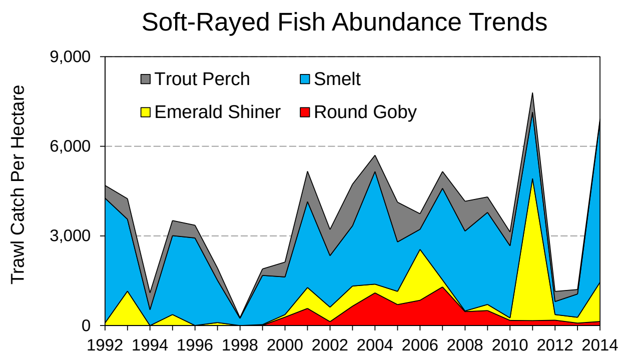


Figure C.5. Catch-per-hectare (2.471 acres) of common soft-rayed forage fishes (all ages combined) collected with a bottom trawl from approximately 30 sites between the 50 and 100 ft depth contours in the New York waters of Lake Erie, October, 1992 to 2014.

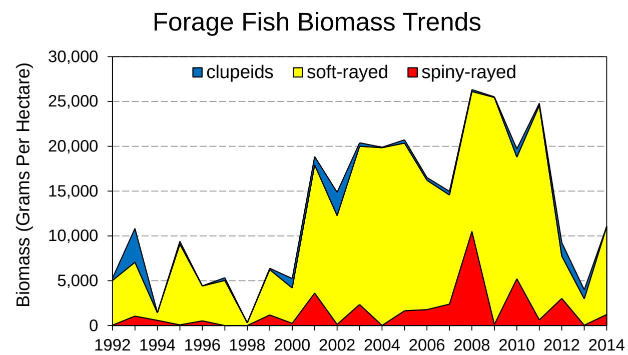


Figure C.6. Biomass (grams-per-hectare (2.471 acres)) of functional groups of forage fishes collected with a standard trawl from approx. 30 sites in the New York waters of Lake Erie, October, 1992 to 2014.

Beginning in 2001, emerald shiners consistently contributed to total forage biomass and abundance (Figures C.2 and C.5). Emerald shiner abundance declined notably between 2007 through 2010, then increased sharply to a time-series high in 2011 when they were the most abundant forage species encountered in this survey. However, much of this increase was attributable to a single massive trawl collection. Emerald shiner abundance estimates declined once again in 2012 and 2013, but increased again in 2014. They remain an important component of the eastern basin forage community.

The estimated biomass of forage-sized fish was 11,080 grams/ha (4,484 grams/ac) in 2014 (Figure C.6). This represented an increase from 2013 but remained lower than biomass estimates from 2001-2011. Rainbow smelt (all life stages) and emerald shiners (all life stages) comprised 82% of the 2014 biomass estimates (Figure C.7). YOY yellow perch were the only other species making a significant biomass contribution. Overall forage fish diversity in 2014 remained high relative to the entire time series.

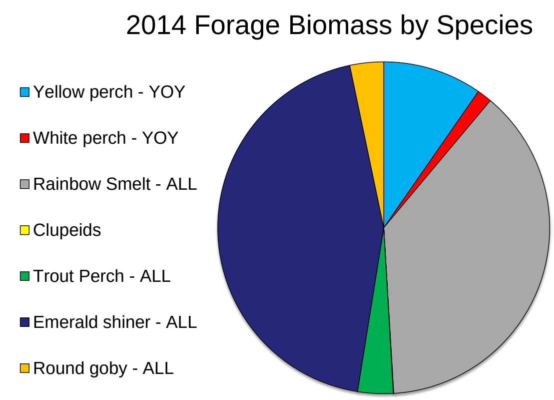


Figure C.7. Biomass (grams-per-hectare (2.471 acres)) of forage fishes by life stage collected with a bottom trawl from 33 sites between the 50 and 100 ft depth contours in the New York waters of Lake Erie, October 2014.

Discussion

This October trawling program continues to indicate robust yellow perch abundance relative to a period of particularly low abundance through the 1990's. These results also closely mirror findings from other Lake Erie jurisdictions and support the view that yellow perch abundance in eastern Lake Erie has rebounded and stabilized since the 1990's. Average or better age-1 yellow perch indices in seven of the last eleven years suggest favorable abundance of adult yellow perch (age-2+) will continue for the near future. These age-1 yellow perch measures correlate very well with subsequent age-2 abundance measures in this assessment, as well as those observed in the annual Warmwater Gill Net Assessment (see Section D).

Bottom trawl estimates suggest high abundance of forage-sized fishes in the New York waters of Lake Erie in 2014. Overall abundance was the second highest in the series, mainly due to especially high abundance of YOY rainbow smelt and a moderate abundance of emerald shiners. Yearling and older rainbow smelt remained at low levels of abundance for the third consecutive year while round gobies have stabilized at low levels of abundance. Trout-perch abundance declined for the third consecutive year in 2014 and were at their second lowest abundance estimate in the series. Trout-perch are rarely observed in the diets of any major predators in the eastern basin of Lake Erie (see Sections F and L). Alewife abundance was above average in 2012 and again in 2013, which typically follows particularly warm winters with little ice cover. No alewife were collected in 2014 trawl samples following the extensive winter ice cover on Lake Erie in 2013-14 and a subsequent wide-spread die-off observed during spring 2014.

Despite elevated abundance of forage fishes in 2014, overall biomass estimates remain relatively low compared to values over the past 15 years. Round gobies were first detected in this survey in 1999, and quickly increased in abundance, subsequently driving up biomass estimates. The increase in round goby was coincident with accompanying increases in trout perch, emerald shiners, and occasionally YAO rainbow smelt. The biomass of spiny-rayed fishes also increased during this time period due to increases in production of both yellow perch and white perch. However, round goby abundance began to decline in 2008, and other species peaked and then declined in subsequent years. The combination of low abundances of round gobies plus declines in trout-perch has led to lower levels of overall forage biomass over the past three years. Comparatively, biomass estimates are now equal to biomass estimates prior to the invasion of round gobies.

Despite apparent wide oscillations in abundance and biomass of prominent forage fish species over the last 23 years, other surveys which monitor predator fish growth continue to describe generally high and stable growth rates for walleye, smallmouth bass (see Section D) and lake trout (see Section F) through this same period of time. We conclude that although forage fish abundance, biomass and species composition has been highly variable over the past two decades, we find no evidence that eastern Lake Erie's forage fish community has been limiting for dominant predator fishes.

Throughout this survey it has become apparent that abundance of pelagic species varies markedly in pre- and post-turnover collections. For example, catches of emerald shiner in trawls typically increase dramatically following lake turnover. Therefore, sampling time (i.e. pre- or post-turnover) can have a substantial effect on abundance estimates of some species such as emerald shiners, rainbow smelt, alewife, and even trout perch. Future investigations will re-assess our trawl sampling methodology to address this potential bias and develop robust and standardized estimates to characterize forage fish abundance.

References

Culligan, W. J., F. C. Cornelius, D. W. Einhouse, D. L. Zeller, and R. C. Zimar. 1992. 1992 Annual Report to the Lake Erie Committee. New York Department of Environmental Conservation, Albany. 52 pp.

Forage Task Group 1998. Report of the Lake Erie Forage Task Group, March 1999. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Forage Task Group 2014. Report of the Lake Erie Forage Task Group, March 2014. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Yellow Perch Task Group 2014. Report of the Lake Erie Yellow Perch Task Group, March 2014. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

D. WARMWATER GILL NET ASSESSMENT

Jason M. Robinson

Introduction

An annual gill net assessment of the warmwater fish community represents the oldest, standard survey performed by New York's Lake Erie Fisheries Unit, and 2014 marked the 34th year of this ongoing effort. The principal objective of this September gill net survey is to produce measures of abundance, age composition and growth of walleye, smallmouth bass and yellow perch in New York's portion of Lake Erie. Walleye and yellow perch measures of abundance and age composition are also contributed to the Lake Erie Committee's (LEC) inter-agency Walleye and Yellow Perch Task Groups for lake wide assessment of these percid populations. A secondary objective is to monitor trends in abundance for other commonly encountered warmwater fish species.

Methods

This annual, autumn gillnetting survey commenced in 1981, and program methods were significantly altered after 1992 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 (< 1993) gillnetting program 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 (<50 ft) stratum, where a standard sampling strategy has been performed since 1981.

This assessment utilizes a stratified, random approach with stations selected from a 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. Fourteen individual gill net panels were 50 ft by 6 ft and consisted of stretch mesh sizes, ranging from 1.25 to 6.0 inches for a particular net. An examination of gill net catches from 1993 to 2004 found the 6-inch panel contributed miniscule catches for all commonly encountered species, but otherwise experienced excessive net damage. Excessive damage to the 6.0-inch netting occurred because our interagency standard monofilament twine diameter is too weak to retain species large enough to be entangled in this panel. 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 fall turnover. Target sampling effort is 40 overnight gill net sites, with four to six nets set each sample day. The 40 net target was achieved in 2014 and most other survey years. Nets are set between 12:00 PM and sunset and retrieved between sunrise and 12:00PM the following day. Data from gill nets that sampled for more than 24 hours or from nets that became badly damaged, tangled, or fouled by filamentous algae or other debris are omitted from abundance analyses.

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

Results

Abundance measures (mean catch per gill net-night) for fifteen of the most commonly encountered species in the nearshore component of this 34-year gill net series are reported in Table D.1. Most species were encountered well within observed, historic ranges of abundance. Rare catches of alewife in recent years, and stonecats for approximately a decade, are particularly noteworthy.

Table D.1. Mean catch rates (fish per gill net) of selected warmwater species per variable mesh gill net from nearshore stations (<50 ft) in New York waters of Lake Erie, September-October, 1981-2014.

Species	Gill Net Index (1981-2013)			Gill Net Index 2014	
	min	max	mean	mean	conf. lmt.
walleye	2.1	33.1	14.1	8.3	5.1 - 11.5
smallmouth bass	2.7	46.1	21.8	13.0	9.7 - 16.2
rock bass	2.3	15.4	6.1	2.3	1.4 - 3.1
white perch	0.0	49.3	12.0	21.4	6.7 - 36.1
gizzard shad	0.8	183.7	25.5	5.5	2.4 - 8.6
redhorse	0.8	6.9	3.3	4.1	2.3 - 5.9
white sucker	0.2	9.2	2.6	1.2	0.6 - 1.9
white bass	0.0	27.3	7.5	16.9	10.4 - 23.3
drum	0.5	9.0	2.1	1.2	0.4 - 1.9
catfish	0.0	7.2	1.3	1.4	0.4 - 2.5
stonecat	0.0	3.8	0.7	0.2	0.0 - 0.4
quillback	0.0	1.5	0.5	0.2	0.0 - 0.4
carp	0.0	0.8	0.1	0.0	0.0 - 0.0
yellow perch	0.0	21.3	5.2	3.6	0.8 - 6.5
alewife	0.0	4.7	0.4	0.0	0.0 - 0.0

<u>Walleye</u>

The walleye abundance index in 2014 was 8.3 fish per net (Figure D.1), well below the long-term mean and only the 24th highest observed in the history of the survey.

In all, 16 age groups contributed to the 2014 sample. Age-2 walleye (2012 year class) dominated the catch (71%), followed by age-4 fish (2010 year class; 13%) (Figure D.2).

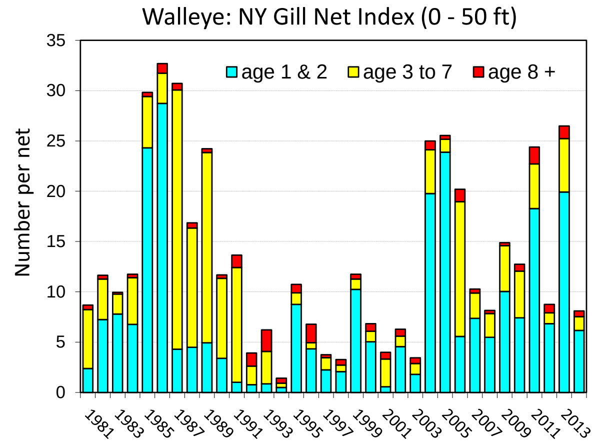


Figure D.1. Walleye catch by age category per gill net set from nearshore stations (< 50 ft) in New York waters of Lake Erie, September-October, 1981 – 2014.

Age-1 and age-2 walleye have typically comprised a large fraction of the overall walleye sample each year in nearshore gill nets (Figures D.1 and D.2). Juvenile walleye are not typically caught at offshore, bottom-set gill net stations (Figure D.2), and adult walleye have proven difficult to sample effectively during September. Measures of adult walleye abundance from this assessment remain highly variable and do not provide a sensitive index of adult abundance. However, it is interesting to note that 2014 was only the second year in the time series in which the offshore index exceeded the nearshore index. This was true for all age classes greater than age-4.

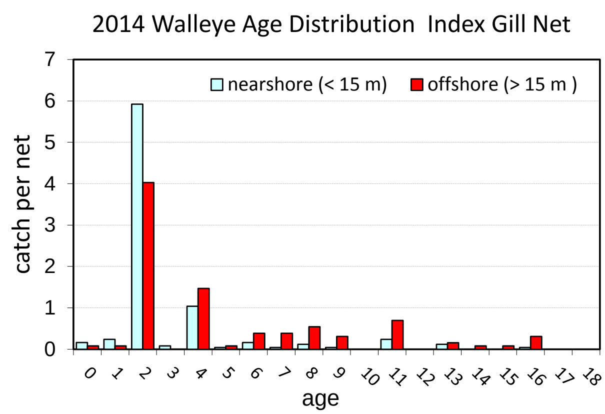


Figure D.2. Age composition of walleye collected from the New York waters of Lake Erie, September - October, 2014 (15 m = 49.2 ft).

Yearling walleye catch rates in 2014 ranked as only the 27th largest recorded at 0.24 age-1 walleye per net, well below our established threshold for a "weak" year class. However, yearling measures of at least moderate or stronger year class abundance have now been observed in eight of the last ten years (Figure D.3). Consecutive weak year classes have not been observed since the early 1990's.

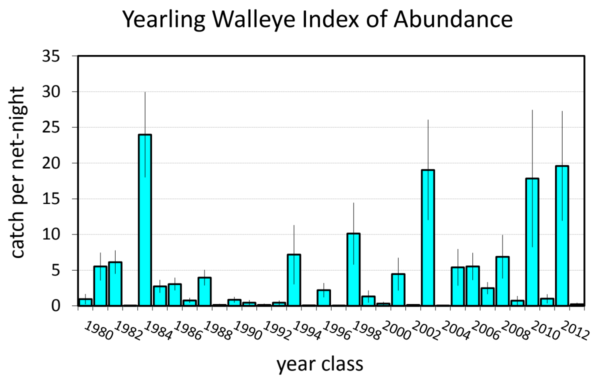


Figure D.3. Relative abundance of age-1 walleye collected from the New York waters of Lake Erie, September-October, 1981-2014.

Length-at-age trends for juvenile walleye are presented in Figure D.4. Age-1 and age-2 walleye in 2014 were very near the long-term average.

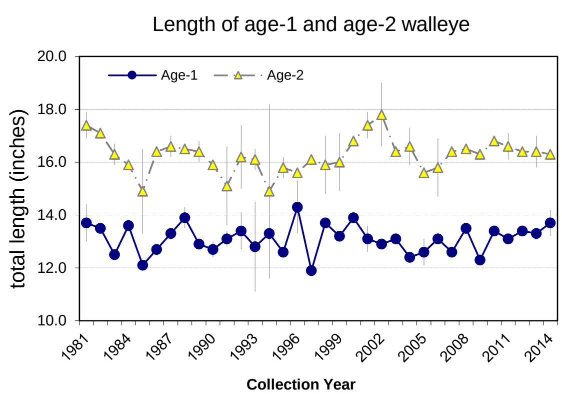


Figure D.4. Mean total length of age-1 & age-2 walleye collected form variable mesh gill nets in the New York waters of Lake Erie, September-October, 1981-2014. Error bars are 2 standard errors.

Smallmouth Bass

Smallmouth bass abundance in 2014 was below the average (Table D.1, Figure D.5) value for the 34 year time series.

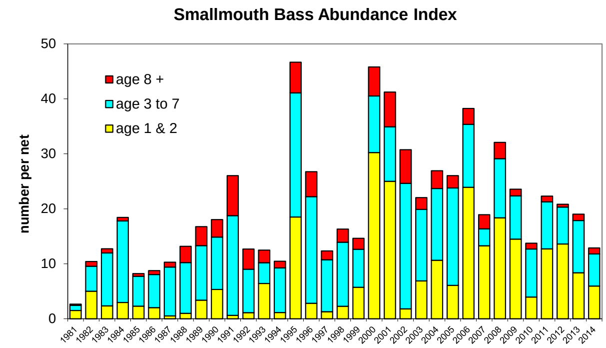


Figure D.5. Smallmouth bass catch rates by age category from nearshore stations (< 50 ft) in New York waters of Lake Erie, September-October, 1981-2014.

Sub-adult smallmouth bass (age-2) dominated the 2014 nearshore sample, which included 15 age groups from age-0 to age-16 (Figure D.6). Offshore gill nets caught notably fewer sub-adult smallmouth bass, and fewer smallmouth bass overall, than companion nearshore gill nets.

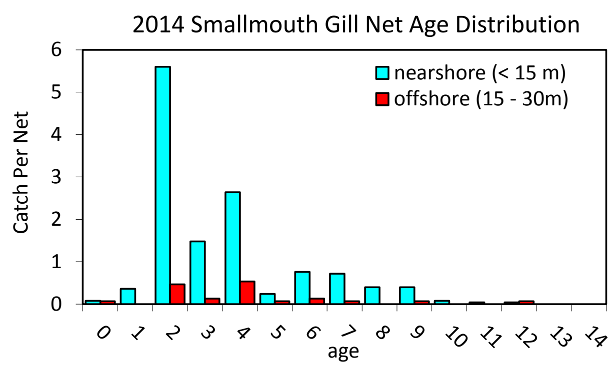


Figure D.6. Age composition of smallmouth bass collected from the New York waters of Lake Erie, September-October, 2014 (15 m = 49.2 ft).

Overall, smallmouth bass abundance in gill nets has remained generally stable for most of the last ten years (Figure D.5). However, from 2010 to 2014 older cohorts of smallmouth bass were less frequently encountered (Figure D.7).

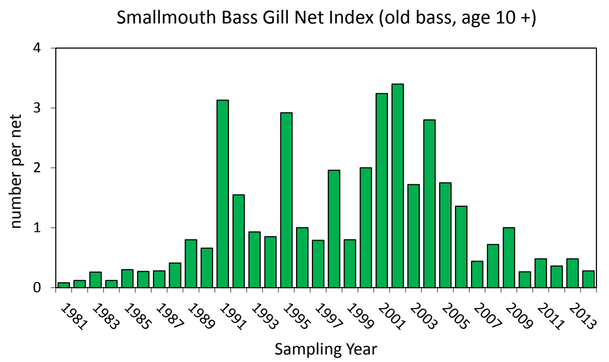


Figure D.7. Age-10 and older smallmouth bass catch rates from nearshore stations (< 50 ft) in New York waters of Lake Erie, September-October, 1981-2014.

The recruitment index for age-2 smallmouth bass in 2014 (5.1 fish per net) exceeds the time series average of 4.6 fish per net (Figure D8).

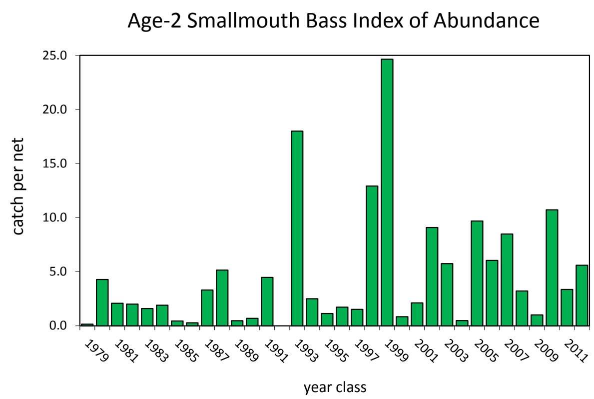


Figure D.8. Relative abundance of age-2 smallmouth bass collected from the New York waters of Lake Erie, September - October, 1981 - 2014.

Einhouse et al. (2002) related recruitment patterns of smallmouth bass in New York's portion of Lake Erie to mean summer water temperature, finding warmer than average summer water temperatures corresponded with production of larger smallmouth bass year classes. This data series has been updated annually and provides insight into one important environmental variable influencing recruitment, and is also useful for understanding potential recruitment impacts from other more recent events, such as the round goby invasion. Figure D.9 shows the highly significant ($r^2 = 0.6$; $p<0.00001$) regression of mean summer water temperature with the age-2 smallmouth bass recruitment index in the period before round goby abundance, plus 13 additional observations during the period round goby have been abundant in eastern Lake Erie. Nearly all observations of smallmouth bass recruitment during the period of goby abundance have been within the range expected based on summer water temperature. Two of the most recent observations for the 2010 and 2011 year classes were beyond the prediction limits developed during the pre-goby period.

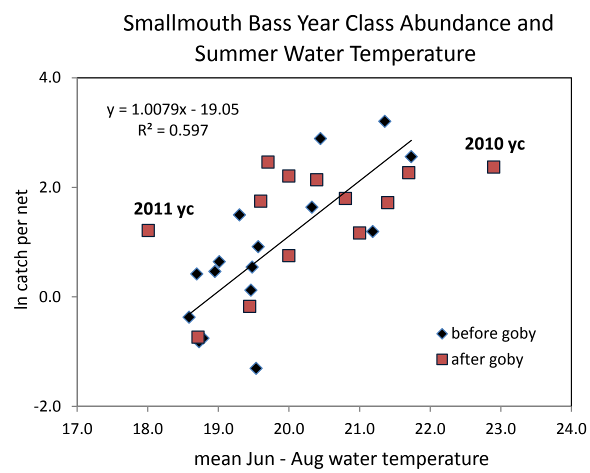


Figure D.9. Regression of the smallmouth bass age-2 abundance index with mean summer (June-September) water temperature from 1983 to 1999. Thirteen additional observations are plotted for the period (2000 – 2012) that round goby have been abundant.

Age-2 and age-3 smallmouth bass cohorts averaged 11.4 in and 13.9 in total length, respectively (Figure D.10). All of the highest length-at-age measures recorded in this series were observed in recent years. Large sample sizes typically support this length analysis, with N = 146 for age-2 and N = 39 for age-3 smallmouth bass in 2014.

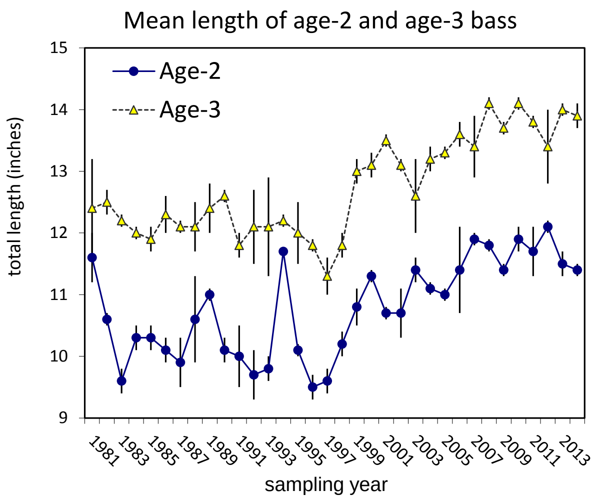


Figure D.10. Mean total length of age-2 and age-3 smallmouth bass collected from gill nets in the New York waters of Lake Erie, September-October, 1981-2014. Error bars are 95% confidence limits.

Yellow Perch

In the offshore stratum (50 to 100 ft), yellow perch were encountered at relatively high levels of abundance in 2014 (Figure D.11). However, the total yellow perch index has been declining since 2011.This deeper stratum has been sampled since the interagency index fishing protocol was implemented in New York, starting in 1993. Yellow perch are otherwise not encountered in high densities among the shallower (0 to 50 ft), long-term gill net locations. Age-4 yellow perch (2010 year class) dominated the catch, accounting for 54% of the yellow perch captured. The Age-2 yellow perch index was below the long term average and overall abundance of all yellow perch declined 42% from 2013. Adult cohorts of yellow perch from age-3 to age-7 have contributed substantially to this annual sample for more than a decade (Figure D.11).

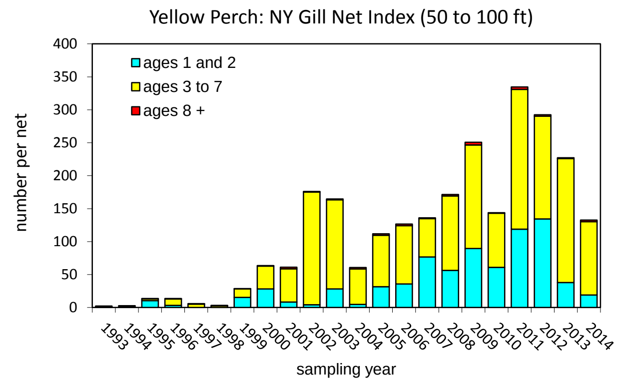


Figure D.11. Yellow perch catch rates by age category per variable mesh gill net set from sampling locations between 50 and 100 ft in New York waters of Lake Erie, September-October, 1993 - 2014.

Discussion

Overall walleye abundance in 2014 was below the long-term average, with the age-2 fish dominating the catch. As this gillnetting survey is conducted in shallow, nearshore regions, juvenile walleye are typically more abundant than adult walleyes in most sampling years. The 2014 index for yearling walleye (2013 year class) was very poor and is not likely to contribute substantially to the fishery in the coming years.

Smallmouth bass abundance in 2014 was below the long term average, with ages 2, 3, and 4 comprising most of the catch. Standard recruitment measures suggest 2012 produced an above average smallmouth bass year class. This observation supports the hypothesis that warmer summers produce higher levels of bass recruitment given the relative warm summer water temperatures measured in 2012. A previous study found that recruitment patterns of smallmouth bass in New York's portion of Lake Erie are strongly influenced by mean summer water temperature (Einhouse et al. 2002), with warmer summer water temperatures corresponding with production of larger smallmouth bass year classes. Mean summer water temperatures in 2012 were nearly 1.5º C above average.

One of the most conspicuous long term trends from our smallmouth bass data series is the measure of length-at-age for age-2 and age-3 smallmouth bass, which continues to show significantly elevated growth rates that began when round gobies became abundant in eastern Lake Erie. Gobies have now been abundant for over a decade in eastern Lake Erie (see Section M), roughly corresponding to the period of elevated smallmouth bass growth rates. This observation of increased growth by piscivores following the invasion of round goby has recently been more rigorously examined using this data series and reported by Crane et al. 2015.

Presently the observed mean length of Lake Erie smallmouth bass after three and four growing seasons, respectively, exceed measures for New York's other fast growing populations by approximately 2 inches (Green et al. 1986). Higher mortality rates are known to accompany more rapid growth rates in many fish populations, consistent with the relative scarcity of older eastern Lake Erie bass in recent years. As such, Lake Erie smallmouth bass are an excellent candidate for a more comprehensive study of bass bioenergetics, mortality rates, and population/fish community dynamics.

For more than a decade yellow perch status has been considerably improved relative to an earlier period of low abundance through the 1990's. Excellent juvenile recruitment during several recent years, coupled with a conservative harvest strategy by eastern basin jurisdictions (Yellow Perch Task Group 2014), seem to have fostered improved status of yellow perch in Lake Erie's eastern basin, the lake's least biologically productive zone. However, the gillnet index of yellow perch abundance has been decreasing since 2011. This decrease has yet to influence yellow perch angler catch rates, which were measured at their highest level in 2014 (see Section N).

Long term index netting remains invaluable as a tool to quantify and understand the relationships between fishing mortality, age structure, and year class strength. Index gillnetting in the New York waters of Lake Erie is one of our most important tools for informing management and to ensure the continued sustainability of Lake Erie sport fish populations.

References

Crane, Derek P., J. M. Farrell, D. W. Einhouse, J. R. Lantry and J. L. Markham. 2015. Trends in body condition of native piscivores following invasion of Lakes Erie and Ontario by the round goby. Freshwater Biology (2015) 60, 111 – 124.

Einhouse, D. W., W. J. Culligan, and J. Prey. 2002. Changes in the smallmouth bass fishery of New York's portion of Lake Erie with Initiation of a spring black bass season. American Fisheries Society Symposium 31:603-614, 2002.

Green, D. M., B. L. Schonhoff, and W. D. Youngs. The New York State Bass Study 1977-1980, Use of angler Collected Data to Determine Population Dynamics. New York State Department of Environmental Conservation, Bureau of Fisheries report. April, 1986.

Ryan, P., S. Orsatti, D. Einhouse, D. Davies, R. Knight, M. Rawson, M. Turner, J. Murphy, and S. Nepszy. 1993. Interagency Protocol for Index Fishing with Gill Nets in Lake Erie. Report to the Standing Technical Committee and the Great Lakes Fishery Commission. September, 1993.

YPTG 2014. 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

Jason M. Robinson

Introduction

Following 1986 legislation that prohibited the use of gill nets in New York waters of Lake Erie, a small commercial trap and hoop net fishery targeting yellow perch emerged and has remained for the last 28 years. Four fishermen were issued licenses and two reported commercial fishing activity during 2014.

Methods

Commercial fishermen are required to submit monthly reports summarizing daily fishing effort and catches. The standard unit of effort is the number of net lifts that occurred, irrespective of the amount of time the gear may have fished. Catches are reported as pounds harvested. Non-target species returned to the lake are not always reported. Due to increased fishing activity in the last 10 years, we resumed collections of yellow perch ageing structures (anal spines) beginning in 2005 to assess the age distribution of the commercial harvest. These data, along with harvest and effort totals are reported annually to the Lake Erie Committee's Yellow Perch Task Group (YPTG) to produce a comprehensive, basin-wide summary of yellow perch status in the eastern basin of Lake Erie (Yellow Perch Task Group 2014).

Results

Commercial catch reported by two fishermen in 2014 totaled 10,355 lbs. of yellow perch, 1,885 lbs. of burbot, 319 lbs. of rock bass, 315 lbs. of catfish, 137 lbs. of suckers, 100 lbs. of walleye, 74 lbs. of white perch, and 2 lbs. of bullhead. The walleye catch was not harvested because walleye are not a salable species. The 2014 commercial yellow perch harvest declined 35 percent from 2013, and was the lowest reported harvest since 2007; accompanying trap netting effort decreased 43 percent (Figure E.1). Seasonal fishing activity in 2014 extended from April through November, with the greatest yellow perch yield during May (Table E.1).

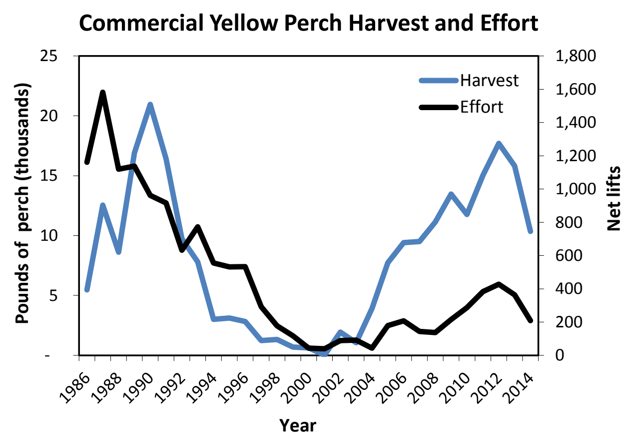


Figure E.1. Total commercial yield of yellow perch, and trap net lifts, reported by commercial fisherman operating in New York's portion of Lake Erie, 1986 to 2014.

Table E.1. The distribution of catch and effort of the four most reported species in New York's 2014 Lake Erie commercial fishery.

	Comercial catch of prominent species (lbs)				Effort
Month	Yellow Perch	Burbot	Rock Bass	Catfish	(# of lifts)
Apr	33	5			4
May	7,335	85			44
Jun	1,425	145	1		26
Jul	228	385	30		18
Aug	299	1,000	103	45	33
Sep	617	130	10	150	46
Oct	409	135		120	38
Nov	9		175		
Total	10,355	1,885	319	315	209

We sampled commercially harvested yellow perch on three occasions during periods of high commercial fishing activity in May and June to characterize age distribution of the 2014 commercial harvest. Age determination from 150 yellow perch anal fin samples identified 8 cohorts that ranged from age-3 to age-10, but age-4 through age-7 age groups comprised 88% of the sample (Figure E.2). The mean length of yellow perch from this sample was 9.5 inches and the sex ratio was strongly skewed to mature males; 83% of the yellow perch examined were males expressing gametes, and with the exception of one identified female, gender could not be determined externally for the remaining fish.

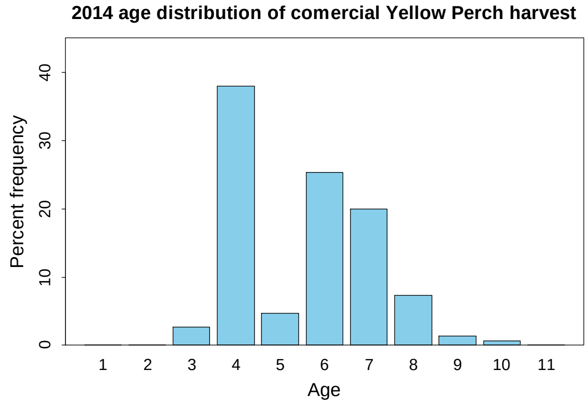


Figure E.2. Percent frequency age distribution of 150 yellow perch sampled from the commercial harvest in New York's portion of Lake Erie, May and June 2014.

Discussion

A small trap net fishery in the vicinity of Barcelona Harbor targeting yellow perch has continued since 1986 in New York's portion of Lake Erie. Commercial fishing activity has been somewhat elevated during the most recent 10 year period (2005 to 2014), generally corresponding to a period of increased yellow perch abundance in Lake Erie's eastern basin. Despite recent increased commercial fishing activity, recreational fishery harvest accounted for an estimated 93% of the total measured harvest (commercial and recreational combined) in New York's waters during 2014. Nevertheless, significant expansion of the commercial fishery is not recommended, as it could become increasingly difficult to maintain New York's long-term yellow perch harvest within internationally established limits if total allowable catches (TAC) needed to be sharply reduced. In 2003, New York harvested 96 percent of its yellow perch TAC share (YPTG 2014).

References

Yellow Perch Task Group. 2014. Report of the Lake Erie Yellow Perch Task Group, March 2014. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

F. COLDWATER GILL NET ASSESSMENT

James L. Markham

Rehabilitation of a self-sustaining lake trout population in the eastern basin of Lake Erie continues to be a major element of New York's Great Lakes coldwater fisheries management programs, in cooperation with member agencies of the Great Lakes Fishery Commission's Lake Erie Committee (LEC), the U.S. Fish and Wildlife Service (USFWS), and the US Geological Survey's Lake Erie Biological Station at Sandusky, Ohio. A lake trout management plan (Markham et al. 2008) was approved by the LEC in 2008 and serves as a guide for ongoing rehabilitation efforts.

New York's 2014 annual coldwater assessment program consisted of: (1) standardized deepwater gill netting in August, and (2) monitoring sea lamprey wounding on lake trout (see Section G). Additional netting in November to sample the lake trout spawning population was not conducted in 2013 and 2014 due to poor weather conditions.

Methods

A standardized, random transect design gill net sampling protocol has been employed to assess the lake trout population in the New York waters of Lake Erie since 1986. Sampling is conducted in August each year, following lake stratification. LORAN-C lines of position having a relative North/South orientation are used to establish 13 equidistant candidate transects in each of two areas from Dunkirk west to the New York/Pennsylvania boundary. This zone delineates summertime lake trout habitat in the New York waters of Lake Erie. Six randomly selected transects in each of the two areas are sampled each survey year. Five net gangs are fished per sampling night on each transect, yielding 60 lifts annually. However, if bias is encountered (i.e., major thermocline shift overnight), lifts are deleted and/or the entire transect may be reset another day.

On any given transect, the first net gang (#1) is fished parallel with shore (on contour), at or below the 50°F isotherm. Each net gang consists of 10 randomly placed, 50 foot panels of monofilament mesh, ranging from 1.5 to 6.0 inch by 0.5 inch increments (standard mesh sizes). In 1996, additional 50 foot panels of 7.0 and 8.0 inch mesh were added to each net gang to improve collections of older-aged lake trout (Culligan et al. 1997). Each gang is 600 feet total length. Each of the next three successive net gangs are set on bottom along contours at increments of 5.0 feet greater depth or 0.5 miles distance from the previous gang, whichever occurs first, along the transect in a northerly (deeper) direction. The fifth gang is set 50 feet deeper than the shallowest gang (#1) or 1.0 mile distant from the fourth gang, whichever occurs first.

Data gathered from lake trout include total length, weight, sex, maturity, stomach contents, fin clips, and sea lamprey attacks. Snouts are retained from all lake trout for coded-wire tag retrieval. Otoliths are collected from any lake trout without a clip or coded-wire tag. Secondary targets (i.e. burbot, whitefish, and other salmonids) are processed using the same protocol. Otoliths and/or scales are collected from all secondary targets as needed.

Klondike strain lake trout are an offshore form from Lake Superior and are thought to behave differently than commonly stocked "Lean" strain lake trout. Klondikes were first stocked in Lake Erie in 2004, and are separated in most analyses to examine differences with all Lean strain lake trout. Lean strain lake trout comprise all other strains stocked, including Finger Lakes, Lake Champlain, Slate Island, and Lewis Lake.

In 2014, a slight adjustment to the long term standard procedures was implemented to determine the extent of the lake trout distribution in offshore portions of the basin that are outside of the standard sampling program, and to assess whether population characteristics differed between these offshore and traditional sampling areas (Figure F.1). A total of 10 of the standard 60 gill net gangs were switched to new locations to sample lake trout in the offshore areas, and consequently two fewer transects were sampled this survey year. The offshore sampling locations were randomly selected from a grid system.

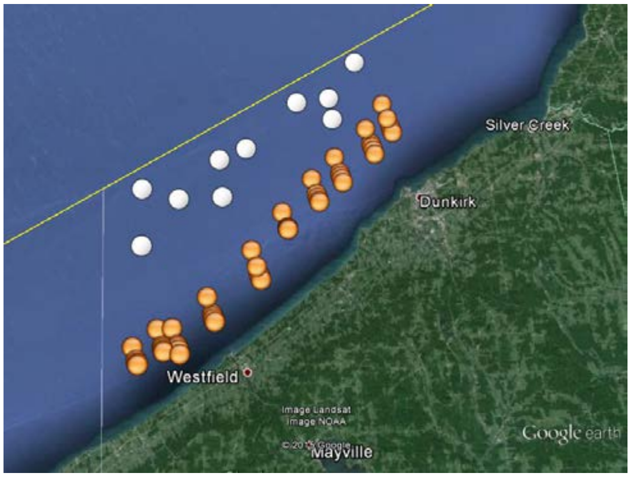


FIGURE F.1. Locations of individual gill nets used for assessment of coldwater species in the New York waters of Lake Erie, August 2014. White dots indicate locations of ten randomly selected offshore nets set outside of the standard sampling protocol.

Results

The 2014 lake trout gill net assessment in New York's portion of Lake Erie sampled 837 individuals in 60 lifts. This was the most lake trout sampled in the 30-year survey time series. Aside from the ten non-standard sites used to sample the deep areas, one other sample was considered biased due to a temperature shift; none of these eleven samples were included in abundance estimates. Fifteen age classes, ranging from age 1 to 19, were represented in the sample of 744 known-age fish (Tables F.1 and F.2). Ages 4 through 6 were the most abundant cohorts, representing 80% of the total catch. Age 10-and-older fish remain in very low abundance. The oldest fish sampled in 2014 was a 19 year old female from the 1993 year class.

Growth and Maturity

Mean length-at-age and weight-at-age of Lean strain lake trout remains consistent with averages from the previous ten years (2004-2013) (Figures F.2 and F.3). Small variations in both mean length and weight compared to the ten year average occur at older ages and seem to be an artifact of low sample sizes. Consistent with past results, mean length and weight of Klondike strain lake trout were significantly lower than Lean strain lake trout at ages 4-and-older (two sample t-test; $P<0.01$). In general, Klondike strain lake trout are smaller in both length and weight by age-3 compared to Lean strain fish.

TABLE F.1. Number, mean total length (inches TL), mean weight (lbs.), and percent maturity of known age and sex lake trout (**Lean strain**) by age class collected in gill nets (all mesh sizes) from New York waters of Lake Erie, August 2014.

AGE	SEX	NUMBER	MEAN LENGTH (inches TL)	MEAN WEIGHT (pounds)	PERCENT MATURE
2	Male	5	16.2	---	0.0
	Female	3	16.1	1.5	0
3	Male	1	19.3	---	100.0
	Female	1	19.6	2.7	0
4	Male	152	25.1	7.1	99
	Female	62	25.5	7.7	48
5	Male	109	26.9	8.7	100
	Female	109	27.4	9.5	99
6	Male	59	27.8	9.7	100
	Female	42	28.3	10.7	100
7	Male	33	28.6	10.6	100
	Female	27	29.1	11.8	100
8	Male	17	29.7	12.3	100
	Female	14	30.8	13.2	100
9	Male	1	30.2	12.2	100
	Female	0	---	---	100
11	Male	7	32.1	16.4	100
	Female	8	31.6	13.4	100
12	Male	3	33.1	17.5	100
	Female	6	31.5	14.0	100
13	Male	2	31.9	---	100
	Female	4	32.8	16.8	100
14	Male	3	32.6	18.1	100
	Female	1	32.4	17.3	100
15	Male	2	30.6	---	100
	Female	1	33.9	16.5	---
19	Male	0	---	---	100
	Female	1	33.9	20.6	---

TABLE F.2. Number, mean total length (inches TL), mean weight (lbs.), and percent maturity of known age and sex lake trout **(Klondike strain)** by age class collected in gill nets (all mesh sizes) from New York waters of Lake Erie, August 2014.

AGE	SEX	NUMBER	MEAN LENGTH (inches TL)	MEAN WEIGHT (pounds)	PERCENT MATURE
4	Male	1	21.9	4.4	0
	Female	1	21.5	---	0
6	Male	30	24.8	6.9	100
	Female	30	25.6	8.0	100
7	Male	6	25.6	7.6	83
	Female	0	---	---	100
8	Male	0	---	---	100
	Female	1	27.5	10.5	100
10	Male	2	26.4	8.5	100
	Female	0	---	---	-----

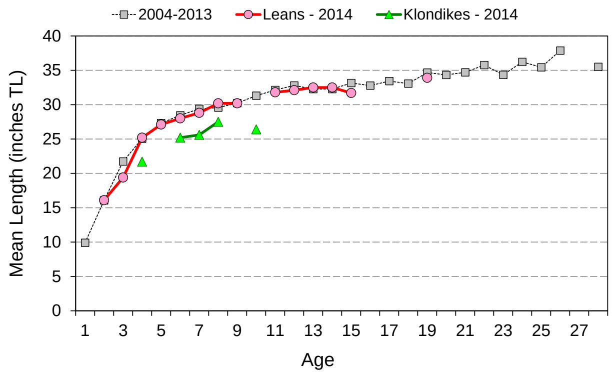


FIGURE F.2. Mean length-at-age of Lean strain and Klondike strain lake trout collected in gill nets from New York waters of Lake Erie, August 2014, and the 10-year average from 2004-2013 for current growth rate comparison.

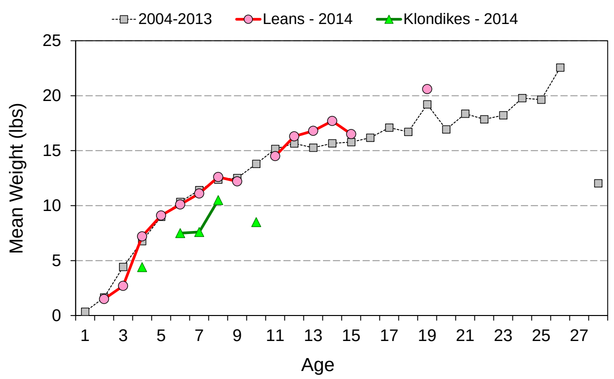


FIGURE F.3. Mean weight-at-age of Lean strain and Klondike strain lake trout collected in gill nets from New York waters of Lake Erie, August 2014, and the 10-year average from 2004-2013 for current growth rate comparison.

Lean strain lake trout males are 100% mature by age-4, and females by age-5 (Table F.1). Despite differences in growth, Klondike strain lake trout have similar maturity schedules to Lean strain fish in Lake Erie (Table F.2).

Overall Abundance

The relative abundance of lake trout caught in 2014 assessment netting was 12.9 lake trout/lift in 2014 (Figure F.4). This was the highest estimate in the time series and continues a general trend of increasing abundance that began in 2000. This was the ninth consecutive year that lake trout abundance was above the time series average of 4.8 fish/lift. Overall abundance in New York was above the lake trout management plan objective of 8.0 fish/lift, but basinwide abundance estimates remain below target (Markham et al. 2008; Coldwater Task Group 2014).

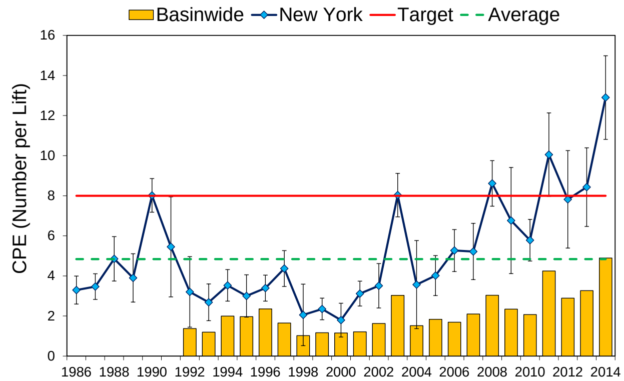


FIGURE F.4. Catch per effort (number fish/lift) and confidence limits (approximated as 2 SE's) of lake trout caught in standard assessment gill nets (mesh sizes 1.5 – 6.0 in) from New York waters of Lake Erie, August 1986-2014. Basinwide abundance, target basinwide abundance, and NY series average are also shown.

The burbot abundance index in 2014 was 0.6 fish/lift, which was an 8% decrease from 2013 and below the time series average of 2.0 fish/lift for the sixth consecutive year (Figure F.5). This was the lowest measure of burbot abundance in this survey since 1987. Contrary to lake trout, burbot abundance has declined 88% since 2004.

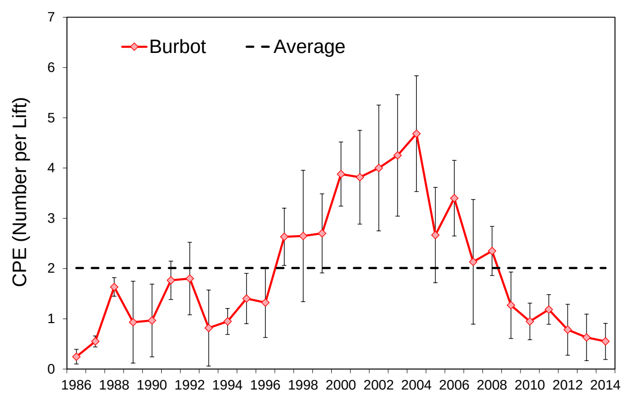


FIGURE F.5. Catch per effort (number fish/lift) and confidence limits (approximated as 2 SE's) of burbot caught in standard assessment gill nets (mesh sizes 1.5 – 6.0 in) from New York waters of Lake Erie, August 1986-2014. Dashed line indicates time series average.

Whitefish catches continue to be highly variable in this survey (as depicted by large confidence limits), both between years and within years. Whitefish abundance decreased in 2014 to 1.2 fish/lift, below the time series average of 2.8 fish/lift for the second consecutive year (Figure F.6). Whitefish abundance has declined 90% since a peak observed in 2007.

Other notable species caught during the survey included 9 brown trout, 33 yellow perch, 50 white bass, and 48 walleye. This was the fourth highest abundance of walleye caught in the coldwater assessment survey and above the time series average for the seventh consecutive year (Figure F.7). Walleye abundance in this survey has been generally increasing since the early 2000s.

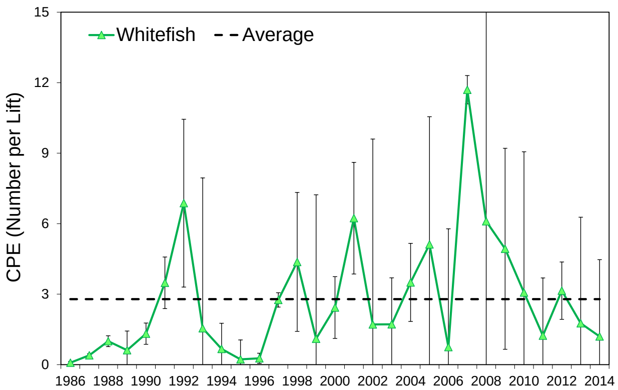


FIGURE F.6. Catch per effort (number fish/lift) and confidence limits (approximated as 2 SE's) of whitefish caught in standard assessment gill nets (mesh sizes 1.5 – 6.0 in) from New York waters of Lake Erie, August 1986-2014. Dashed line indicates time series average.

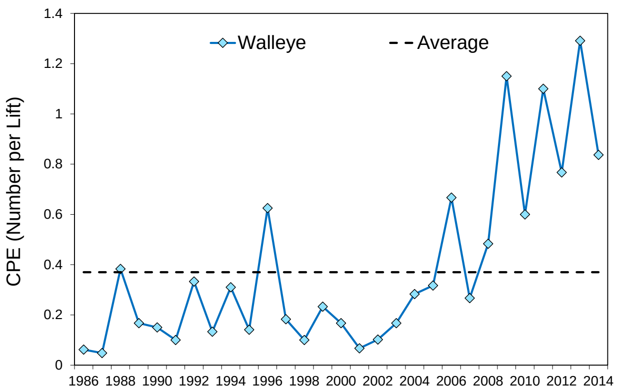


FIGURE F.7. Catch per effort (number fish/lift) of walleye caught in coldwater assessment gill nets (all mesh sizes) from New York waters of Lake Erie, August 1986-2014. Dashed line indicates time series average.

Abundance by Age

The relative abundance of lake trout by age shows ages 4, 5, and 6 were the most prevalent cohorts caught in the survey (Figure F.8). This breaks a pattern that has occurred since 2002 of younger sub-adult cohorts (≤ age-5) dominating the catches. An increase was also observed in the relative abundance of lake trout age-7-and-older (Figure F.9). This metric had shown a lower abundance of age 7+ lake trout from 2004-2013 (0.61 fish/net) compared to the 1997-2003 (1.39 fish/net) time period. The 2014 index (1.82 fish/net) was the second highest value in the series.

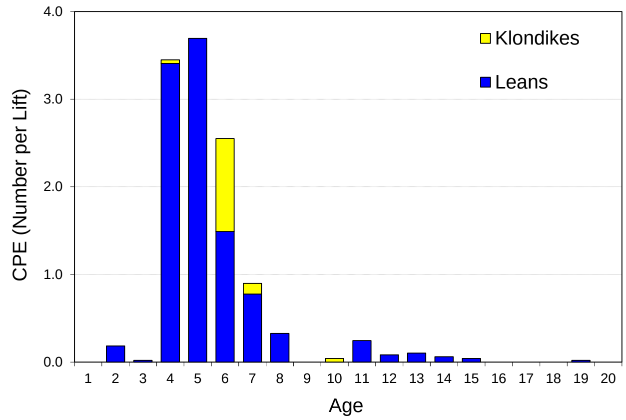


FIGURE F.8. Relative abundance by age of Lean strain and Klondike strain lake trout collected from standard assessment gill nets fished in New York waters of Lake Erie, August 2014.

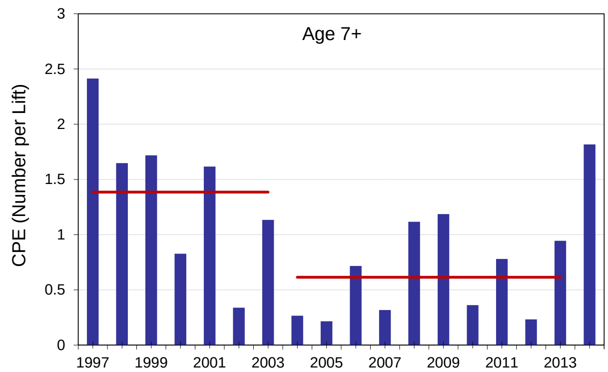


FIGURE F.9. Relative abundance of age-7-and-older lake trout collected from assessment gill nets (all mesh sizes) fished in New York waters of Lake Erie, August 1997-2014. Red lines represent averages for their respective time periods.

Adult Abundance

The relative abundance of age-5-and-older lake trout in the New York waters of Lake Erie increased in 2014 to 8.1 fish/lift, representing the highest index in the time series (Figure F.10). This is over twice the 2013 value and over four times the 2012 index, and well above the average of 1.9 fish/lift. Adult abundance in New York waters was above the objective of 2.0 fish/lift established in the lake trout management plan for the second consecutive year (Markham et al. 2008). Overall basinwide adult abundance increased above target levels for the first time (Coldwater Task Group 2014).

The catch per lift (CPE) of mature females age-6-and-older in Lake Erie, representing mature, repeat spawning fish, was 2.37 fish/lift in 2014 (Figure F.11). This was the highest value lakewide in the time series and over four times as high as the 2013 estimate. It was also well above the time series average (0.48 fish/lift). The basinwide index increased above target levels established in the lake trout management plan for the first time (Markham et al. 2008, Coldwater Task Group 2014).

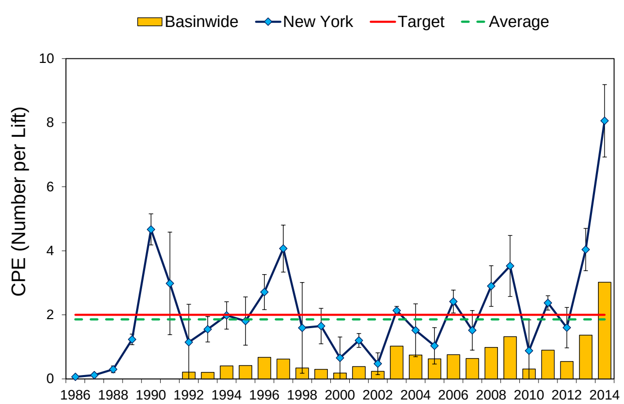


FIGURE F.10. Relative abundance of age-5–and-older lake trout collected from standard assessment gill nets fished in New York waters of Lake Erie, August 1985-2014. Confidence intervals are approximated as 2 SE's. Basinwide abundance, target basinwide abundance, and NY series average are also shown.

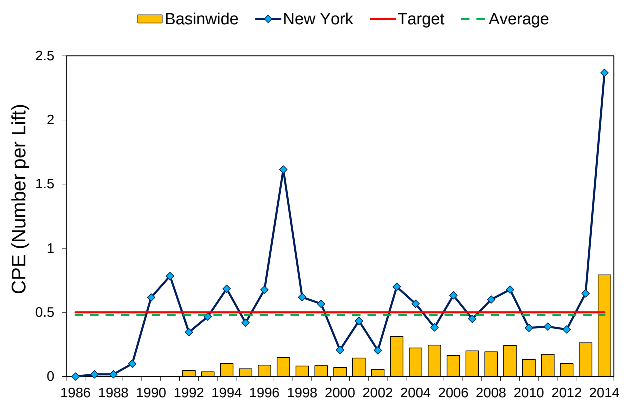


FIGURE F.11. Relative abundance of mature females age-6-and-older from standard assessment gill nets (mesh sizes 1.5 – 6.0 in) in New York waters of Lake Erie, August 1985–2014. Basinwide abundance, target basinwide abundance, and NY series average are also shown.

Survival

Estimates of annual survival (S) for individual cohorts were calculated by strain and year class using a 3-year running average of CPE with ages 4 through 11. A running average was used due to the high year-to-year variability in catches. Mean overall adult survival estimates varied by strain and year. Survival estimates prior to 1986 are low due to excessive mortality from a large, untreated sea lamprey population. Substantial increases in lake trout survival occurred following the first successful treatments of sea lamprey in Lake Erie in 1986. Survival estimates during this period (1987-91) ranged from 0.71 for the Superior (SUP) strain to 0.93 for the Finger Lakes (FL) strain, and from 0.62 – 0.77 for all strains combined, which was higher than the target survival rate of 60% or higher (Lake Trout Task Group 1985; Markham et al. 2008) (Table F.3).

More recent estimates indicate that survival has declined well below target levels, presumably due to increased levels of sea lamprey predation (see Section G). Survival estimates of the 1997-2001 year classes of SUP strain lake trout range from 0.23-0.44 (Table F.3). Survival estimates from the 1996, 1997, and 1999-2003 FL strain are much higher, but were generated from very low sample sizes. More recent estimates from the 2005 year class of FL strain indicate lower survival rates. All recent survival estimates are below the ranges previously observed for these strains during the period of successful lamprey control.

TABLE F.3. Cohort 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, 1985–2014. Three-year running averages of CPE from ages 4–11 were used due to year-to-year variability in catches. Shaded cells indicate survival estimates that fall below the 0.60 target rate. Asterisk (*) indicates years where only partial ages were available.

	STRAIN				
Year Class	**LL**	**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	0.616				0.615
1992	0.568				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	0.76		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*				0.417	0.420
2005*			0.409		0.682
2006*			0.726	0.143	0.715
2007*			0.737	0.481	0.851
MEAN	**0.592**	**0.575**	**0.727**	**0.321**	**0.603**

Estimates of the 2003, 2004, 2006 and 2007 year classes of Klondike (KL) strain fish indicate very low survival rates at adult ages that are comparable to survival rates of SUP strain lake trout from the 1997-2001 year classes. Mean overall survival estimates were above the target of 60% or higher (Lake Trout Task Group 1985; Markham et al. 2008) for the FL strain but below target for the Lewis Lake (LL), SUP, and KL strains. The Finger Lakes strain, the most consistently stocked lake trout strain in Lake Erie, had an overall mean survival estimate of 0.73. Mean overall survival for all strains combined was at target levels.

Strains

Six different lake trout strains were among the 745 fish caught with hatchery-implanted coded-wire tags (CWT's) or fin-clips (Table F.4). Lake Champlain (LC), KL, and FL strains remain the most numerous strains caught in Lake Erie in 2014. Lake Champlain strain have been the most stocked lake trout in Lake Erie in the past six years and had the highest returns in 2014. Klondike strain lake trout have only been stocked in low amounts for six of the last eleven years while FL strain has been the most numerous and consistent strain stocked (see Section H, Figure H.2). All other Lean lake trout strains (Lewis Lake (LL), Slate Island (SI), Traverse Island (TI), Apostle Island (AI), Michipocoten (MIC), Lake Ontario (LO), and Lake Erie (LE) remain minor contributors in survey catches. Superior (SUP) strain lake trout, previously a commonly stocked and the most prevalent strain encountered in assessment nets a decade ago, have been declining for several years and none were caught for the third consecutive year. The FL strain remains the most common lake trout strain caught at older ages; all but nine lake trout age-7-and-older were FL strain fish.

TABLE F.4. Number of lake trout per stocking strain by age collected in gill nets from New York waters of Lake Erie, August 2014. Stocking strain codes are: FL = Finger Lakes, LO = Lake Ontario, KL = Klondike, LL = Lewis Lake, SI = Slate Island, TI = Traverse Island, AI = Apostle Island, LC = Lake Champlain, LE = Lake Erie, and MIC = Michipocoten. Shaded cells indicate cohorts with a stocking history.

AGE	FL	LO	KL	LL	SI	TI	AI	LC	LE	MIC
1										
2	7							7		
3					1					
4			2		1			213		
5								214		
6	71		60	2			3	25		
7	60		6							
8	31		1							
9	1									
10			2							
11	15									
12	9									
13	6									
14	4									
15	3									
16										
17										
18										
19	1									
20										
21										
22										
23										
24										
25										
26										
27										
28										
29										
30										
TOTAL	**208**	**0**	**71**	**2**	**2**	**0**	**3**	**459**	**0**	**0**

Diet

Stomach analysis of lake trout and burbot revealed diets exclusively comprised of fish (Table F.5). Rainbow smelt have been the long-term main prey item for lake trout, but round gobies have become more prominent in recent years, especially when smelt are less abundant. Klondike strain lake trout have typically shown a higher incidence of round gobies in stomach contents compared to lean lake trout strains (Markham 2010).

In 2014, rainbow smelt was the dominant diet item for Lean strain lake trout (70%), but round gobies were more prominent in Klondike strain fish (69%) (Table F.5). Conversely, round goby was the second most common prey item in Lean lake trout stomachs (40%) while smelt was in Klondike stomachs (54%). Yellow perch was the only other identifiable fish species found in lake trout stomachs in 2014.

TABLE F.5. Frequency of occurrence of diet items from non-empty stomachs of lake trout and burbot collected in gill nets from New York waters of Lake Erie, August 2014.

PREY SPECIES	Lean Lake Trout (N=388)	Klondike Lake Trout (N=26)	Burbot (N=16)
Smelt	271 (70%)	14 (54%)	4 (25%)
Round Goby	155 (40%)	18 (69%)	11 (69%)
Yellow Perch	3 (>1%)		1 (6%)
Trout Perch			1 (6%)
Unknown Fish	22 (6%)		1 (6%)
Number of Empty Stomachs	333	38	4

Similar to Klondike strain lake trout, burbot stomachs typically have a higher incidence of round gobies. Consistent with past observations, round gobies were the most abundant prey species for burbot in 2014, occurring in 69% of burbot stomachs (Table F.5). Rainbow smelt were the second most common prey (25%) in burbot samples. One yellow perch and one trout perch were the only other identifiable prey item in burbot stomachs.

Pilot Offshore Survey

A total of 67 lake trout were caught in the ten offshore nets in 2014 (see Figure F.1). Net depths ranged from 94 to 156 feet, and fewer lake trout were generally encountered in the net locations where depth exceeded 140 feet compared to shallower locations (Figure F.12). CPE in offshore nets was 5.5 lake trout per lift, which was less than half the catch rate for lake trout encountered in the standard assessment net locations (12.9 lake trout/lift). The age distribution and strain composition of the lake trout from the offshore nets were similar to the lake trout caught in the standard net locations (Figure F.13). Other species caught included whitefish, burbot, white bass, yellow perch, and walleye.

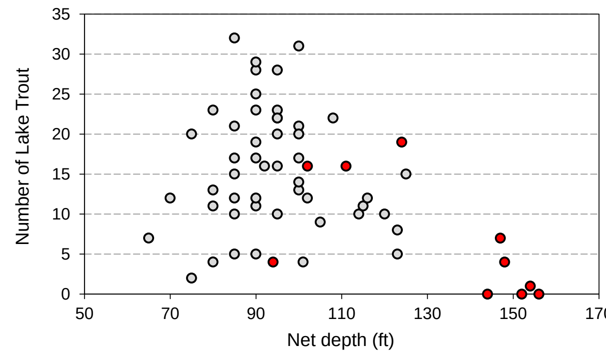


FIGURE F.12. Number of lake trout caught per net for each sampled depth (ft) for all assessment gill nets fished in the New York waters of Lake Erie, August 2014. Red dots signify catches from offshore nets.

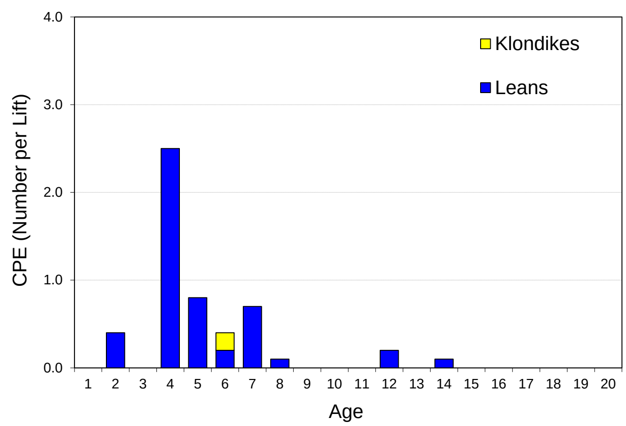


FIGURE F.13. Relative abundance by age of Lean strain and Klondike strain lake trout collected from offshore assessment gill nets fished in New York waters of Lake Erie, August 2014.

Discussion

Overall lake trout abundance in the New York waters of Lake Erie continues to increase and was at its highest level measured in the 30-year time series in 2014. However, the age structure of the population appears to be changing compared to the past decade. Prior to 2014, young, sub-adult lake trout (≤ age-4) comprised the bulk of the population. However, in 2014 older sub-adults (age-4) and young adults (ages 5 and 6) comprised the majority of the population. The increased relative abundance of young adults was also evident in time-series highs of both age-5-and-older lake trout and mature females metrics. The higher stocking rates since 2008 (see Section H) are likely responsible for the increased abundance as well as seemingly good returns from the more recently stocked Lake Champlain (LC) strain lake trout. Perhaps the increases in adult lake trout are also an indication of a very recent improvement in survival of adult aged fish, although wounding rates on lake trout continue to be well above target levels (see Section G).

Poor survival of adult lake trout since the 1997 year class coincides with an increase in the Lake Erie sea lamprey population in 1997 (see Section G). Lake trout strains from Lake Superior, which include Superior and Klondike strains, continue to perform the poorest and appear to be more susceptible to attacks from sea lampreys than other strains from outside Lake Superior (i.e. FL strain) (Schneider et al. 1996). Klondike strain lake trout, which exhibited excellent post-stocking survival and high sub-adult abundance, have declined rapidly as adults. Adult survival estimates for this strain are very low (0.14 – 0.48). Likewise, Superior strain lake trout had an average survival rate of 0.36 (range 0.23 – 0.44) for year classes stocked from 1997 – 2001. Comparatively, FL strain lake trout during this same time period had an average survival rate of 0.77 (range 0.70 – 0.85). The Lake Erie lake trout rehabilitation plan recommends a diversity of lake trout strains for successful re-establishment of lake trout stocks (Markham et al. 2008). However, with Lake Erie's continuing sea lamprey issues, it now appears more appropriate to eliminate stocking strains that are most susceptible to sea lamprey mortality as adults despite their favorable performance at younger ages. Instead, strains that survive sea lamprey attacks or avoid them altogether, such as the FL strain and possibly the Lake Champlain (LC) strain (which is predominately FL strain genetically), should be emphasized to provide the best opportunity for restoration.
Very recently a large portion of Lake Erie's lake trout stocking has been re-distributed to locations in Ohio and Pennsylvania (as opposed to New York) in an attempt to increase adult lake trout populations near seemingly more favorable spawning habitat. Consequently, this may affect our ability to gauge stocking success through returns of age-2 lake trout in New York assessment efforts, mainly because young lake trout do not appear to stray away from their stocking locations and will be less likely to be encountered in New York survey nets. In 2014, there were a total of 14 age-2 lake trout sampled in New York's coldwater gill net assessment, and five of these were stocked in Ohio, six in Pennsylvania, and three in New York.

The pilot offshore netting program conducted in 2014 proved useful for gathering an improved understanding of lake trout distribution in the New York waters of Lake Erie and for establishing baseline estimates of abundance and strain composition in areas outside of our standard assessment netting program. This new component of our survey netting indicated that there were substantial numbers of lake trout residing outside our standard sampling locations. However, lake trout relative abundance in the offshore nets was generally much lower than in nets set at standard survey locations. Abundance appeared to decline at depths over 140 feet; maximum lake trout densities occurred in much shallower (85-110 feet) locations. Thus, while our standard assessment provides a measure of relative abundance, the pilot offshore component indicates that the higher densities of lake trout in shallower depths does not reflect the abundance in regions exceeding 140 feet. Lake trout catches in the offshore nets did not appear to show a large difference in age distribution or strain composition compared to catches at shallower depths. We recommend this offshore component of the coldwater gillnet survey be continued at least two additional years to determine the importance of offshore regions for characterizing lake trout dynamics in the eastern basin of Lake Erie.

References

Coldwater Task Group. 2014. Report of the Lake Erie Coldwater Task Group, March 2014. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Culligan, W. J., F. C. Cornelius, D. W. Einhouse, D. L. Zeller, R. C. Zimar, B. J. Beckwith, and M. A. Wilkinson. 1997. NYSDEC Lake Erie 1997 Annual Report to the Lake Erie Committee. New York Department of Environmental Conservation, Albany.

Markham, J.L. 2010. Coldwater gill net assessment. Section F *in* Einhouse, D.W., J.L. Markham, K.A. Kapuscinski, M.L. Wilkinson, M.T. Todd, D.L. Zeller, R.C. Zimar, and B.J. Beckwith. NYSDEC Lake Erie 2009 Annual Report. New York State Department of Environmental Conservation, Albany, New York, USA.

Lake Trout Task Group. 1985. A Strategic Plan for the Rehabilitation of Lake Trout in Eastern Lake Erie. Report to the Great Lakes Fishery Commission's Lake Erie Committee, Ann Arbor, Michigan, USA.

Markham, J., A. Cook, T. MacDougall, L. Witzel, K. Kayle, C. Murray, M. Fodale, E. Trometer, F. Neave, J. Fitzsimons, J. Francis, and M. Stapanian. 2008. A strategic plan for the rehabilitation of lake trout in Lake Erie, 2008-2020. Lake Erie Committee, Great Lakes Fisheries Commission, Ann Arbor, MI. Available at http://www.glfc.org/lakecom/lec/LEC_docs/other_docs/manplan2008.pdf [accessed 14 January 2008]

Schneider, C.P., R.W. Owens, R.A. Bergstedt, and R. O'Gorman. 1996. Predation by sea lamprey (*Petromyzon marinus*) on lake trout (*Salvelinus namaycush*) in southern Lake Ontario, 1982-1992. Canadian Journal of Fisheries and Aquatic Sciences 53(9):1921-1932.

G. 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 undoubtedly played an integral part in the eventual demise of Lake Erie's lake trout population. The Strategic Plan for Lake Trout Restoration in Eastern Lake Erie formulated in 1985 (Lake Trout Task Group 1985) pointed to the lack of lamprey treatment as a bottleneck for 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 lamprey control. Since 1986, the Great Lakes Fisheries Commission has conducted regular lampricide treatments of key Lake Erie tributaries to control lamprey populations and mitigate damage inflicted on the lake's coldwater fish community.

This report outlines sea lamprey assessment efforts undertaken by the New York State Department of Environmental Conservation's (DEC's) Lake Erie Unit. Two types of DEC assessments monitor adult sea lamprey abundance: 1) a long term wounding rate index on lake trout and other species, and 2) an index of sea lamprey nest counts on standard stream sections. Other lake wide adult and larval sea lamprey assessments, plus all Lake Erie sea lamprey control efforts, are pursued by the United States Fish and Wildlife Service and the Department of Fisheries and Oceans Canada in partnership through the Great Lakes Fishery Commission. A full report of these activities can be found in the Lake Erie Coldwater Task Group Report (Coldwater Task Group 2014).

Methods

Wounding Rate Assessment

Lake trout are the only Lake Erie salmonine used for sea lamprey wounding assessments due to availability throughout the Great Lakes and vulnerability to sea lamprey attacks. More recently, sea lamprey wounds on burbot have also been reported due to observed population declines. Samples are obtained from gill net assessments targeting lake trout, burbot and other coldwater species during August along New York's portion of Lake Erie from Dunkirk westward to the New York/Pennsylvania boundary.

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 frequencies on lake trout are reported as the number of fresh (A1-A3) wounds per 100 fish. 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. Burbot wounding rates are reported for fresh (A1-A3) and A4 wounds on all individuals.

In 2013 and 2014, a pilot program was undertaken to record lampreys observed by anglers attached to fish, and lamprey wounds on harvested fish during the Open Lake Sport Fishing Survey (see Section N). During interviews, angler survey technicians asked anglers if they observed lampreys on any fish that they caught, and also recorded wounds (fresh or healed) observed on any harvested fish. This information minimally provides a list of sport fish species attacked by sea lampreys, and perhaps over time would also provide information to create a fish community wounding index.

Sea Lamprey Nest Assessment

Sea lamprey nest counts are conducted annually between June 1 and June 15 on standard sections of four streams: Delaware Creek, Clear Creek, North Branch of Clear Creek, and Canadaway Creek. Nest counts begin following peak adult lamprey catches in portable assessment traps operated by the US Fish and Wildlife Service on Cattaraugus Creek at the base of Springville Dam and at Spooner Creek, a tributary to Cattaraugus Creek. All Clear Creek count sites are located on Seneca Nation of Indian Territory (SNI), and activities there are conducted with permission of the Seneca Nation.

Results

Wounding Rate Assessment

Lake trout collected in coldwater assessment netting (Section F) had a total of 144 A1-A3 wounds observed on 818 lake trout greater than 21 inches TL in 2014, resulting in a wounding rate of 17.6 wounds per 100 fish (Table G.1; Figure G.1). This was an increase from the 2013 wounding rate of 14.2 wounds/100 fish and the third consecutive year wounding rates have increased. Wounding rates remain well above the target rate of 5.0 A1-A3 wounds per 100 fish (Lake Trout Task Group 1985a, Markham et al. 2008), and have been above target for 19 of the past 20 years.

TABLE G.1. Frequency of sea lamprey wounds observed on several standard length groups of lake trout collected from gill nets in New York waters of Lake Erie, August 2014.

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	7	0	0	0	0	0.0	0
21-25	136	1	2	12	27	11.0	19.9
25-29	549	7	38	63	320	19.7	58.3
>29	133	1	6	14	190	15.8	142.9
>21	818	9	46	89	537	17.6	65.6

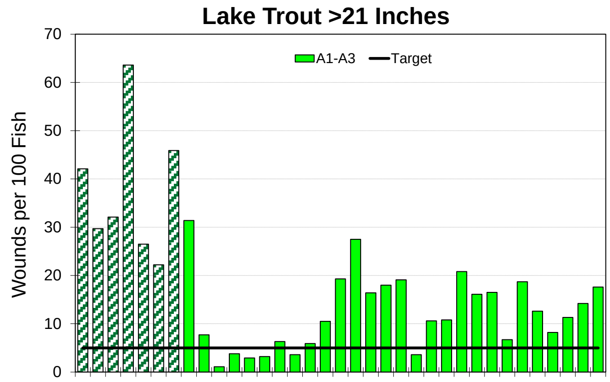


FIGURE G.1. Number of fresh (A1-A3) sea lamprey wounds per 100 adult lake trout greater than 21 inches sampled in gill nets from New York waters of Lake Erie, August - September, 1980-2014. The target wounding rate is $\leq$5% (5 wounds per 100 lake trout). Patterned bars indicate pre-treatment period.

Typically wounding rates increase with increasing lake trout size, with the highest wounding rates on lake trout >29 inches. In 2014, lake trout in the 25-29 inch size class had the highest A1-A3 wounding rate (19.7 wounds/100 fish) with fish >29 inches slightly lower (Table G.1). Lake trout <21 inches rarely show signs of attacks from sea lampreys, and no wounds were evident on this size class in 2014.

Fresh A1 wounds are considered indicators of the attack rate for the current year at the time of sampling (August). Nine A1 wounds were found across all size categories >21 inches in 2014, generating an A1 wounding rate of 1.1 wounds/100 lake trout greater than 21 inches (Table G.1; Figure G.2). This was the lowest A1 wounding rate since 2002 and below the post-treatment series average of 2.2 wounds/100 fish.

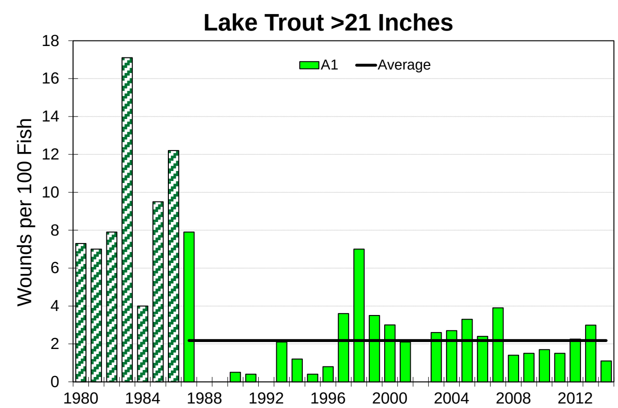


FIGURE G.2. Number of A1 sea lamprey wounds per 100 adult lake trout greater than 21 inches sampled in gill nets from New York waters of Lake Erie, August - September, 1985-2014. The post-treatment average includes 1987 through 2013. Patterned bars indicate pre-treatment period.

Cumulative attacks from previous years are indicated by A4 wounds. Altogether 537 A4 wounds were found on 818 lake trout >21 inches in 2014, resulting in a wounding rate of 65.6 wounds/100 fish (Table G.1). This was the second highest A4 wounding rate in the time series and above the series average (31.1 wounds/100 fish) for the tenth consecutive year (Figure G.3). Similar to past surveys, the highest A4 wounding rates were found on lake trout greater than 25 inches TL (Table G.1). A4 wounding rates on lake trout >29 inches

TL remain very high (142.9 wounds/100 fish) with many fish possessing multiple healed wounds.

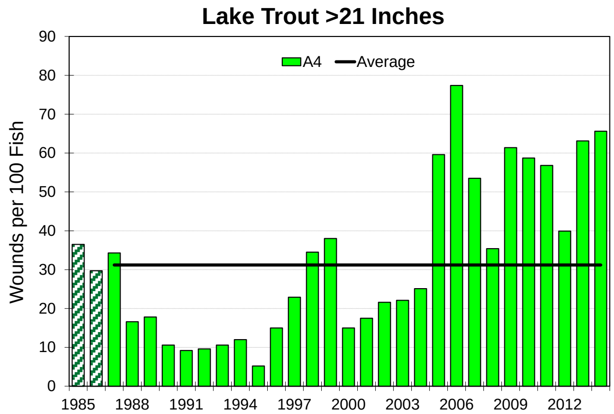


FIGURE G.3. Number of healed (A4) sea lamprey wounds observed per 100 adult lake trout greater than 21 inches sampled in gill nets from New York waters of Lake Erie, August, 1985-2014. The post-treatment average includes 1987 through 2013. Patterned bars indicate pre-treatment period.

Lake Champlain (LC), Finger Lakes (FL) and Klondike (KL) were the most prevalent lake trout strains sampled in 2014 (Table G.2). Similar to the last four years, A1-A3 wounding rates were higher on Klondike strain lake trout while A4 wounding rates were highest on Finger Lakes strain fish. Lake Champlain lake trout are comprised mainly of Finger Lakes mixed with Superior and Clearwater Lake strains, and had A1-A3 wounding rates that were intermediary between FL and KL strain lake trout.

TABLE G.2. Frequency of sea lamprey wounds observed on lake trout >21 inches, by strain, in New York waters of Lake Erie, August 2014. Superior (SUP) strains include Apostle Island, Traverse Island, Slate Island, and Michipicoten strains.

Lake Trout Strain	Sample Size	Wound Classification				No. A1-A3 Wounds Per 100 Fish	No. A4 Wounds Per 100 Fish
		A1	A2	A3	A4		
FL	201	1	11	10	196	10.9	97.5
KL	71	2	11	13	54	36.6	76.1
LC	451	6	21	52	215	17.5	47.7
LL	2	0	0	0	2	0.0	100.0
SUP Strains	4	0	1	1	6	50.0	150.0

Burbot, once the most abundant coldwater predator observed in eastern basin coldwater assessments, have declined since 2004 and are now at low abundance (See Section F). Coincidentally, both A1-A3 and A4 wounding rates on burbot have increased since 2004 in the New York waters of Lake Erie. In 2014, fresh A1-A3 wounding rates on burbot increased slightly to 3.0 wounds/100 fish while the A4 wounding rate decreased to 6.1 wounds/100 fish (Figure G.4). It should be noted that sample sizes used to develop indices of burbot wounding were particularly low the last two sampling years (38 in 2013, 33 in 2014).

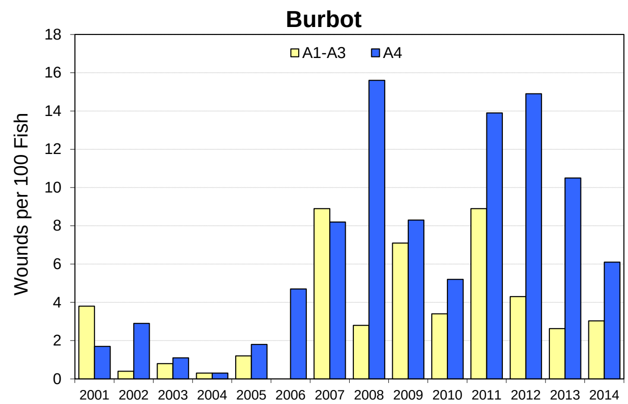


FIGURE G.4. Number of A1-A3 and A4 sea lamprey wounds per 100 burbot (all sizes) sampled in gill nets from New York waters of Lake Erie, August, 2001-2014.

A total of eight sea lamprey wounds were observed by creel survey technicians on 779 fish examined during the 2014 Open Lake Sport Fishing Survey (Table G.3). Five healed wounds were observed on lake trout, one healed wound on steelhead, and one healed and one fresh wound on walleye. Interviewed anglers did not observe lampreys attached to any of their catches during the 2014 open lake survey. These anglers in 2014 reported catching 23 species representing 4,499 individual fish. The previous year (2013) interviewed anglers reported catching five fish with sea lamprey attached.

TABLE G.3. Number of recorded wounds (fresh or healed) on processed fish species during the Open Lake Sport Fishing Survey, May – October 2014.

Species	Wounds Observed Fresh	Wounds Observed Healed	Number of Fish Examined
Steelhead	0	1	12
Brown Trout	0	0	1
Lake Trout	0	5	10
Smallmouth Bass	0	0	20
Yellow Perch	0	0	237
Walleye	1	1	499

Sea Lamprey Nest Assessment

Sea lamprey nest counts were conducted in all four standard streams between 5 June and 10 June 2014. Sampling conditions in 2014 were ideal for conducting the survey with clear and low water conditions. Additionally, a sea lamprey trapping program that occurred in 2013 by the SNI on Clear Creek did not occur in 2014.

The overall index for sea lamprey nesting was 27.0 nests/mile in 2014, which was slightly above the post-treatment time series average of 22.5 nests/mile (Figure G.5). Large numbers of sea lamprey nests were counted on Clear Creek (139; 34.8 nests/mile) and on North Branch Clear Creek (22 nests; 44.0 nests/mile), both tributaries to Cattaraugus Creek (Table G.4). Four nests were found on Canadaway Creek (5.0 nests/mile) while no nests were observed on Delaware Creek for the fifth consecutive year (Table G.3). Nesting rates on both Clear Creek and N. Branch Clear Creek were below their five year mean but above the 1981-2009 time series mean (Table G.3). Nesting rates were at or below means on both Delaware and Canadaway Creeks in 2014. Supplemental sea lamprey nest counts were not conducted on Chautauqua Creek in 2014.

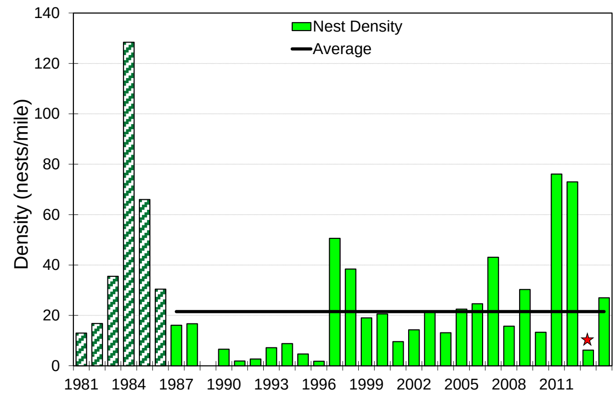


FIGURE G.5. Sea lamprey nest density (nests/mile) from standard stream sections on New York tributaries of Lake Erie, 1981-2014. No sampling was conducted in 1989. * Sea lamprey trapping occurred in Clear Creek in 2013 that may have affected overall nest density estimates. The post-treatment average includes 1987 through 2012. Patterned bars indicate pre-treatment period.

Discussion

Despite ongoing efforts to control sea lamprey in Lake Erie, wounding rates on lake trout and lake-wide estimates of adult sea lampreys (see Coldwater Task Group 2014) continue to indicate the presence of a large sea lamprey population. Larval assessments conducted from 2011-13 revealed that sea lamprey recruitment in Lake Erie is most likely emanating from Lake St. Clair and the St. Clair River in addition to the traditional spawning tributaries located mainly in the lake's eastern basin

TABLE G.4. Minimum, maximum, and mean indices from 1981-2009, and individual year and 5-year mean indices from 2010-2014, of sea lamprey nest density (nests/mile) from standard stream sections on New York tributaries of Lake Erie.

		1981 - 2009			2010-2014					
STD. STREAM SECTION	**Mile**	**Minimum**	**Maximum**	**Mean**	**2010**	**2011**	**2012**	**2013**	**2014**	**5- Year Mean**
Delaware Creek	0.8	0.0	148.8	9.7	0.0	0.0	0.0	0.0	0.0	0.0
Clear Creek	4.0	1.8	148.5	29.9	19.5	87.5	96.5	9.3 *	34.8	59.6
N. Br. Clear Creek	0.5	0.0	92.0	16.0	6.0	196.0	74.0	2.0 *	44.0	80.0
Canadaway Creek	0.8	0.0	30.0	7.0	0.0	20.0	27.5	0.0	5.0	10.5
OVERALL	**6.1**	**1.8**	**128.4**	**24.3**	**13.3**	**76.1**	**73**	**6.2**	**27.0**	**39.1**

* Sea lamprey trapping occurred in Clear Creek in 2013 that may have affected nest density estimates in Clear Creek and N. Br. Clear Creek.

(Coldwater Task Group 2014). Because the St. Clair system is very large and larval sea lamprey populations are dispersed, traditional treatment methods such as lampricide or granular Baylucide are unlikely to be effective due to high cost and low success rates. Other treatments methods, such as the sterile male program, are being considered as alternative treatment options.

Strain-specific wounding rates continue to show that Lake Superior lake trout strains (KL, AI, TI, SI, MIC) have higher wounding rates, and hence higher mortality rates (see Section F, this report), than FL strain lake trout. Finger Lakes strain lake trout may have co-evolved with sea lampreys and appear to not only avoid sea lamprey attacks but survive attacks better than other strains of lake trout (Schneider et al. 1996). These observations are supported in Lake Erie; large trout >29 inches are mainly FL strain lake trout and exhibit a high rate of healed (A4) wounds (indicative of survival from an attack). The Lake Champlain strain, which has only been stocked in Lake Erie since 2009, is a mix of Finger Lakes/Superior/Clearwater Lake strains (T. Copeland, USFWS, Personal Communication) and appears to possess intermediate levels of sea lamprey avoidance compared to FL and Lake Superior strains. Fresh (A1-A3) wounding rates were slightly higher than FL strain lake trout within the same length groups but lower than KL strain fish. If sea lamprey control in Lake Erie contines to fall short of benchmarks recommended by the Lake Erie Lake Trout Rehabilitation Plan (Markham et al. 2008), then selection of strains better able to survive sea lamprey attacks, such as the FL and LC strains, may need to be exclusively used to achieve rehabilitation goals.

The pilot program conducted in in 2013 and 2014 to record lamprey observations and wounds on sportfish species documented that sea lampreys do not exclusively target coldwater species. Observations from angler catches over this two year pilot survey found either wounds and/or lampreys on smallmouth bass, walleye and yellow perch, and northern pike. An independent lake sturgeon assessment (see Section M) also recorded wounding on sturgeon examined in the vicinity of Buffalo Harbor. We are also aware that sea lamprey attack Lake Erie and Niagara River muskellunge populations (through observations shared via angler photos). Taken together, these observations confirm that sea lampreys have the potential to affect mortality rates of many other species and are a concern for Lake Erie's entire fish community. An additional objective of this pilot survey of angler catches was to assess whether sufficient sea lamprey and sea lamprey wounding observations could be obtained from interviewed anglers to retain this metric as an ongoing index from the angler survey. Two years of pilot survey results found the frequency of sea lamprey observations and wounding rates from warm water species are sufficiently low that we conclude this particular assessment will not provide added value as a long term index. The Lake Erie Unit will continue to explore other alternatives to expand a wounding index to include other prominent species in the Lake Erie fish community.

References

Coldwater Task Group. 2014. Report of the Lake Erie Coldwater Task Group, March 2014. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

King, L.E., Jr. and T.A. Edsall. 1979. Illustrated Field Guide for the Classification of Sea Lamprey Attack Marks on Great Lakes Lake Trout. Great Lakes Fishery Commission, Special Publication 79-1, Ann Arbor, Michigan. 41 pp.

Lake Trout Task Group. 1985. A Strategic Plan for the Rehabilitation of Lake Trout in Eastern Lake Erie. Report to the Great Lakes Fishery Commission's Lake Erie Committee, Ann Arbor, Michigan, USA.

Lake Trout Task Group. 1985a. A Sea Lamprey Management Plan for Lake Erie. Report to the Great Lakes Fishery Commission's Lake Erie Committee, Ann Arbor, Michigan, USA.

Markham, J., A. Cook, T. MacDougall, L. Witzel, K. Kayle, C. Murray, M. Fodale, E. Trometer, F. Neave, J. Fitzsimons, J. Francis, and M. Stapanian. 2008. A strategic plan for the rehabilitation of lake trout in Lake Erie, 2008-2020. Lake Erie Committee, Great Lakes Fisheries Commission, Ann Arbor, MI. Available at http://www.glfc.org/lakecom/lec/LEC_docs/other_docs/manplan2008.pdf [accessed 14 January 2013].

Schneider, C.P., R.W. Owens, R.A. Bergstedt, and R. O'Gorman. 1996. Predation by sea lamprey (*Petromyzon marinus*) on lake trout (*Salvelinus namaycush*) in southern Lake Ontario, 1982-1992. Canadian Journal of Fisheries and Aquatic Sciences 53(9):1921-1932.

H. SALMONID STOCKING SUMMARY

James L. Markham and Michael T. Todd

New York has stocked salmonids into Lake Erie annually 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. 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 the majority of the lake wide stocking effort focuses on steelhead and lake trout.

Results and Discussion

A total of 338,171 salmonines were stocked into the New York waters of Lake Erie in 2014 (Table H.1). Stocking targets were exceeded for lake trout and steelhead, but were below target for domestic rainbow trout and brown trout. Overall numbers of stocked yearling brown, rainbow, and steelhead trout have remained relatively consistent since the late 1990s (Figure H.1).

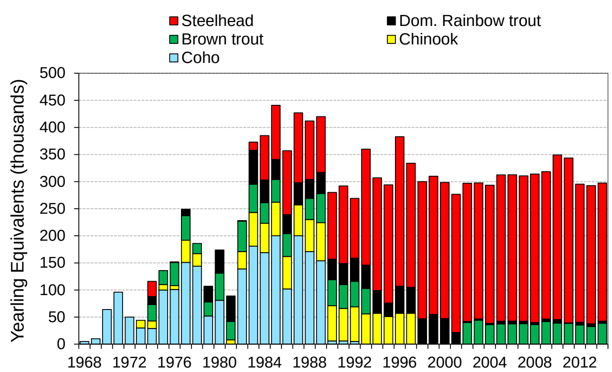


FIGURE H.1. Number (in yearling equivalent units) of Pacific salmon, Brown Trout, and Rainbow Trout (domestic and Steelhead) stocked in New York waters of Lake Erie, 1968-2014.

Lake Trout

A total of 40,691 yearling Lake Champlain strain lake trout were stocked in New York's portion of Lake Erie via the *R/V* Argo on 6 May 2014 offshore of Dunkirk in 70 feet of water. Additionally, yearling lake trout were also stocked into the Ohio (81,042), Pennsylvania (52,715), and Ontario (55,632) waters of Lake Erie. Altogether, 230,080 yearling lake trout were stocked in Lake Erie in 2014, the fourth highest annual stocking effort since rehabilitation efforts began, and surpassing the current annual Lake Trout stocking target of 200,000 yearlings (Figure H.2). All lake trout stocked in NY, OH, and PA were reared at the USFWS Allegheny National Fish Hatchery located in Warren, PA. Other than New York waters, lake trout were also stocked in the vicinity of Catawba and Fairport, OH, and at Northeast, PA. In Canadian waters, the Province of Ontario stocked lake trout on Nanticoke Shoal in eastern Lake Erie.

In addition to the yearlings, fall fingerling lake trout were stocked in the Ohio and Pennsylvania waters of Lake Erie in 2014 as part of a multi-year study to determine the optimal stocking strategy for lake trout in the west and central basins. A total of 99,100 fall fingerling Finger Lakes strain lake trout were stocked at Catawba (40,364) and Fairport Harbor (40,179). The remaining 18,557 were stocked in Northeast, PA.

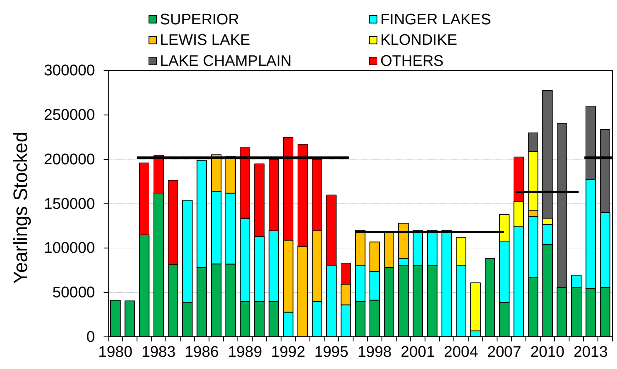


FIGURE H.2. Yearling and fall fingerling (in yearling equivalents) lake trout stocked by all jurisdictions in Lake Erie, 1980-2014, by strain. Stocking goals through time are shown by black lines; the current stocking goal is 200,000 yearlings per year. Superior includes Superior, Apostle Island, Traverse Island, Michipicoten, and Slate Island strains; others include Clearwater Lake, Lake Ontario, Lake Erie, and Lake Manitou strains.

Steelhead

Steelhead remain the most numerous salmonid species stocked in NY's portion of Lake Erie with 255,000 yearlings stocked in 9 tributaries in 2014 (Tables H.1 and H.2; Figure H.1). All tributaries achieved their annual stocking target in 2014; surplus yearling steelhead were stocked in the South Branch Eighteen Mile Creek (2,000 surplus fish) and Cattaraugus Creek (18,000 surplus fish). All stocked steelhead were Washington strain fish. In addition to the steelhead strain rainbow trout, a small number of domestic rainbow trout yearlings (3,950) were distributed to two sites in 2014: 1) the Bison City Rod and Gun Club located in the lower Buffalo River, and 2) the Erie Basin Marina located near the mouth of the Buffalo River.

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 2014. A total of 10,000 unmarked yearling steelhead were stocked into two pens on 17 April and released on 8 May 2014. Increases in fish weights and lengths during the 21-day growing period were not measured. Club members did report, however, that fish mortality in the pens was negligible. This was the tenth consecutive year of this project, which is scheduled to continue in 2015.

Brown Trout

A total of 38,530 yearling brown trout were distributed in Lake Erie between Barcelona Harbor, Dunkirk Harbor, the lower reach of Cattaraugus Creek, and Lake Erie's Point Breeze Marina in 2014 (Table H.1). This yearling total did not meet the stocking target of 45,000 fish due to shortages within the New York hatchery system. However, a surplus of 5,000 fall fingerling brown trout were stocked in the lower reach of Cattaraugus Creek in November.

TABLE H.1. Summary of trout stocking in New York waters of Lake Erie in 2014.

Species	Location	Date Stk	YC	Hatchery	Strain	Mos	Stage	#/lb.	Clip/Mark	Num Stk.	Proposed 2015
Lake Trout	Dunkirk	5/6/2014	2013	ANFH	Lake Champlain	16	Ylg	12.4	600257	40,691	
Lake Trout Totals											
	Lake Trout Yearlings									**40,691**	**40,000**
Brown Trout	Point Breeze	5/1/2014	2013	CSFH	Domestic	16	Ylg	3.9	None	4,300	5,000
Brown Trout	Cattaraugus Creek	4/28/2014	2013	SRSFH	Domestic	16	Ylg	5.9	None	10,000	10,000
Brown Trout	Barcelona Harbor	4/17/2014	2013	RSFH	Domestic	16	Ylg	3.5	None	7,000	10,000
Brown Trout	Dunkirk Harbor	4/29/2014	2013	RSFH	Domestic	16	Ylg	3.5	None	17,230	20,000
Brown Trout	Cattaraugus Creek	11/13/2014	2014	RSFH	Domestic	11	FF	11.1	None	5,000	
Brown Trout Totals											
	Brown Trout Yearlings									**38,530**	**45,000**
	Brown Trout Fall Fingerlings									**5,000**	
Rainbow Trout	Silver Creek	4/23/2014	2013	SRSFH	Washington	12	Ylg	25	None	10,000	10,000
Rainbow Trout	Walnut Creek	4/23/2014	2013	SRSFH	Washington	12	Ylg	25	None	10,000	10,000
Rainbow Trout	Canadaway Creek	4/23/2014	2013	SRSFH	Washington	12	Ylg	25	None	20,000	20,000
Rainbow Trout	18 Mile Creek	4/25/2014	2013	SRSFH	Washington	12	Ylg	30	None	20,000	20,000
Rainbow Trout	18 Mile Creek S. Branch	4/25/2014	2013	SRSFH	Washington	12	Ylg	30	None	20,000	18,000
Rainbow Trout	Chautauqua Creek	4/24/2014	2013	SRSFH	Washington	12	Ylg	22	None	40,000	40,000
Rainbow Trout	Cayuga Creek	4/17/2014	2013	SRSFH	Washington	12	Ylg	29	None	10,000	10,000
Rainbow Trout	Buffalo Creek	4/17/2014	2013	SRSFH	Washington	12	Ylg	29	None	15,000	15,000
Rainbow Trout	Cazenovia Creek	4/17/2014	2013	SRSFH	Washington	12	Ylg	29	None	10,000	10,000
Rainbow Trout	Cattaraugus Creek	4/29/2014	2013	SRSFH	Washington	12	Ylg	30	None	90,000	72,000
Rainbow Trout	Buffalo River Net Pens	5/8/2014	2013	SRSFH	Washington	13	Ylg	---	None	10,000	10,000
Rainbow Trout	Bison City R&G Club	4/8/2014	2013	CSFH	Domestic	16	Ylg	3.2	None	3,160	5,000
Rainbow Trout	Erie Basin Marina	4/8/2014	2013	CSFH	Domestic	16	Ylg	3.2	None	790	
Rainbow Trout Totals											
	Steelhead Yearlings (Washington and Skamania Strains)									**255,000**	**235,000**
	Domestic Rainbow Trout Yearlings (Randolph Strain)									**3,950**	**5,000**
TOTAL ALL SPECIES										**338,171**	**325,000**

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

TABLE H.2. Approximate numbers (x 1000) of salmon and trout planted in New York waters of Lake Erie from 1970 through 2014. Lake Trout numbers include those stocked in Pennsylvania, Ontario, and Ohio waters also. Totals do not include fry stockings.

Species/ Type	YEAR 1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
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
TOTAL	**64**	**96**	**50**	**155**	**285**	**361**	**820**	**821**	**605.1**	**864**	**689**	**232**	**829**	**1179**	**1157**	**1229**	**1267**	**1216**	**1253**	**1495**	**1260**	**1245**	**1391**

Species/ Type	YEAR 1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Coho Y	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
Coho f	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chin f	497	500	500	500	500	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake Y	217	200	160	82.9	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
Lake F	42	0	82	0	0	0	40.5	7	0	0	0	0	58.4	0	0	0	0	0	0	123.7	0	99.1
Lake fry	150	200	0	0	301	81	0	262.7	130.2	283.5	109.2	0	0	0	0	0	0	0	0	0	0	0
Lake adt	0	0	2.7	1	0	0	1	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brown Y	47	0	0	0	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
Brown F	0	0	0	0	0	0	0	0	0	33.6	39.5	0	0	0	0	0	25	0	7.4	0	0	5
Brown f	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	40	0	0	0	0
Rbow Y	43	42	2.5	42.5	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
Rbow F	0	0	21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	15	0	0	0
Rbow f	0	0	0	90.6	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rbow adt	0	1	0	0	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sthd Y	214	208	218	274.8	228	253	255	250.8	255	255	251.3	255	270	270	268	265	272	303.7	304.3	255	255	255
Sthd F	0	0	0	20	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	**1060**	**951**	**986.2**	**1012**	**1019**	**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**

Legend: Y=Standard stocked yearling; F=Fall fingerling; adt=Surplus broodstock

I. THE 2013 LAKE ERIE SALMONID ANGLER DIARY PROGRAM

James L. Markham

The Lake Erie Salmonid Angler Diary Program began in 1983 to gain additional data from the open water and tributary salmonid fishery. It provides a means of monitoring the quality of the salmonid fishery as well as the performance of various stocked species. The program also serves as an outreach effort, connecting anglers to resource managers. Catch per effort indices are obtained by individual angler, tributary, and for the overall fishery.

Methods

Volunteers participating in the Lake Erie Salmonid Angler Diary Program are encouraged to record information about each personal fishing trip over the calendar year in a standard, DEC provided diary, according to established methods. Each new volunteer is given written instructions for proper data collection prior to receiving a diary. Anglers are recruited each year through public notification channels (i.e., newspaper columns, letters to sportsman's groups, hotlines, etc.). Through ongoing recruitment, we attempt to maintain a cadre of at least 50 active anglers each year.

The diary program is summarized for each calendar year and is limited to Lake Erie and its tributaries, upstream to the first barrier impassable to fish. Because diaries are not returned to DEC until after January each calendar year, there is a one-year lag in reporting diary results.

Upon receipt by DEC, diary entries are coded to data sheets, and transferred into a spreadsheet for analysis. Once data entry are error-checked, diaries are returned to anglers for their personal use. An overall program summary is provided to each cooperator annually. Each cooperator also receives a summary of their personal effort and catch data for the year. Summaries only include trout and salmon-directed effort.

Results and Discussion

A total of 46 diaries were issued in 2013. This was the lowest number of diaries issued since 2001 and well below the time series average of 74. Of these, 34 diarists (74%) reported data fishing specifically for trout in Lake Erie. A total of 33 anglers reported tributary data while only four anglers reported fishing in the open lake. Three anglers reported trips in both the open water and tributary components of the fishery. Stream angling, primarily for steelhead, continues to dominate the salmonid fishing component, and because of this only tributary fishing activity will be reported here.

Tributaries

A total of 33 anglers recorded 331 trips and 1,092 hours of fishing time in 2013 (Table I.1). The number of trips and angler effort totals were both below average for the time-series. The average trip length was 3.3 hours, which was below the average of 4.0 hours.

A total of 968 salmonids were caught by diary cooperators in 2013. The vast majority of the catch (953 fish or 98%) were steelhead, which have dominated the angler diary catch every year, even when significant numbers of other salmonid species (pre-1994) were annually stocked (see Section H, Figure H.1). The size of the angled steelhead ranged from 8.0 to 33.0 inches total length (TL) with an average length of 21.9 inches for legal-size fish (>12" TL) (Figure I.1). Steelhead between 24.0 and 26.0 inches comprised the bulk of the catch; catches of steelhead over 28.0 inches dropped dramatically. Only 14 steelhead (1.5%) were 30 inches or longer. A total of 14 brown trout (2%) and one chinook salmon were the only other salmonid species recorded by diary anglers in 2013. This was only the second chinook salmon reported by dairy anglers since 2006.

TABLE I.1. Summary of directed trips for salmonids from New York tributaries of Lake Erie reported by angler diary cooperators, 1983-2013.

YEAR	# DIARIES ISSUED	ANGLERS REPORTING	# OF TRIPS	TOTAL ANGLER-HOURS	AVG. HRS. PER TRIP	TOTAL SALMONIDS CAUGHT				
						LT	BT	RT/SHD	CO	CH
1983	152	36	518	1,656	3.2	0	55	380	166	63
1984	151	26	282	952	3.4	1	26	204	72	49
1985	86	23	230	936	4.1	0	26	213	53	30
1986	110	29	351	1,271	3.6	0	14	357	89	26
1987	75	17	366	1,054	2.9	1	13	460	36	58
1988	50	14	305	858	2.8	1	18	455	50	42
1990	72	24	373	1,418	3.8	0	28	338	21	18
1991	55	28	303	1,367	4.5	0	24	441	50	2
1992	104	35	535	2,215	4.1	0	14	640	16	5
1993	99	36	573	2,365	4.1	0	66	992	39	34
1994	78	25	390	1,451	3.7	0	18	763	9	3
1995	44	18	198	677	3.4	0	0	338	2	3
1996	45	18	172	686	4.0	0	2	161	1	2
1997	51	24	233	907	3.9	0	4	332	0	1
1998	47	22	259	998	3.9	0	2	519	0	15
1999	38	21	196	866	4.4	0	0	406	4	20
2000	39	18	179	824	4.6	0	2	400	2	10
2001	35	22	222	979	4.4	0	1	610	1	0
2002	91	51	434	2,268	5.2	0	13	1,163	3	0
2003	92	56	549	2,424	4.4	0	121	1,293	15	13
2004	90	50	513	2,490	4.9	0	34	1,504	14	2
2005	89	53	530	2,334	4.4	0	57	1,498	1	4
2006	82	50	591	2,379	4.0	0	83	1,920	1	2
2007	76	37	331	1,346	4.1	0	14	1,024	0	0
2008	64	41	426	1,870	4.4	1	55	1,450	2	0
2009	61	45	439	2,068	4.7	0	31	1,423	0	0
2010	58	40	385	1,726	4.5	0	31	899	0	0
2011	55	32	375	1,281	3.4	1	23	877	0	1
2012	55	33	411	1,593	3.9	0	21	1,333	0	0
2013	46	33	331	1,092	3.3	0	14	953	0	1

TABLE I.2. Trout and salmon effort and catch from Lake Erie tributaries as reported in angler diaries for the 2013 calendar year.

			Catch by Species			
Water	**Trips**	**Angler-Hours**	**BT**	**RT/STH**	**CH/CO**	**CPE**
Chautauqua Creek	23	130.3	0	34	0	0.26
Canadaway Creek	28	99.3	2	57	0	0.59
Silver/Walnut Creeks	15	41.0	0	66	0	1.61
Cattaraugus Creek	108	393.6	7	443	1	1.15
Eighteen Mile Creek	56	154.2	3	73	0	0.49
Buffalo/Cayuga/ Cazenovia Creeks	22	56.6	0	36	0	0.64
Clear Creek	32	109.6	0	104	0	0.95
Other Streams	47	107.4	2	140	0	1.32
TOTAL	**331**	**1091.8**	**14**	**953**	**1**	**0.89**

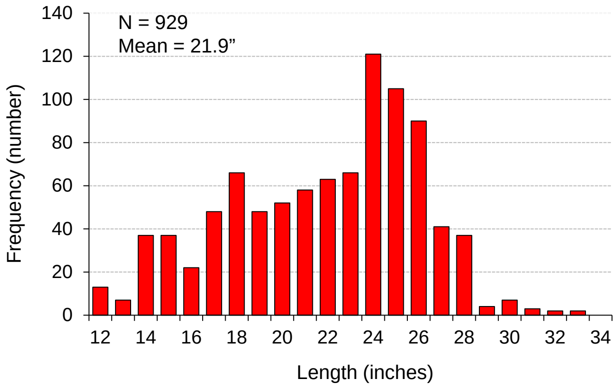


FIGURE I.1. Length frequency distribution of legal-size (12+ inches) steelhead caught by angler diary cooperators in the New York tributaries of Lake Erie, 2013.

Cattaraugus Creek continued to be the most popular destination for diary anglers in 2013, totaling 33% of the trips, 36% of the effort, and 47% of the catch (Table I.2). Catch-per-effort (CPE) on Cattaraugus Creek was 1.15 fish/hour, which was well above average (0.66 fish/hr) and the highest catch rate in this creek over the past 13 years (Table I.3). Eighteen Mile Creek was the next most fished stream by diary anglers followed by Chautauqua Creek while the least amount of effort (15 trips; 41.0 angler-hrs) occurred on Silver/Walnut Creeks. However, for the second consecutive year, the highest catch rates were from Silver/Walnut Creeks (1.61 fish/hour). Catch rates in 2013 on Eighteen Mile Creek (0.49 fish/hr) increased over the previous three years, but remain below average and well below the highs experienced in the mid-2000s. Catch rates on both Canadaway and Chautauqua Creeks decreased substantially in 2013. Catch rates on Chautauqua Creek were near the lowest in the series (0.26 fish/hr) while Canadaway was well below its average. As is typical for the diarists, small streams listed in the "Other" category had a substantial amount of angler effort (107.4 angler/hours), trips (47), and catch (142 fish). Catch rates on these streams remain very high (1.32 fish/hour) and were similar to recent years.

TABLE I.3. Catch rates (fish/hour) of salmonids in major New York tributaries as reported by diary cooperators, 2000-2013.

	2000 - 2012			
Water	**High**	**Low**	**Average**	**2013**
Chautauqua Creek	1.11	0.24	0.58	0.26
Canadaway Creek	1.21	0.25	0.84	0.59
Silver/Walnut Creeks	1.52	0.33	0.76	1.61
Cattaraugus Creek	0.90	0.44	0.66	1.15
Eighteen Mile Creek	0.94	0.37	0.60	0.49
Buffalo/Cayuga/ Cazenovia Creeks	0.86	0.08	0.44	0.64

The overall tributary catch rate was 0.89 fish/hour in 2013, which was the highest value in the time-series (Figure I.2); the previous high catch rate was measured only a year earlier in 2012. This was well above the time series average of 0.54 fish/hour and represented a 65% increase since 2010. Individual catch rates by diary anglers ranged from 0.0 to 2.71 fish/hour with the majority of the catch rates ranging between 0.10 and 0.60 fish/hour. Only five anglers recorded catch rates of 1.0 fish/hr or more. As such, these striking differences in angler catch rates may also partly explain catch rate differences measured between streams. Each angler diarist did not fish each stream described for this program, and it remains difficult to separate the effects of variable angler skill and steelhead fishing quality between streams.

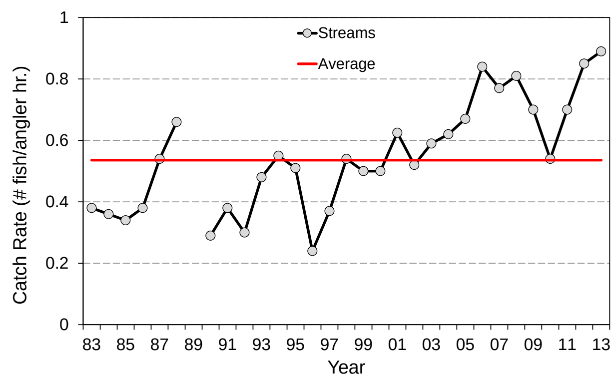


FIGURE I.2. Catch rates (fish/hour) of salmonids for the tributary fishery reported in angler diaries, 1983 – 2013.

The overall harvest rate of salmonids by diarists in the Lake Erie tributaries was 3.5% for steelhead and 0.0% for brown trout in 2013, consistent with strong catch-and-release preferences observed in past angler diary programs and tributary angler surveys (Markham 2006; Markham 2008; Markham 2012).

References

Markham, J. L. 2006. Lake Erie Tributary Creel Survey: Fall 2003-Spring 2004, Fall 2004-Spring 2005. Project #: F-48-R-8, Job 111. New York State Department of Environmental Conservation, Albany. 45 pp.

Markham, J. L. 2008. Lake Erie Tributary Creel Survey: Fall 2007-Spring 2008. Project #: F-55-R-1, Job 1. New York State Department of Environmental Conservation, Albany. 23 pp.

Markham, J. L. 2012. Lake Erie Tributary Creel Survey: Fall 2011-Spring 2012. Project #: F-61-R, Study 7. New York State Department of Environmental Conservation, Albany. 22 pp.

J. Stocked Steelhead Emigration Study

James L. Markham

An otolith microchemistry study conducted by Bowling Green State University (BGSU) in 2009 and 2010 found that adult steelhead collected in Lake Erie tributaries in Ohio and Pennsylvania exhibited modest straying rates consistent with observations for salmonids in other systems (Boehler et al. 2012; Boehler et al. In preparation). However, the BGSU research also found that adult steelhead in two New York tributaries (Cattaraugus, Chautauqua Creeks) were mainly comprised of PA and OH stocked steelhead; only 18% originated from New York stocking. Possible reasons for the high incidence of straying into New York tributaries suggested by Boehler et al. included stocking practices in Ohio and Pennsylvania were not producing a strong stream imprint to compel fish to return to their stream of stocking, or that New York tributaries were being preferentially selected by straying adult steelhead due to biotic or abiotic factors. However, a third hypothesis for the small observed contribution by New York stocked steelhead could be poor post-stocking survival. In response to this 3rd hypothesis, in spring 2013 we began a pilot study to examine post-stocking emigration by juvenile steelhead and assess whether newly stocked steelhead were detectable in predator diets. The emigration portion of this study was continued in 2014.

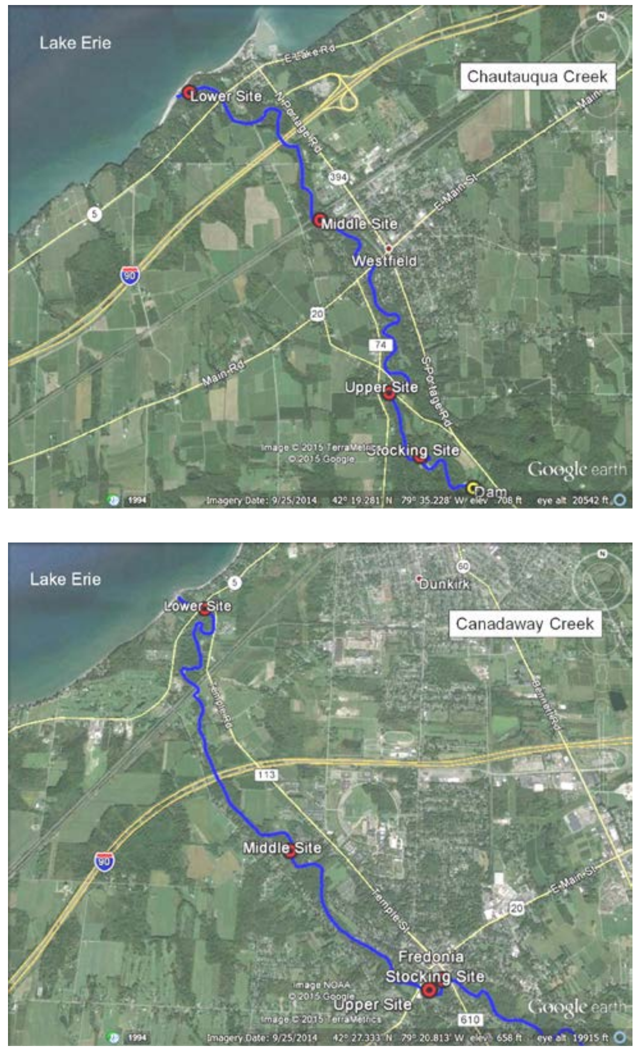


FIGURE J.1. Stocking and sampling sites in Chautauqua and Canadaway Creeks (Chautauqua County, NY) used for a steelhead smolt emigration study in 2013 and 2014.

Methods

Two streams, Canadaway and Chautauqua Creeks, were chosen for this study based on their size and convenience for sampling. Initial electrofishing sites were established near the stocking location (upper) and near the creek mouth (lower) to monitor out-migration (Figure J.1). A third (middle) sampling site was added for each stream in 2014. These sites were sampled once prior to stocking in April, and then at least once each week post-stocking through the end of May. Additional sampling occurred thereafter depending on availability of personnel and continued presence of juvenile steelhead. During each sampling event, a single sampling pass was conducted using a Smith-Root Model 15-D gasoline powered backpack electrofishing unit.

Blocker seines were not used. Steelhead trout were the only species collected, but observations of other fish species present were also noted. All trout were placed into buckets and then transferred to in-stream flow-through holding containers until examination at the conclusion of sampling a particular site. Trout from each run were counted, measured (mm TL), and weighed (g). All fish were released alive upon completion of data collection. Other data collected at each site included water and air temperature, stream clarity, and flow conditions.

Results

Stocking

Yearling steelhead from the NYSDEC Salmon River Fish Hatchery were stocked in Canadaway Creek (20,000 fish) on 23 April 2014 and in Chautauqua Creek (40,000 fish) on 24 April 2014 (see Section H). A sample of 250 hatchery fish from each stream was measured and weighed prior to stocking. The length frequency pattern of this sample was a normal distribution with a mean length of 5.1 inches (130 mm) and range of 3.0 – 7.2 inches (77 – 182 mm) (Figure J.2). The weight distribution exhibited a more skewed pattern with an average weight of 20.8 g (0.73 oz) and a range of 4 – 56 g (0.14 – 1.98 oz) (Figure J.3).

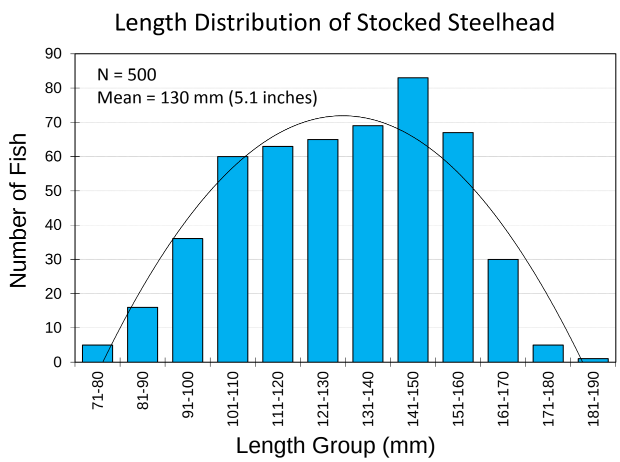


FIGURE J.2. Length frequency distribution of steelhead stocked in Canadaway and Chautauqua Creeks, NY, April 2014.

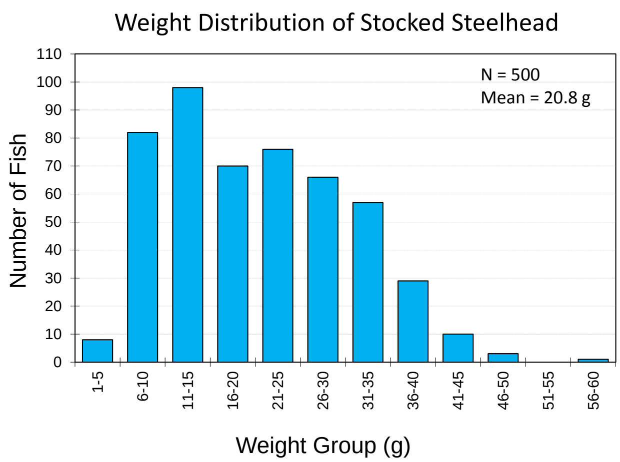


FIGURE J.3. Weight frequency distribution of steelhead stocked in Canadaway and Chautauqua Creeks, NY, April 2014.

Smolt Emigration

Pre-stocking sampling occurred on 21 April at all three sampling locations on both streams. No trout were sampled at any of the sites in Canadaway Creek while four trout were sampled at the upper site on Chautauqua Creek. These fish ranged from 3.3 – 6.1 inches (85 – 156 mm) in length.

Ten post-stocking sampling days were completed for each stream between 25 April and 1 August 2014. Sampling was extended beyond May due the continued presence of stocked steelhead in the streams. The lower site on Canadaway Creek was not sampled on 7 July (Julian date 188) due to poor sampling conditions. Similar to 2013, overall catches of juvenile steelhead were higher in Chautauqua Creek (646) compared to Canadaway Creek (344). The highest overall catches occurred at the upper sites in the beginning of the survey, but dropped quickly after 10 May (Julian Date 130) in both streams (Figure J.4). Catches at the upper sites during the first three sampling dates on Canadaway Creek and first four sampling dates on Chautauqua Creek were only based on partial sampling of the site due to very high numbers of fish present. Catches at the middle and lower sites were low compared to catches at the upper sites throughout the entire sampling period. Occasional catches of juvenile steelhead occurred that were well outside our length distribution determined at the time of stocking, and these fish were thought to be either naturally produced or emigrants of steelhead stocked in adjacent Pennsylvania tributaries. Because of this, steelhead less than 3.0 inches (75 mm; N=10) and greater than 7.5 inches (190 mm; N=16) were excluded from further statistical analyses. Water temperatures during the sampling period steadily rose from the upper-40's (°F) at stocking and peaked

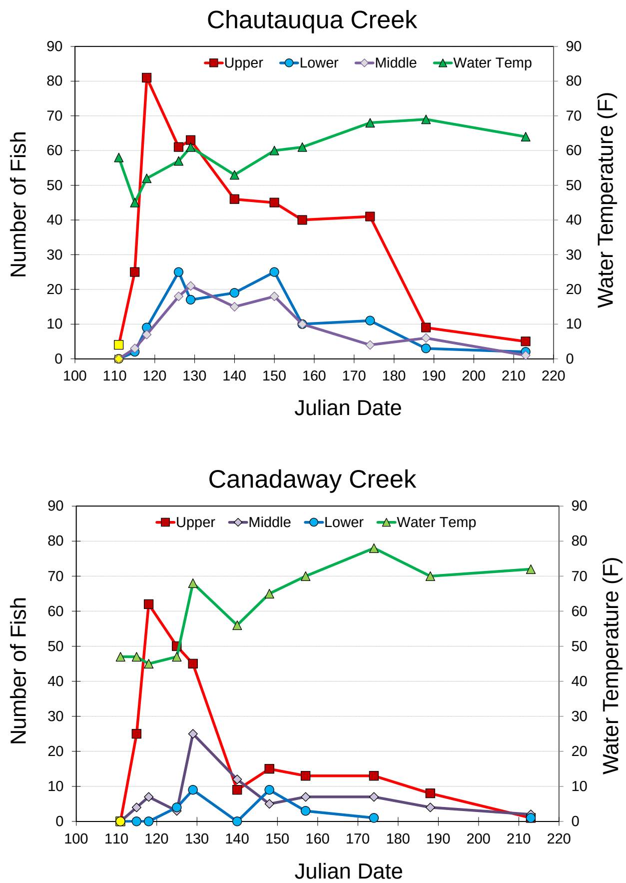


FIGURE J.4. Total number of steelhead sampled and water temperature (ºF) by site and sample date on Chautauqua Creek and Canadaway Creek in 2014. Yellow symbols indicate pre-stocking sampling.

at the upper-70's on Canadaway Creek and upper-60's on Chautauqua Creek during the beginning of July. Steelhead were detected at all sites throughout the survey with the exception of three sampling dates at the lower site on Canadaway Creek.

The overall mean length of sampled steelhead was significantly different between sampling sites on both streams (Canadaway: F=31.34; P<0.0001; Chautauqua: F=68.95; P<0.0001). Overall mean length on Canadaway Creek was significantly larger at the lower site (163 mm) compared to the middle (124 mm) and upper (120 mm) sites. On Chautauqua Creek, mean overall length was significantly different between all the sites (lower: 147 mm; middle: 127 mm; upper = 121 mm).

Mean lengths of sampled steelhead by sampling date were significantly different for all sites on both streams with the exception of the middle sampling site on Canadaway Creek (Figures J.5; Table J.1). In general, a trend of decreasing mean length over time was apparent at all sites on Chautauqua Creek while trends were not as apparent on Canadaway Creek (Figure J.6). Lower sample sizes obtained from the lower site on Canadaway Creek precluded meaningful analysis. Plots of individual lengths of sampled steelhead by stream, site and sampling date also show the general decline in length during the survey period and appear to confirm the emigration of larger steelhead >140mm from upper sites on both streams prior to the 20 May (Julian date 140) sampling. (Figure J.6).

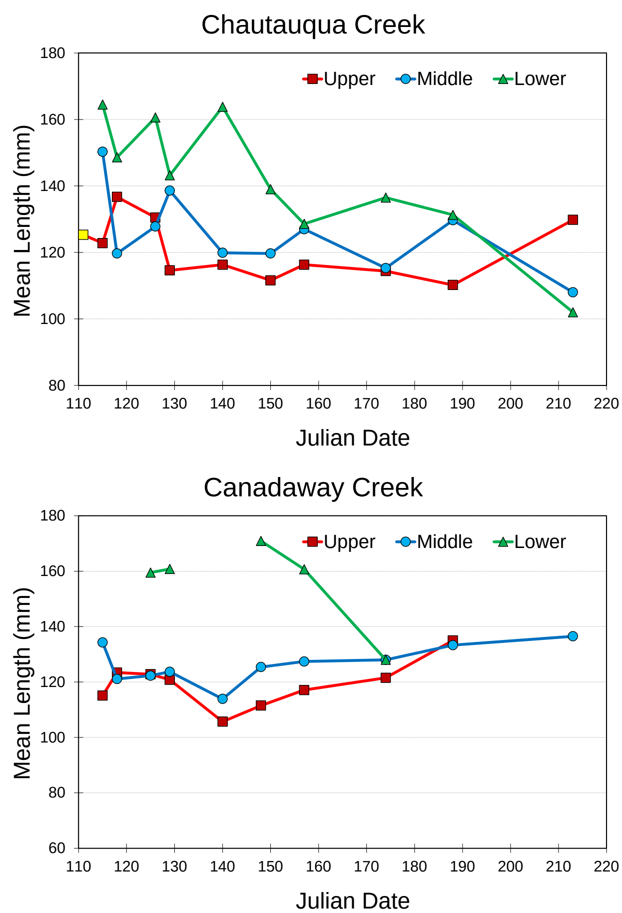


FIGURE J.5. Mean length (mm) by sample date and site of steelhead caught on Chautauqua Creek and Canadaway Creek in 2014. Yellow symbols indicate pre-stocking sampling events.

TABLE J.1. Mean length, sample size and statistical grouping by sample date for steelhead caught at the lower, middle, and upper sampling sites on Chautauqua Creek and Canadaway Creek in 2014. Dates with the same statistical grouping letter do not have significantly different mean lengths.

Chautauqua - Lower

Date	Julian Date	Mean Length	N	Grouping
4/21/2014	111			
4/25/2014	115	164.5	2	A
4/28/2014	118	148.6	9	ABCD
5/6/2014	126	160.6	23	ABC
5/9/2014	129	143.2	16	ABCD
5/20/2014	140	163.8	17	AB
5/30/2014	150	139	25	BCD
6/6/2014	157	128.6	10	D
6/23/2014	174	136.5	10	CD
7/7/2014	188	131.3	3	D
8/1/2014	213	102	2	E

Canadaway - Lower

Date	Julian Date	Mean Length	N	Grouping
4/21/2014	111			
4/25/2014	115			
4/28/2014	118			
5/5/2014	125	159.5	2	AB
5/9/2014	129	160.8	4	AB
5/20/2014	140			
5/28/2014	148	170.9	8	A
6/6/2014	157	160.7	3	AB
6/23/2014	174	128.0	1	B
7/7/2014	188			
8/1/2014	213			

Chautauqua - Middle

Date	Julian Date	Mean Length	N	Grouping
4/21/2014	111			
4/25/2014	115	150.3	3	A
4/28/2014	118	119.7	7	BC
5/6/2014	126	127.8	18	ABC
5/9/2014	129	138.6	21	AB
5/20/2014	140	119.9	15	BC
5/30/2014	150	119.7	18	BC
6/6/2014	157	127.0	10	ABC
6/23/2014	174	115.3	4	BC
7/7/2014	188	129.7	6	ABC
8/1/2014	213	108	1	C

Canadaway - Middle

Date	Julian Date	Mean Length	N	Grouping
4/21/2014	111			
4/25/2014	115	134.3	4	A
4/28/2014	118	121.1	7	A
5/5/2014	125	122.3	3	A
5/9/2014	129	123.7	25	A
5/20/2014	140	113.9	12	A
5/28/2014	148	125.4	5	A
6/6/2014	157	127.4	7	A
6/23/2014	174	128.0	7	A
7/7/2014	188	133.3	4	A
8/1/2014	213	136.5	2	A

Chautauqua - Upper

Date	Julian Date	Mean Length	N	Grouping
4/21/2014	111	125.3	4	ABC
4/25/2014	115	122.8	25	ABC
4/28/2014	118	136.6	49	A
5/6/2014	126	130.5	50	AB
5/9/2014	129	114.6	50	BC
5/20/2014	140	116.3	46	BC
5/30/2014	150	111.6	45	C
6/6/2014	157	116.3	40	BC
6/23/2014	174	114.4	41	BC
7/7/2014	188	110.2	9	C
8/1/2014	213	129.8	4	AB

Canadaway - Upper

Date	Julian Date	Mean Length	N	Grouping
4/21/2014	111			
4/25/2014	115	115.1	25	AB
4/28/2014	118	123.4	62	AB
5/5/2014	125	122.8	50	AB
5/9/2014	129	120.8	45	AB
5/20/2014	140	105.7	9	B
5/28/2014	148	111.5	15	AB
6/6/2014	157	117.1	13	AB
6/23/2014	174	121.5	11	AB
7/7/2014	188	135.0	2	A
8/1/2014	213			

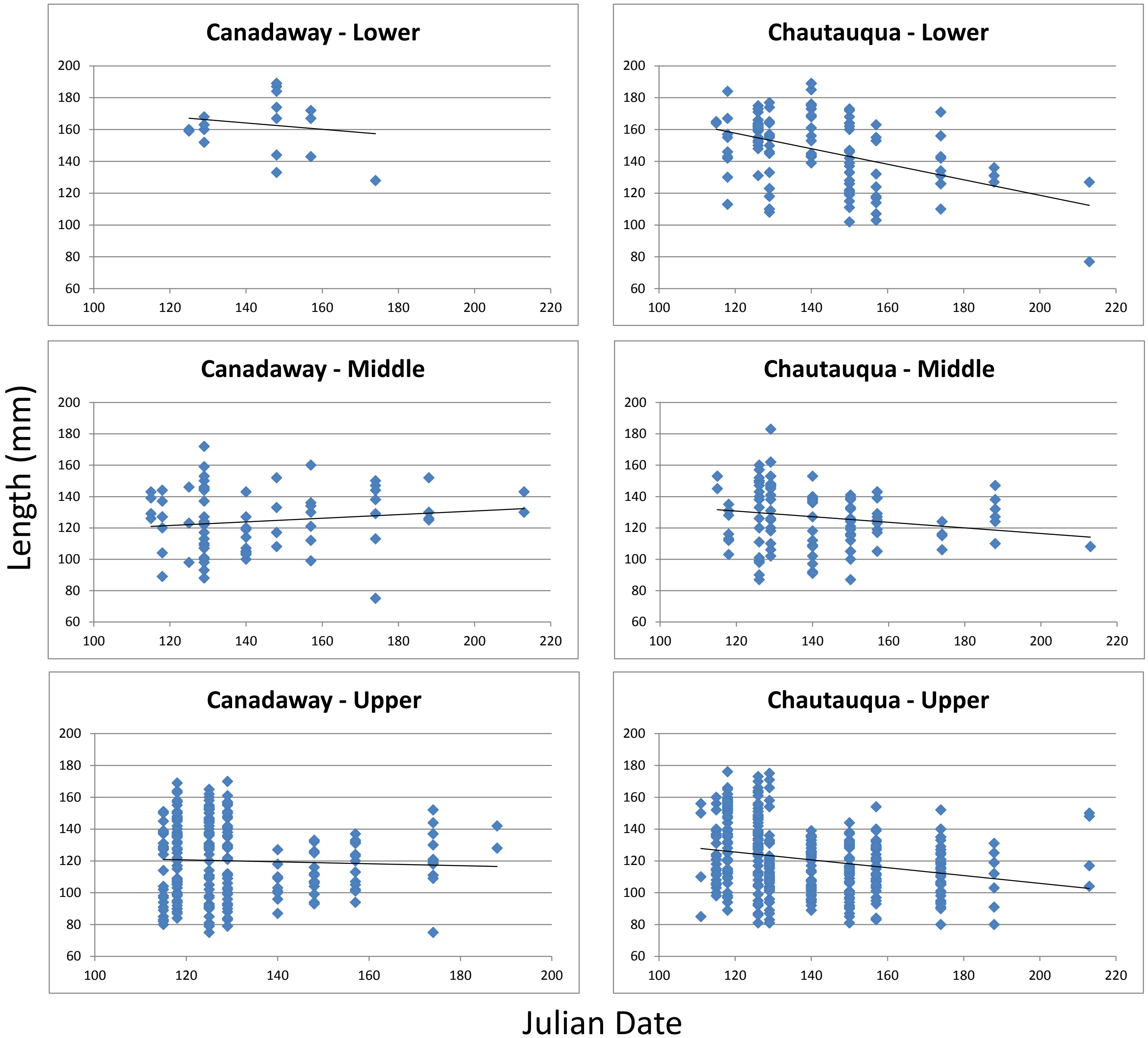


FIGURE J.6. Individual lengths (mm) by sample date and site of steelhead caught on Chautauqua Creek and Canadaway Creek in 2014. Black lines are linear regressions describing trends in fish length over the sample period.

Condition factors (Fulton's K; Everhart and Youngs 1981) were calculated and compared for steelhead between 3.9 – 5.1 in (100-130 mm) at stocking and during the pooled June, July, and August sampling months (Julian Dates ≥157) at the upper sampling site on both streams. We tracked condition to determine whether condition declined for steelhead that remained in streams at least six weeks following the stocking date. Results of this analysis showed that average fish condition between stocking and 6+ weeks after stocking was not significantly different on Canadaway Creek (stocking K=0.87, N=104, survey K=0.86, N=26; t-test: p=0.355 t=1.979) but was significantly different on Chautauqua Creek (stocking K=0.87, N=89, survey K=0.72, N=91; t-test: p<0.0001 t=1.973). Lower sample sizes of survey steelhead on Canadaway Creek (N=26) may have affected detection of significant differences.

Discussion

Steelhead stocking programs are ideally implemented such that juveniles stocked as smolts are physiologically ready to imprint and then migrate quickly from the river (Wagner 1968). However, this two year study of steelhead emigration patterns following stocking showed that many of the steelhead stocked in the New York tributaries do not smolt and fail to emigrate from the stream. Both survey years found many stocked steelhead remain in the streams through the end of May (5-6 weeks after stocking), and some fish remained present two months subsequent to the stocking date. Although measures of condition (K) did not conclusively document a decline in condition over the survey period, food resources for juvenile trout in these streams are limited, and combined with high summer stream temperatures, it seems doubtful many of these non-migrant trout would survive through the summer.

Several studies (Chrisp and Bjornn 1978; Bjornn et al. 1979; Seelbach 1987) have determined that the minimum size at smolting is around 6.0 in (153 mm) and that stocked steelhead smaller than this length threshold will not smolt and instead remain in the stream for an additional year or more. However, initial results from our survey indicate that the threshold length may be closer to 5.5 in (140 mm) in our NY tributaries. Measures of individual fish lengths over the sampling period (see Figure J.6) indicate that the majority of the steelhead larger than 140 mm emigrated from the upper sampling sites by sampling Julian date 140 (20 May). In some instances, larger fish were observed at later sampling dates at either middle or lower sites prior to becoming absent from the samples entirely. Almost all the steelhead sampled at the upper sites in both streams after May 20, 2014 were less than 140 mm (Canadaway: 94% N=50; Chautauqua: 97% N=185).

High water events appeared to influence steelhead emigration. A noticeable decline in abundance at the upper sampling sites occurred between sampling dates 129 and 140 on both streams. This apparent outmigration coincided with a thunderstorm and subsequent flood on Julian date 133 (13 May, 2014). This particular flooding event was more pronounced on Canadaway Creek than on Chautauqua Creek, but an emigration of larger fish was apparent on both streams. Another minor flooding event occurred on 16 May, 2014). A second flooding event occurred on 21 May, 2014 which was more severe on Chautauqua Creek than Canadaway Creek, but outmigration following this event was not as noticeable as the initial flooding event.

The results of this two year study demonstrated a need to pursue a more detailed investigation examining stocking size and stocking location. An expanded study comparing the performance of two size groups of steelhead and two stocking locations (upstream vs mouth) is planned in 2015. This study should provide further insights into the influence of stocking size on smolting and adult returns, and will inform stocking practices that should ultimately improve the steelhead fishery in New York's Lake Erie tributaries.

References

Bjornn, T.C., J. King, and J. Lukens. 1979. Evaluation of pilot rearing program for steelhead trout at Hagarman and Dworshak national fish hatcheries. Completion report to the U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Boehler, C.T., J.G. Miner, J.R. Farver, and B.J. Fryer. 2012. Within-stream release-site fidelity of steelhead trout from Lake Erie hatchery stocks. Journal of Great Lakes Research 38:251-259.

Boehler, C.T., J.G. Miner, J.R. Farver, and B.J. Fryer. In Preparation. Highly variable and elevated straying rates of steelhead trout from Lake Erie tributaries. Bowling Green State University, Bowling Green, Ohio.

Chrisp, E.Y. and T.C. Bjornn. 1978. Parr-smolt transformation and seaward migration of wild and hatchery steelhead trout in Idaho. University of Idaho, Idaho Cooperative Fisheries Research Unit, Federal Project F-49-12, Final Report, Moscow.

Everhart, W.H., and W.D. Youngs. 1981. Principles of Fishery Science, 2nd ed. Cornell University Press, Ithaca, NY.

Seelbach, P.W. 1987. Smolting success of hatchery-raised steelhead planted in a Michigan tributary of Lake Michigan. North American Journal of Fisheries Management 7:223-231.

Wagner, H.H. 1968. Effects of stocking time on survival of steelhead trout, *Salmo gairdnerii*, in Oregon. Transactions of the American Fisheries Society 97:374-379.

K. BEACH SEINE SURVEY

Donald W. Einhouse

Introduction

From 1998 to 2000, the Lake Erie Unit (LEU) investigated whether juvenile walleye and smallmouth bass abundance indices could be achieved through a long term, standardized mid-summer beach seine assessment. That investigation encountered young-of-the-year (YOY) life stages of both target species. However, we also found it difficult to maintain survey standards across years due to erratic occurrence of filamentous algae and other debris at standard survey locations. Also, the requirement of especially calm wind conditions for effective beach seining was an additional limiting factor for executing this survey. As such, we concluded beach seining to be a flawed method for producing long term abundance measures for YOY walleye and YOY smallmouth bass in Lake Erie (Culligan et al. 2001). During the ensuing years, we also experimented with near shore boat electrofishing as another approach to achieve a YOY index for these species. Unfortunately, those pilot electrofishing surveys also proved unsatisfactory due to the requirement for calm weather for working in very shallow water. We are currently considering the benefits of modifying this survey to function solely as a long term index of the inshore fish community.

In 2011 we re-visited the beach seining survey due to cancellation of a longstanding mid-summer acoustic survey. Despite the previous shortcomings of beach seining for producing abundance indices, other information was obtained about the inshore fish community which is not monitored by other LEU surveys. Due to ongoing constraints for reinstituting the acoustic survey, we continued the beach seine survey from 2011 to 2014.

Methods

We used a 150-ft beach seine (5-ft. high, 0.25-in delta bar mesh, 5-ft x 5-ft bag size, and 0.125-in bag mesh) during daytime hours deployed from an 18-ft skiff in a semi-circle over approximately 3 to 5 ft depths and retrieved the seine toward the beach. Before reaching shore or a debris zone, the seine was pursed together and the catch collected in the bag of the seine.

Four beach sites were sampled from July 17 to 22, 2014 (Barcelona, Dunkirk, Hanover, and Sturgeon) during a single sampling repetition. The number of seine hauls completed for each site visit ranged from five to eight. In all, 27 individual seine hauls were completed for the 2014 beach seining effort.

Fish species from each seine haul were identified to the extent possible in the field and binned into categories of abundant (> 100), common (10 – 100) or rare (< 10). Any YOY walleye, YOY smallmouth bass and YOY yellow perch were counted and measured. We also recorded observations for wind speed and direction, cloud cover, substrate, turbidity and water temperature.

Table K.1. Daytime catch rates (number per seine haul) of young-of-the-year (YOY) walleye and YOY smallmouth bass collected with a 150 ft (46 m) bag seine at selected beach locations along the New York's portion of Lake Erie, July 1998-2000 and 2011-2014.

	YOY WALLEYE CATCH Per HAUL					YOY SMALLMOUTH CATCH Per HAUL				
	BARCELONA	DUNKIRK	HANOVER	STURGEON	WOODLAWN	BARCELONA	DUNKIRK	HANOVER	STURGEON	WOODLAWN
1998	0.0	5.3	0.0	0.0	-	16.7	2.0	1.2	0.0	-
1999	0.3	0.0	1.7	0.0	-	1.9	32.7	44.5	21.9	-
2000	0.0	0.0	0.0	1.0	-	0.2	0.0	0.0	0.4	-
2011	0.0	0.0	0.0	-	-	1.2	0.3	0.3	-	-
2012	0.6	1.0	1.5	3.1	1.3	3.9	1.1	0.2	0.2	0.5
2013	0.0	0.0	0.0	0.0	-	0.3	0.0	0.0	0.1	-
2014	0.0	0.3	0.0	0.5	-	2.0	0.6	0.0	0.0	-

Results

Beach seine collections in 2014 consisted mostly of minnow species (emerald and spottail shiners), YOY rainbow smelt and yearling-and-older (YAO) round goby. Minnow species were consistently the most encountered taxa during previous beach seine investigations from 1998 to 2000, and 2011 to 2013. Spottail shiner, sand shiner and brook silverside are three species regularly encountered in seine catches, but otherwise generally absent in LEU trawl surveys.

The principal targets of this survey were YOY walleye and YOY smallmouth bass, and both species were scarce or absent in 2011 and 2013, commonly encountered in the 2012 survey, and uncommon but detectable in 2014. The 2014 YOY walleye collection of just 6 individuals averaged 2.0 inches total length. Walleye collected in 2014 were smaller than the individuals collected in 2012, which averaged 2.5 inches (N = 70) during July 10-13, 2012, and 3.4 inches (N = 18) during July 23-25, 2012. YOY smallmouth bass collected (N = 17) in 2014 were also smaller than those observed in previous years collections but we never more than 17 YOY smallmouth bass individuals during each of the last four years.

Discussion

During both 2011 and 2013 the beach seine survey produced disappointing catches of YOY walleye and smallmouth bass. Earlier results (1998 – 2000) found measurable densities of both YOY target species in 1998 and 1999, but scarce encounters during 2000. Subsequent recruitment measures showed 2000 produced a very weak year class for both walleye and smallmouth bass. Gill net recruitment measures of 1998 and 1999 smallmouth bass year classes were particularly strong and consistent with large YOY collections from the beach seining effort. These results suggested that the beach seine survey did provide some indication of year class strength, albeit not a sensitive index. Our 2011 survey produced results very similar to those from 2000. Additional evidence from another ongoing survey (see Section D) suggests YOY smallmouth bass should have been detectable in 2011, but not particularly abundant. Also, a long term gill net survey has now measured the 2011 and 2013 walleye year classes as small relative to a 34 year abundance index series. While we had the misfortune of initially re-evaluating this beach seine survey during a year (2011) when our principal targets were scarce, the subsequent 2012 beach seine survey did provide sharply contrasting results that reflect stronger walleye and smallmouth bass year classes. Our long term gill net survey conducted in 2013 measured age-1 walleye abundance as one of the largest in our 34 year data series and validated the strong 2012 walleye year class observed in the beach seining survey. The most recent seining 2014 effort detected only six YOY walleye. This year class was also scarcely detected by just three individuals in the 2014 trawl survey (Section C) and five individuals in the 2014 warm water gill net survey (Section D). Overall, during this recent four year trial our July beach seining experiment has proved no more effective for collecting YOY walleye than other long term sampling programs.

There are likely more effective approaches to assessing abundance of YOY walleye and YOY smallmouth bass in eastern Lake Erie that remain either untested or impractical within the limitations of our overall field program. For example, an August electrofishing or bottom trawl survey might achieve generally higher catch rates for YOY smallmouth bass and YOY walleye, as these juvenile fish have attained larger sizes and become generally more vulnerable to these sampling gears. However, LEU staff are already encumbered with robust gill net surveys during August and September (see Sections D and F). Given the limited utility of a July beach survey we do not plan to continue this program in its current form in 2015.

References

Culligan, W. J., D. W. Einhouse, J.M. Markham, D. L. Zeller, R. C. Zimar, and B.J. Beckwith. 2001. 2000 Annual Report to the Lake Erie Committee. New York Department of Environmental Conservation, Albany. 67 pp.

L. PLANNED EASTERN BASIN WALLEYE ACOUSTIC TELEMETRY STUDY

Jason M. Robinson

Introduction

Walleye in the Great Lakes are known to move across large geographic areas through multiple management jurisdictions. Having an understanding of fish movement dynamics and how they relate to fishing activity is essential when managing a complex, valuable, multijurisdictional fishery such as the Lake Erie walleye fishery. Adult walleye originating in the western basin are known to migrate into the eastern basin during the summer months and then return to the western basin (Figure L.1). This influx of walleye into the eastern basin supplements the walleye catch in the eastern basin.

Walleye inhabiting the western and central basins of Lake Erie are currently managed using a binational quota system whereby a cohort-based statistical catch-at-age model is used to assess abundance and inform annual total allowable catch limits for each management jurisdiction. Existing uncertainties surrounding walleye dynamics and life history in the eastern basin have prevented the inclusion of the eastern basin population in the more formal management structure of the western and central basins.

Eastern basin walleye indices are not explicitly included in the western and central basin management approach for two reasons; 1) Catch-at-age information in the eastern basin is collected from a mixture of western basin migrants and eastern basin resident walleye, and 2) there is a large amount of uncertainty and variability surrounding the annual age and size structure of the western basin migrants. These uncertainties suggest that managers may be unable to use catch-at-age information to adequately track cohorts of western basin walleye in the eastern basin. Additionally, since the proportion of western basin walleye, and the origin of individual walleye in the eastern basin is unknown, the ability to track eastern basin cohorts is also compromised.

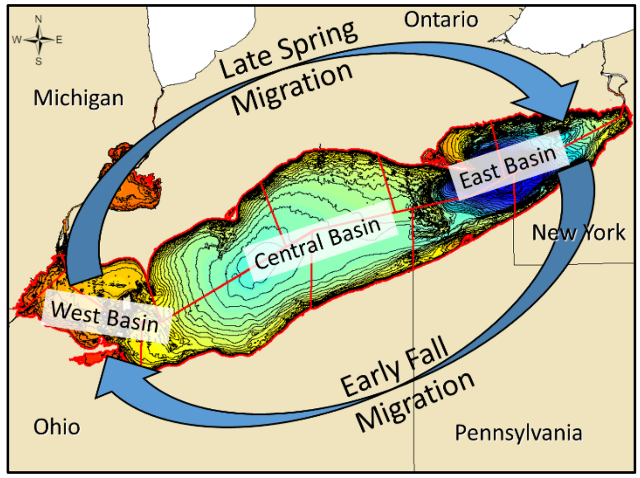


Figure L.1. Depth contour map of Lake Erie with jurisdictions and major basins labeled. Blue arrows represent known major seasonal directional migrations of adult western basin walleye. Walleye Quota Management area includes the western and central basins only.

Zhao et al. (2011) suggested an alternative approach to walleye assessment in the eastern basin whereby an annual population estimate would be produced for eastern basin resident walleye using traditional mark-recapture techniques, and the contribution of the western basin migrants would be estimated as a function of the western basin population estimate. The eastern basin population estimate would rely on producing population estimates for the major walleye spawning populations (i.e. Van Buren Bay, and Grand River), then using the proportional contribution of those populations to produce a basin-scale estimate of adult walleye. The Van Buren Bay and Grand River populations are thought to constitute approximately 90% of the entire Eastern Basin spawning stock (Zhao et al. 2011). However, Zhao et al. (2011) acknowledge that further assessment of other spawning locations in the eastern basin is necessary prior to implementing this approach. Identifying discrete spawning stocks, quantifying the proportional contribution of individual spawning stocks, and describing spawning site fidelity of those stocks is necessary to apply the approach of Zhao et al. (2011) with confidence.

Proposed Eastern Basin Telemetry Project

Beginning in the spring of 2015, the Lake Erie Fisheries Research Unit will deploy acoustic receivers in the eastern basin collaboratively with other walleye investigators as part of the Great Lakes Acoustic Telemetry Observation System (GLATOS) to monitor the timing, magnitude, demographics, and spatial extent of the western basin migrants tagged on western basin spawning areas by Ohio DNR. Additionally, acoustic transmitters will be surgically implanted into the body cavities of walleyes from eastern basin spawning aggregations to estimate spawning site fidelity and movement patterns of individual eastern basin spawning stocks. The relative contribution of eastern basin origin walleye to the mixed-origin fisheries in the eastern basin, and elsewhere will be assessed by applying acoustic tags to walleye in the summer mixed fishery, then tracking their movements to determine spawning stock origin. Acoustic receivers will be placed on known spawning areas in the spring and then moved to three cross-basin lines spanning the eastern basin to monitor summer and fall movement. The specific objectives of this project are to:

1. Determine the relative contribution of western and eastern basin walleye stocks to the eastern basin fishery.
2. Determine the timing, magnitude, demographics, spatial extent, and consistency of the western basin migrants' movement into the eastern basin.
3. Identify spawning sites and determine the spawning site fidelity of individual eastern basin walleye spawning stocks.
4. Determine the extent of movements of eastern basin spawning stocks out of the eastern basin.

This study will complement the ongoing efforts of a multi-agency walleye investigation being led by western basin investigators by improving their ability to detect western basin tagged fish in eastern basin waters. In turn existing acoustic arrays in the western and central basin will allow us to detect the westward movement of walleye tagged as part of this eastern basin study. Individuals catching or finding a walleye with an internal or external tag(s) will be encouraged to report this information by filling out an electronic tag return form or by calling NYS DEC's Lake Erie Fisheries Research Unit (716-366-0228). Reward incentives for reporting recovered transmitters will be clearly marked on tags.

Knowledge gained during this project will particularly improve understanding of walleye life history and movement dynamics in the eastern basin of Lake Erie, as well as assist in addressing knowledge gaps for the lake wide walleye resource and ultimately provide information useful for advancing walleye stock assessment and management activities throughout Lake Erie. Acoustic arrays installed as part of this project will extend the geographic scope of the acoustic network currently in place in Lake Erie and throughout the Great Lakes. Additionally, these new arrays will directly benefit other acoustic telemetry studies (Goulette et al. 2014) already in progress including the walleye movement studies of western basin investigators, Sea Lamprey investigations in the Huron Erie Corridor, Sturgeon assessment based in Buffalo Harbor and the upper Niagara River, as well as future investigations.

Acoustic Telemetry Technology

Acoustic telemetry technology allows passive collection of fish location information. At its simplest this technology can be thought of as conveying information from one place to another using sound waves. In this study we will surgically implant acoustic tags in walleye which will transmit an underwater signal of identification information about the tagged fish to arrays of stationary acoustic receivers (Figure L.2). Acoustic receivers can detect tagged fish that swim through their sphere of detection. Data associated with each tag detection is stored on the receiver until retrieval. This technology allows tracking of fish movements at any time a tagged fish is in the vicinity of a receiver. This approach offers major advantages over traditional tagging studies in which the location of tagged fish can only be detected through sampling, angling, or active tracking (e.g. radio telemetry).

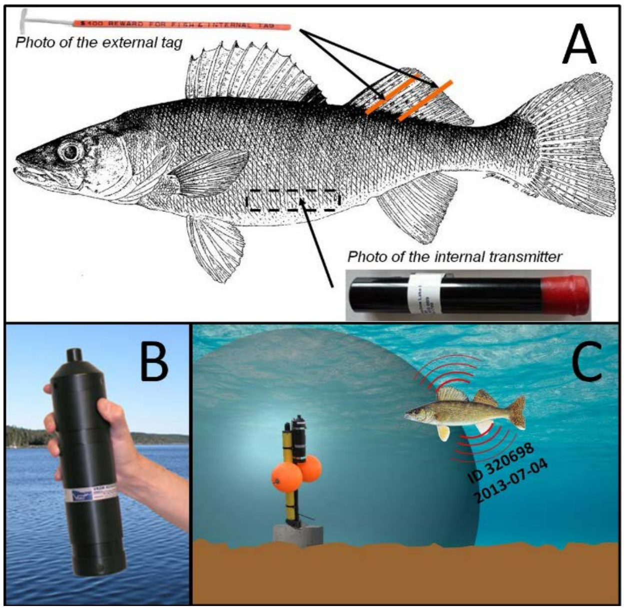


Figure L.2. A) Close-up of an acoustic tag and surgical implant location, with secondary Floy tag location, B) close-up of acoustic receiver, and C) diagram of acoustic receiver deployed on the lake bottom with a tagged walleye entering the sphere of detection. The size of the sphere of detection varies based on local conditions. The estimated size in eastern Lake Erie is a radius of one km.

Methods

Acoustic receiver deployment and data collection

Starting in spring 2015 (following walleye spawning), omnidirectional acoustic receivers (VR2W, Vemco Inc., Halifax, Nova Scotia) will be deployed at strategic locations (Figure L.3) in the eastern basin of Lake Erie to document the movement of walleye. Lines of receivers running roughly perpendicular to the long axis of the lake will assess the movement of western basin tagged walleye into the eastern basin during the summer months. In late autumn receivers lines will be retrieved, tag detections downloaded, and data uploaded to the GLATOS website.

In spring 2016, receivers first will be deployed in the vicinity of seven eastern basin walleye spawning areas for the duration of walleye spawning activity (Fig. L.3). These receivers will document the movement of walleye onto eastern basin spawning areas to inform spawning site fidelity. Following the spawning period, these receivers will be retrieved, tag detections downloaded, and then be redeployed to the cross-basin receiver lines (Figure L.3) for the remainder of the summer and autumn seasons.

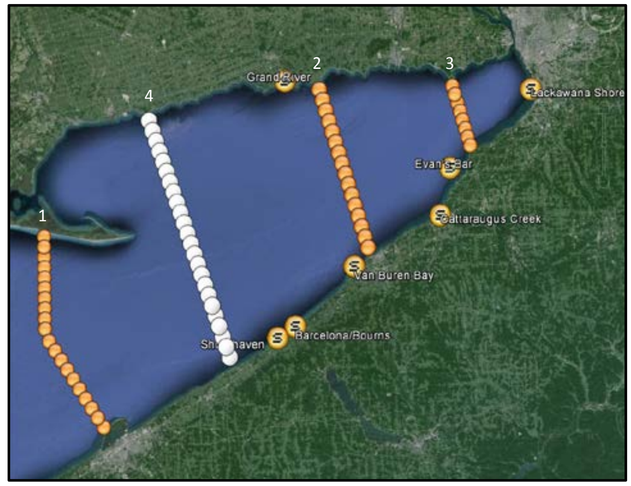


Figure L.3. Planned eastern basin sites for acoustic lines (orange bubbles) and known walleye spawning areas (circles with S). Each bubble represents an acoustic receiver site. White bubbles (Line 4) represent acoustic receivers that will be installed if additional financial resources become available.

Walleye Collection and Tagging Procedures

Beginning in spring 2015, spawning walleye will be collected using a combination of trap netting and pulsed DC electrofishing on selected spawning shoals and in tributary spawning areas (Fig. L.3). The sampling schedule will be dictated by the timing of spawning activity in each year. Mature walleye captured on spawning areas will be assumed to be part of that spawning aggregation. An equal number of male and female walleye will be tagged on each spawning shoal if possible. However, previous sampling on spawning aggregations indicates that the majority of captured individuals will be male (NYSDEC unpublished data, Zhao 2011). We will attempt to tag walleyes of each sex, on each spawning area, in proportion to their observed length frequency.

Tagging effort in the first year will be focused on the Van Buren Bay spawning population which is thought to constitute the majority of the Eastern Basin spawning stock (Zhao et al. 2011). In subsequent years some portion of tagging effort will be devoted to another representative spawning area listed in Figure L.3. However, priority will be given to the Van Buren Bay and Grand River spawning areas because they are thought to constitute a large proportion of the entire Eastern Basin spawning stock (Zhao et al. 2011).

Additional tagging effort will be focused on walleye collected during the summer months when they are in the mixed fishery. This effort will be used to determine the relative contribution of the western basin walleye to the eastern basin fishery. Sampling locations for these tagging efforts will be informed by Lake Erie angler survey data (See Section N) which will identify the timing and location of highest walleye catch. Sampling may include a combination of angling and gillnetting collections. There are also several accompanying uncertainties about our ability to successfully tag walleye during the summertime period, including the ability to capture sufficient walleyes to satisfy this study component and possible walleye mortality concerns due to the effects of barotrauma and high water temperatures. If efforts to tag walleye in the mixed fishery prove unsuccessful, subsequent tagging effort will be redirected to spring spawning aggregations.

Analytical methods for all study components will be developed in collaboration with other Lake Erie walleye acoustic telemetry investigators, and by seeking technical input from MSU's Quantitative Fisheries Center.

References

Goulette, G. S., J. P. Hawkes, J. F. Kocik, J. P. Manning, P. A. Music, J. P. Wallinga, and G. B. Zydlewski. 2014. Opportunistic acoustic telemetry platforms: benefits of collaboration in the Gulf of Maine. 39:441–450.

Zhao Y., D. W. Einhouse, T. M. MacDougall. 2011. Resolving some of the complexity of a mixed-origin Walleye population in the east basin of Lake Erie using a mark–recapture study. North American Journal of Fisheries Management. 31:379-389.

M. LAKE STURGEON MONITORING IN BUFFALO HARBOR

Christopher D. Legard

Introduction

Lake sturgeon were once abundant throughout the Great Lakes but their numbers were severely reduced due to a combination of overfishing and habitat loss (Carlson 1995). Lake Erie supported an intense, but short lived, commercial fishery for lake sturgeon in the late 1800's to early 1900's. In 1885 the commercial landing of sturgeon throughout Lake Erie was nearly 5,000,000 pounds. By 1922 the total commercial catch had decreased to 15,000 pounds (Koelz 1928) and the fishery was closed in New York beginning in 1976 (Carlson 1995). Lake sturgeon were subsequently listed as a threatened species by both New York State and the Province of Ontario.

Through recent times a remnant population of lake sturgeon persisted in Lake Erie but their numbers were thought to be low and sightings were rare. However, reports of lake sturgeon in the vicinity of Buffalo Harbor during the spawning season have increased in recent years. Buffalo Harbor was a historic spawning location for lake sturgeon in Lake Erie, and reports of large numbers of fish here prompted the NYSDEC investigators to initiate an assessment of the spawning population of lake sturgeon in Buffalo Harbor.

Methods

Lake sturgeon were sampled in Buffalo Harbor from 2012 – 2014 using gill nets and set lines. Sampling began in early May and continued for approximately three weeks. In 2012 and 2013 gill nets consisted of four 50-ft x 8-ft panels, two panels had 10-inch stretch mesh and two panels had 12-inch stretch mesh. In 2014 two additional panels of 14-inch stretch mesh were added. Set lines consisted of 25 12/0 baited (fish) circle hooks per line. In 2012 gill nets and set lines were set arbitrarily in the vicinity of the harbor in an attempt to locate areas where sturgeon concentrated. In 2013 and 2014 sampling was focused in areas where sturgeon had been caught in previous years. All lake sturgeon collected were measured for total length, fork length, girth and weight. Single factor ANOVA was used to determine if average total length and average weight differed between years.

A section of the leading fin ray of the left pectoral fin was removed from all fish for age determination. Fin rays were sectioned using a low speed saw, mounted on microscope slides and read by three readers. The average of the three independent age estimates was used to determine the age of each fish. PIT tags were placed posterior to the second dorsal scute on all fish during all years. FLOY tags were placed at the base of the dorsal fin on all fish collected in 2013 and 2014.

Results

A total of 109 lake sturgeon were caught during three years of sampling. In 2012, nine lake sturgeon were caught in 20 daytime gill nets for a catch rate of 0.45 fish/net. An additional six fish were caught on 27 overnight set lines for a catch rate of 0.22 fish/set line. In 2013, 52 lake sturgeon were caught in 13 daytime gill nets, two overnight gill nets and 27 overnight set lines for a catch rate of 3.31 fish/daytime gill net, 0.50 fish/overnight gill net and 0.30 fish/set line. In 2014, 43 lake sturgeon were caught in 22 daytime gill nets and one lake sturgeon was caught on 32 overnight set lines for a catch rate of 1.95 fish/gill net and 0.03 fish/set line.

The average total length was similar in all years (P = 0.12) with a grand mean of 56.9 inches (SD = 4.5).The average weight of all lake sturgeon collected was 56 pounds (SD = 18.5). Average weight was similar during 2012 and 2013, but significantly greater in 2014 (P = 0.02). The average age of lake sturgeon was 16 years old (SD = 8) with a range of 8 to 84 years old. The largest Sturgeon collected was a 6 feet 4 inch, 128 pound female that was estimated to be 84 years old.

Discussion

Lake sturgeon were most effectively sampled in Buffalo Harbor using two hour daytime gill net sets. Overnight set lines caught some fish but were much less efficient than gill nets (Figure M.1).

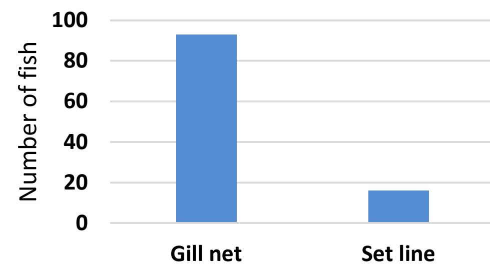


Figure M.1. Total number of lake sturgeon caught in Buffalo Harbor from 2012 to 2014 using gill nets and set lines.

We were able to document a naturally reproducing population of lake sturgeon in Buffalo Harbor that consists of at least 22 different age classes (Figure M.2). However, this population is primarily made up of younger individuals that are likely making their initial appearances on the spawning grounds. Only 15 % of the lake sturgeon we collected were ≥ 20 years old.

Figure M.2. Age distribution of Lake Sturgeon collected in Buffalo Harbor from 2012 - 2014.

A similar age structure occurs for the lake sturgeon population inhabiting the lower Niagara River (Gorsky et al. 2012 and Biesinger et al. 2014). The similarity between these two populations indicates that they may have responded to similar changes in the environment that allowed for increased recruitment beginning in the 1990's.

An age structure dominated by young adult fish is typically cause for concern because the entire population is dependent on a just a few maturing adult cohorts and relatively few larger, older individuals that otherwise would contribute a significant proportion of offspring to the population. However, spawning success in Buffalo Harbor appears to have substantially improved in the mid 1990's and better recruitment appears to have been sustained through 2002. Individuals produced in cohort years since 2003 have not fully recruited to the spawning stock or our survey gear and cannot be assessed until future years. Eight consecutive years of strong recruitment from 1995 – 2002 provide evidence that successful natural reproduction is occurring in Buffalo Harbor during most years.

References

Biesinger, Z., D. Gorsky, G. R. Jacobs, J. A. Sweka, M. A. H. Webb and M. Talbott. Population assessment of Lake Sturgeon in the lower Niagara River. 2014. Section 25 *in* 2013 NYSDEC Annual Report, Bureau of Fisheries Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission's Lake Ontario Committee, March 2014. 13 pp.

Carlson, D. M. 1995. Lake sturgeon waters and fisheries in New York State. Journal of Great Lakes Research 21(1):35–41.

Gorsky, D., E. Trometer, M. Casto Yerty, J. Sweka and G. Jacobs. 2012. Population assessment of Lake Sturgeon in the lower Niagara River. Section 26 *in* 2011 NYSDEC Annual Report, Bureau of Fisheries Lake Ontario Unit and St. Lawrence River Unit to the Great Lakes Fishery Commission's Lake Ontario Committee, March 2012. 6pp.

Koelz, W. 1926. Fishing industry of the Great Lakes. Appendix XI to the Report of the U. S. Commissioner of Fisheries for 1925. 40 pp.

N. OPEN LAKE SPORT FISHING SURVEY

Jason M. Robinson

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. 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 et al. 2007). This nighttime survey component was suspended from 1998 to 2005, and then resumed during 2006 to update the status of this fishery. This nighttime survey will be conducted intermittently in future years as determined by available resources and program need.

From 1988 to 2001, standard angler survey methodology included an aerial boat count component to measure fishing effort. Since 2002, fishing effort has been measured from the five major harbors bordering New York's portion of Lake Erie. 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).

Methods

Survey Procedures

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, a new standard methodology was implemented. Our current method to estimate fishing effort is an "access approach" described by Pollock et al. (1994). The specific application of this access method of angler survey methodology to the New York waters of Lake Erie is described in Einhouse (2005).

Assessment of the daytime open lake sport fishery occurs from May through October each year. Our current methodology employs stratification by day type (weekday-weekend day), harbor, and month. Although survey procedures changed after 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 2014 time series (Einhouse 2005).

Data Analysis

Daytime angler survey estimates for fishing effort, harvest, and catch rates, with associated precision (standard error) measures, were calculated for each stratum using the formulae described in Einhouse (2005).

Survey Results

Estimated overall 2014 open water sport fishing effort in New York waters of Lake Erie was 371,372 angler-hours. Peak fishing activity occurred during June and the most frequently used site was the Buffalo Small Boat Harbor, which accounted for approximately 33 percent of estimated boat fishing effort in 2014 (Table N.1).

TABLE N.1. The distribution of 2014 open water boat fishing effort in New York's portion of Lake Erie.

Harbor	May	Jun	Jul	Aug	Sep	Oct	Total
Barcelona	1,589	14,970	5,828	14,868	2,103	642	40,000
Dunkirk	6,141	12,744	18,786	11,477	4,713	1,225	55,086
Cattaragus	6,842	16,714	15,854	21,050	22,127	1,916	84,503
Sturgeon Pt.	5,922	17,471	11,663	22,643	10,215	966	68,879
Small Boat Harbor	11,495	65,745	19,131	14,720	9,758	2,055	122,904
Grand Total	31,988	127,644	71,261	84,758	48,917	6,804	371,372
(2 std err.)							(51,044)

The total open water boat fishing effort estimate in 2014 increased 20% from 2013 and was the highest since 2001 (Figure N.1). Walleye effort was the largest component of the sport fishery accounting for 50 percent of the overall angling effort (Figure N.2). Yellow Perch and smallmouth bass angling effort was 21 percent and 17 percent of the total effort, respectively. 2013 and 14 were the first years since the beginning of the time series that yellow perch effort exceeded bass effort. Most of the remaining 2014 fishing effort was by anglers fishing for "anything".

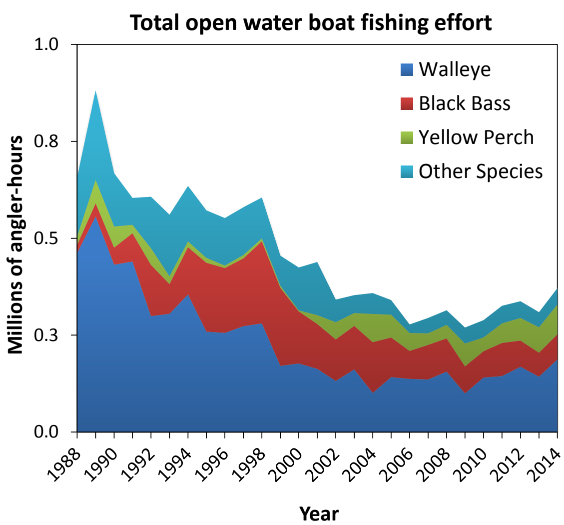


FIGURE N.1. Open water sport fishing effort in New York waters of Lake Erie by walleye anglers, Bass anglers, perch anglers and all others, May-October, 1988-2014.

A total of 26 species were captured by boat anglers in 2014 resulting a total catch of individual 573,000 fish (Table N.2). Sixteen species were harvested resulting in a total harvest of 284,000 fish. Yellow Perch and walleye accounted for approximately 97% of the harvest but only 60% of the fish caught.

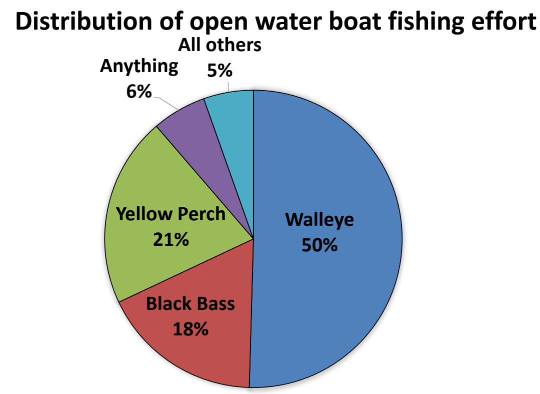


FIGURE N.2. Distribution of directed sport fishing effort by boat anglers in New York waters of Lake Erie, May-October, 2013.

TABLE N.2. Harvest and catch of selected species by boat anglers fishing on the New York waters of Lake Erie, May-October, 2014.

Species	Harvested	2SE	Caught	2SE
Yellow Perch	211,628	44,021	265,752	54,299
Walleye	61,983	14,780	76,220	18,162
Smallmouth Bass	4,564	1,766	86,008	20,748
White Bass	2,186	912	68,100	14,331
Lake Trout	653	368	2,148	1,124
White Perch	565	604	10,953	3,210
*20 other species	1,949	1,031	63,759	9,272
Total	283,527	46,495	572,939	63,338

* > 80 % of catch of other species were Round Goby and Freshwater Drum

Walleye

Estimated 2014 walleye fishing effort was 187,332 angler-hours, a 20% increase from 2013 and the highest effort since 1998. Walleye fishing effort over the last 12 years has been low relative to observations earlier in this data series (Figure N.3).

Estimated 2014 total daytime walleye harvest was 61,983 fish (Table N.2), a 79% increase from 2013. This level of harvest has not occurred since 1989 and represents the third highest harvest in the 27 year time series (Figure N.3).

Walleye catch and harvest peaked during June, and the June through August period contributed over 90 percent to the total catch and harvest estimates (Table N.3). The Buffalo Small Boat Harbor survey location contributed the largest share (33 %) to the walleye catch during 2014.

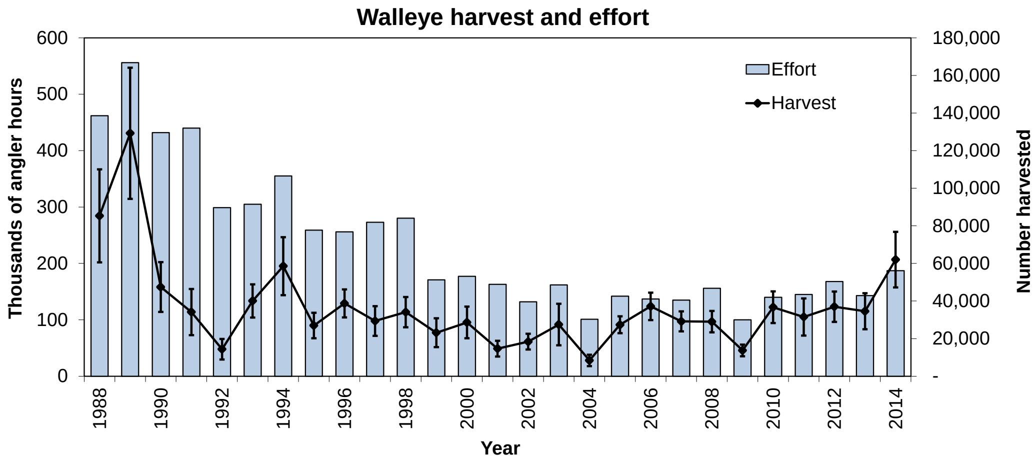


FIGURE N.3. Annual trends in walleye sport fishing effort (angler-hours) and number harvested from May-October, 1988–2014.

TABLE N.3. Distribution of daytime walleye catch and harvest totals in the New York waters of Lake Erie during 2014.

		May	Jun	Jul	Augt	Sep	Oct	Total
Barcelona	catch	75	2,711	1,799	4,030	375	166	9,157
	harvest	46	2,444	1,378	3,340	375	131	7,715
Dunkirk	catch	76	614	9,444	3,130	1,276	29	14,570
	harvest	57	578	8,016	2,950	1,195	10	12,805
Cattaraugus	catch	15	659	4,192	6,661	2,263	13	13,803
	harvest	-	386	3,316	5,397	2,166	6	11,271
Sturgeon	catch	-	4,135	3,039	5,123	725	6	13,028
	harvest	-	3,274	2,520	4,672	621	6	11,093
Buffalo	catch	204	22,927	1,816	619	96	-	25,662
	harvest	181	17,058	1,328	436	96	-	19,099
Total	catch	370	31,047	20,290	19,563	4,736	214	76,220
	harvest	285	23,740	16,558	16,795	4,453	152	61,983

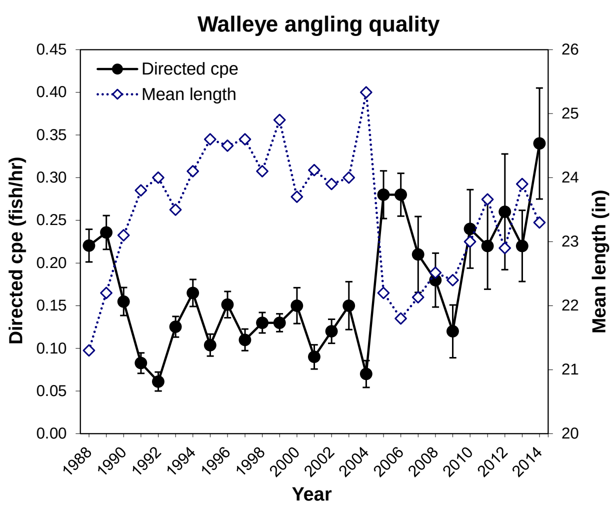


FIGURE N.4. Annual trends in walleye sport fishing quality as measured by mean length harvested (inches) and catch rate (number per hour or cpe) from 1988 to 2014.

The overall 2014 targeted walleye catch rate was 0.34 fish per hour, the highest in the 27 year data series (Figure N.4). Walleye catch rates have been above average (0.17 fish per hour) in nine of the past eleven years. The average total length of harvested walleye in 2014 was 23.3 inches (Figure N.4).

Measures of walleye angler success can also be expressed as frequency of boat limit catches and frequency of zero catches for targeted walleye fishing trips. Table N.4 shows that boat limit catches of walleye remain an uncommon occurrence across all years, while complete lack of success (zero harvest) was less common in 2014 than other recent survey years. During 2014, approximately 6 percent of non-charter walleye fishing boats achieved a party limit, while nearly 29 percent failed to harvest any walleye. The 2014 fishing season was the second full year that a new six walleye daily limit was in place for the New York waters of Lake Erie.

TABLE N.4. Non-charter walleye boat fishing quality metrics, including harvest and catch rates, percentage of boat achieving their daily limit, and percentage of boats that harvested no walleyes from 2003 to 2014.

Year	Ave. Walleye / ang-hr		Ave. Walleye / boat trip		Walleye boat trips		Daily limit
	HPE	CPE	harvest	catch	% Limits	% Zero	regulation
2003	0.14	0.15	2.0	2.1	3.8	39.8	4
2004	0.07	0.07	0.7	0.8	0.0	65.3	4
2005	0.17	0.28	2.2	3.6	7.7	44.6	4
2006	0.23	0.28	3.0	3.7	12.5	32.7	4
2007	0.19	0.21	2.5	2.8	3.4	36.6	5
2008	0.16	0.18	2.0	2.2	2.3	42.3	5
2009	0.12	0.13	1.5	1.6	2.1	50.4	5
2010	0.21	0.24	2.8	3.3	5.1	36.2	5
2011	0.19	0.22	2.6	3.0	4.5	37.7	5
2012	0.19	0.26	2.6	3.3	1.7	40.2	5
2013	0.19	0.22	2.6	2.9	2.7	40.2	6
2014	0.27	0.34	3.5	4.2	6.0	28.7	6

The age distribution of the walleye harvest was determined from otolith samples taken at fish cleaning stations, and was extrapolated to estimate total number of fish caught by age class (Figure N.5). The walleye harvest was dominated by the 2010 and 2003 year classes (ages 4 and 11) which made up approximately 61% of the total harvest. Fish cleaning station data continue to indicate that angler-caught walleye diet is dominated by Rainbow Smelt.

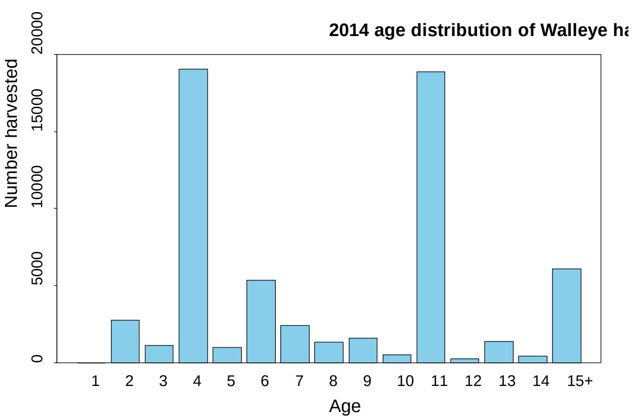


FIGURE N.5. Age distribution of the 2014 walleye harvest estimated by expanding the age distribution of samples at fish cleaning stations by the 2014 walleye harvest estimate.

<u>Smallmouth Bass</u>

Smallmouth Bass harvest was estimated at 4,564 fish in 2014, which amounted to only about 5 percent of the total Bass catch (Table N.2). In 2014, approximately 66 percent of the catch and 56 percent of the harvest was reported from the Buffalo Small Boat Harbor survey location. Estimated Smallmouth Bass harvest was the third lowest estimate in the 27-year survey, and the bass fishing effort was the fifth lowest value observed (Figure N.6).

TABLE N.5. Distribution of smallmouth bass catch and harvest totals in the New York waters of Lake Erie during 2014.

		May	Jun	Jul	Aug	Sep	Oct	Total
Barcelona	Catch	1,722	988	145	23	7	10	2,896
	Harvest	-	-	58	-	-	-	58
Dunkirk	Catch	11,162	13,370	779	528	36	167	26,041
	Harvest	-	605	97	-	-	-	703
Cattaraugus	Catch	887	636	542	622	234	343	3,265
	Harvest	-	-	21	161	20	6	207
Sturgeon	Catch	213	1,732	1,127	1,652	691	80	5,496
	Harvest	-	109	49	330	9	69	566
Buffalo	Catch	13,927	20,604	3,983	4,979	4,555	263	48,310
	Harvest	-	1,559	504	647	321		3,030
Total	Catch	27,911	37,331	6,576	7,805	5,523	863	86,008
	Harvest	-	2,273	729	1,138	349	75	4,564

Smallmouth Bass was the second most frequently caught species (86,008 fish) by boat anglers (Table N.2). The 2014 overall catch rate by bass anglers was 1.29 bass per hour, second only to 2013 in the time series. Mean length of harvested smallmouth bass was 16.5 inches (N=20, Figure N.7).

In 2014, ages were determined from 20 harvested smallmouth bass scale samples collected by angler survey technicians. Ages ranged from age-3 to age-12. The 20 age and length samples collected were insufficient to estimate the age distribution of the harvest.

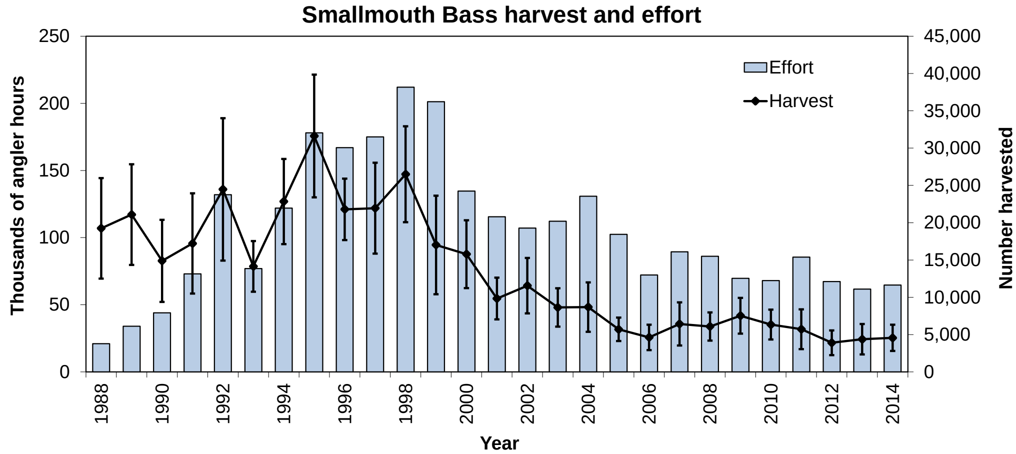


FIGURE N.6. Annual trends in smallmouth bass sport fishing effort (angler-hours) and number harvested from May through October 1988 to 2014.

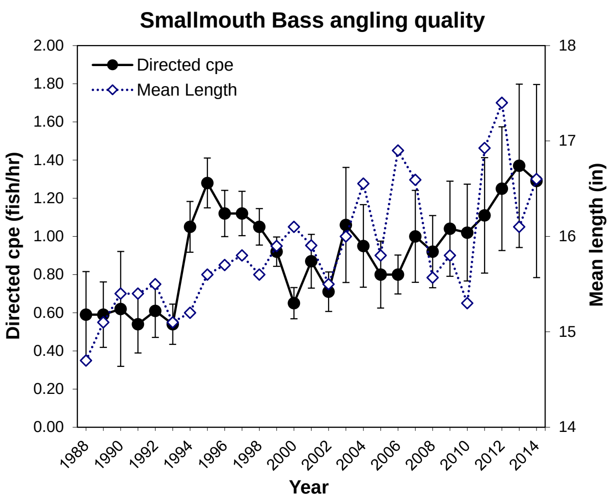


FIGURE N.7. Annual trends in smallmouth bass sport fishing quality as measured by mean length harvested (inches) and catch rate (number per hour or cpe) from 1988 to 2014.

Yellow Perch

Yellow Perch was the most caught and harvested species by boat anglers in 2014 (Table N.2). Yellow perch harvest (211,628 fish) and effort (76,817 ang-hrs) were both the highest measures recorded for the 27 year survey period (Figure N.9).

Approximately 88 percent of the 2014 yellow perch harvest was reported from Cattaraugus Creek and Sturgeon Point Harbors collectively (Table N.6). The highest monthly yellow perch harvest occurred in September (38 percent).

TABLE N.6. Distribution of yellow perch catch and harvest totals in the New York waters of Lake Erie during 2014.

		May	Jun	Jul	Aug	Sep	Oct	Total
Barcelona	Catch	377	93	87	39	7	-	603
	Harvest	377	67	-	23	7	-	474
Dunkirk	Catch	1,267	6,233	1,850	1,842	2,743	-	13,935
	Harvest	895	4,707	1,396	1,610	2,290	-	10,897
Cattaraugus	Catch	31,988	31,143	6,235	11,677	60,850	3,859	145,752
	Harvest	24,540	25,505	5,964	10,132	51,192	3,293	120,628
Sturgeon	Catch	13,150	21,439	363	10,726	34,026	2,078	81,782
	Harvest	10,593	16,396	216	8,818	27,112	1,768	64,904
Buffalo	Catch	7,792	12,778	763	1,153	898	296	23,680
	Harvest	3,935	9,721	76	506	289	197	14,725
Total	Catch	54,573	71,686	9,298	25,438	98,524	6,233	265,752
	Harvest	40,340	56,396	7,652	21,090	80,891	5,259	211,628

The 2014 overall yellow perch catch rate was 3.53 perch per hour, the highest observed in the time series (Figure N.10). The mean length of harvested yellow perch was 11.0 inches in 2014, and has remained very similar in recent years.

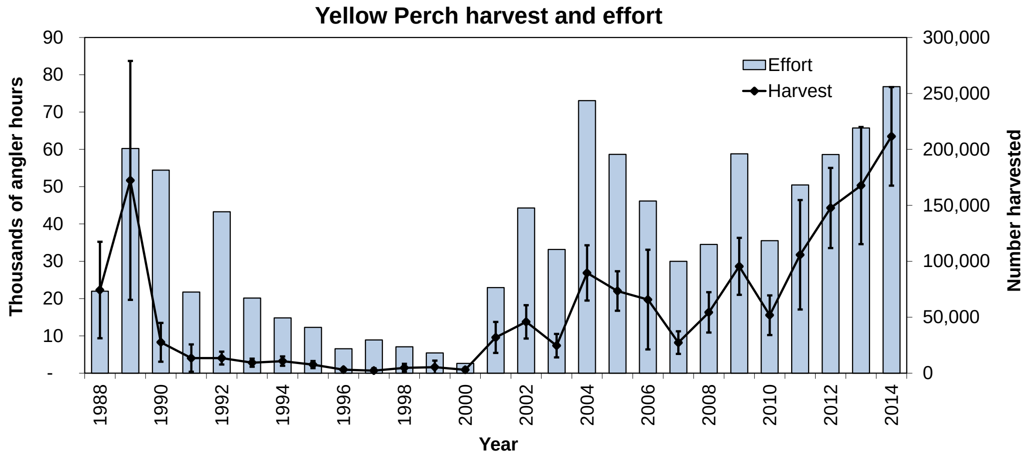


FIGURE N.9. Annual trends in yellow perch sport fishing effort (angler-hours) and number harvested from May through October 1988 to 2014

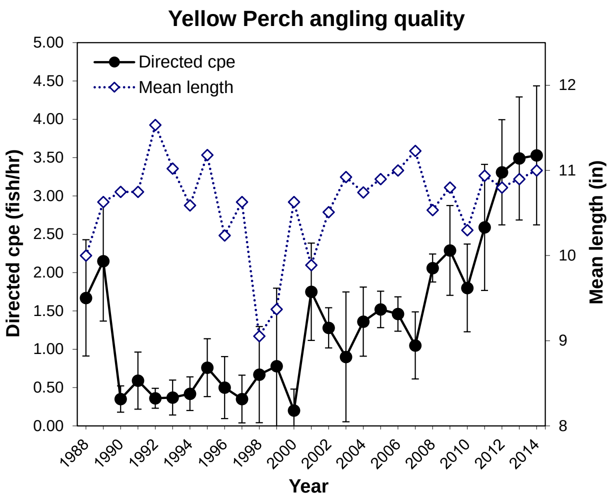


FIGURE N.10. Annual trends in yellow perch sport fishing quality as measured by mean length harvested (inches) and catch rate (number per hour or cpe) from 1988 to 2014.

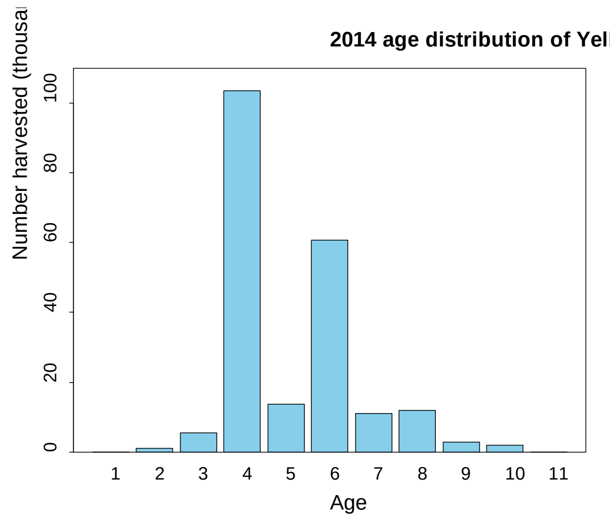


FIGURE N.11. Age distribution of the 2014 yellow perch harvest estimated by expanding the age distribution of samples collected during the angler survey with the 2014 yellow perch harvest estimate.

The age distribution of the yellow perch harvest was determined from anal fin spine samples, and was extrapolated to estimate total number of fish caught by age class. Age-4, age-5 yellow perch, from strong 2010, and 2008 year classes, accounted for approximately 78 percent of the yellow perch harvest (Figure N.11).

<u>Other Species</u>

Sport catch and harvest estimates for other prominent species are presented in Table N.2. Round gobies remained a commonly encountered nuisance species for anglers in 2014. Coho salmon, rainbow trout, brown trout, and lake trout, were the salmonids identified among harvested species in the 2014 survey. Lake trout was the most caught (2,148 fish) and harvested (653 fish) of these four salmonid species. Lake whitefish were also reported by boat anglers during 2014.

Discussion

A major declining trend in boat fishing effort extended through the 1990's. Since that time, overall effort has stabilized, with a very modest increase in fishing effort observed over the last 5 years. Lake Erie's major decline in boat fishing effort from the late 1980's through the 1990's remains consistent with broad trends observed in other waters and is likely attributable to factors independent of fishing quality. Other contributors to fishing effort declines may include high fuel prices and aging of the boat angler population.

In recent years, walleye fishing quality has been excellent compared to the 27 year survey period. The dominant 2003 walleye year class has been mostly responsible for the excellent quality fishing. More recently, the 2003 year class was augmented by strong 2010 year class in New York waters. The 2010 year class began making a significant contribution to New York's walleye harvest in 2013 and equaled the contribution of the 2003 year class in 2014. A strong 2012 year class should begin making a notable contribution to the angling harvest as three year olds in 2015.

Another well-known factor contributing to walleye fishing quality in the eastern basin of Lake Erie is summertime movements of walleye from more westerly Lake Erie waters into the central and eastern basins. The segment of the western basin walleye population largely responsible for this seasonal movement is generally larger and older walleye. The magnitude of this migration varies between years and may be attributable to factors independent of walleye densities (Einhouse and MacDougall 2010). Beginning in 2015, Lake Erie Unit Staff will be undertaking a study which will use acoustic telemetry technology to quantify this annual walleye migration and its importance to the eastern basin fishery.

Bass angling quality has been reasonably constant in recent years, as measured by angler catch rates and average size of harvested smallmouth bass. These measures characterize Lake Erie's Bass angling quality as excellent. However, since 2001, catch rates experienced by smallmouth bass anglers began to diverge from overall harvest totals for Lake Erie. Initially we attributed declining harvest rates to the emerging knowledge of botulism induced fish kills, particularly from 2001 to 2003, which likely reduced motivation to harvest smallmouth bass among some anglers. However, more recently, botulism outbreaks have faded along with accompanying angler concerns about fish consumption, yet the decreasing trend in bass harvest rates has continued. In recent years smallmouth bass harvest totals are the lowest observed in the time series. A notable trend of increasing catch-and-release fishing preferences by Bass angling specialists is partly responsible for the disconnect between harvest trends and catch rates. In addition, anglers targeting species other than smallmouth bass can account for as much as 70 percent of the total smallmouth bass harvest in a given year. As such, Smallmouth harvest estimates for the entire sport fishery are not necessarily indicative of targeted catch or harvest rates attributable to bass specialists, who primarily release black bass. The emergence of excellent quality yellow perch fishing also seems to present a more plausible alternative for anglers interested in consuming their day's catch.

Independent measures of the smallmouth bass population (Section D) suggest the adult Bass population has remained reasonably abundant through recent years. However, these same indicators also suggest increased growth and perhaps elevated natural mortality rates for smallmouth bass in recent years may be resulting in fewer "trophy" fish over 20 inches.

Beginning in 2001 excellent yellow perch fishing quality returned after a full decade of poor fishing. Improvements in yellow perch fishing quality are consistent with other population indicators (Sections C and D) indicating greatly improved status from the low, 1990's levels. In 2014, yellow perch fishing effort and harvest were the highest in the 27 year time series, reflecting the excellent fishing quality.

During 2004, angler survey methodology became a major focus for both NYSDEC and the Lake Erie fisheries management community. Specifically, New York's Lake Erie angler survey methods were subject to an independent scientific review of Lake

Erie's walleye and yellow perch harvest estimation methods, sponsored by the Great Lakes Fishery Commission (GLFC). In response to GLFC's independent review, the Lake Erie Unit prepared a comprehensive report thoroughly documenting past and present angler survey procedures (Einhouse 2005). The findings of the independent review have been published (Lester et al. 2005) and New York has made every reasonable effort to adopt recommendations toward advancing defensible, scientifically sound angler survey methods. The first review panel recommendation was implemented in spring 2006 by monitoring a subordinate component of the walleye fishery (The nighttime fishery). The 2006 nighttime survey found 7 percent of overall walleye fishing effort and 10 percent of the harvest occurred at night (Einhouse et al. 2007). The spring (May-June), nighttime walleye fishery was scheduled for a regularly programmed survey at 3-year intervals, with subsequent surveys to be conducted in 2009 and 2012; however, these planned surveys did not occur due to staffing constraints which suspended this survey since 2006. This previous constraint has now been resolved and angler surveys of additional fishery segments can once again be considered among the Lake Erie Unit's overall program plan. A potential angler survey of the Niagara River is being explored for possible implementation in 2016.

References

Einhouse, D. W. 2005. Angler Survey Methods for Lake Erie's Open Water Sport Fishery. New York State Department of Environmental Conservation, Albany, New York. 68 pp.

Einhouse, D. W., J. L. Markham, D. L. Zeller, R. C. Zimar, and B. J. Beckwith 2007. NYS DEC Lake Erie 2006 Annual Report. New York State Department of Environmental Conservation, Albany, New York.

Einhouse, D. W. and T. M. MacDougall. 2010. An emerging view of stock contributions to Lake Erie's eastern basin walleye resource. In Status of walleye in the Great Lakes: proceedings of the 2006 Symposium. Great Lakes Fish. Comm. Tech. Rep. 69. pp 151 -164.

Lester, N., A. Bingham, W. Clark, K. Pollock, and P. Sullivan. 2005. Report of the Blue Ribbon Panel for Review of Procedures Used to Estimate Percid Harvest in Lake Erie. Great Lakes Fishery Commission Special Publication.

Pollock, K. H. 1994. Angler survey methods and their application in fisheries management. American Fisheries Society Special Publication 25. American Fisheries Society, Bethesda, Maryland.

Schmidt, B. R. 1975. Results and Evaluation of an Aerial Creel Survey Technique on Lake Sharpe, South Dakota. Master's Thesis, South Dakota State U., Brookings, SD, USA.

O. LOWER TROPHIC LEVEL MONITORING PROGRAM

James L. Markham

In 1983, the Lake Erie Fisheries 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 transparency (Secchi), water temperature, and zooplankton. In 1988, sampling efforts shifted to two sites off Dunkirk; one shallow (11 m or 36 feet), and one deep (21.3 m or 70 feet), with sampling frequency increased to two week intervals from May through September (Figure O.1).

In 1999, a lakewide lower trophic level assessment program was initiated (see Forage Task Group 2014). A total of 18 stations in Lake Erie, three offshore and three inshore per basin, were established to gain an understanding of lakewide ecosystem trends and to monitor lake productivity. Variables collected include water temperature, dissolved oxygen, water transparency, total phosphorus, chlorophyll *a*, and zooplankton. Results from New York's program are merged with lakewide lower trophic level data from other jurisdictions and reported within the inter-agency Forage Task Group annual report.

Lake Erie's bi-national fish community goals and objectives for the eastern basin fish community target maintaining mesotrophic conditions that favor a cool-water percid (walleye and yellow perch) community in nearshore waters (Ryan et al. 2003). Within this trophic 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 µg/L (Leach et al. 1977). Fish community objectives for the offshore waters of the eastern basin target maintaining oligotrophic conditions (Secchi > 6 m (20 feet); total phosphorus < 9 µg/L; chlorophyll *a* < 2.5 µg/L) that favor a cold-water salmonid fish community. Our ongoing measures of Secchi, total phosphorus and chlorophyll *a* in nearshore and offshore habitats assess whether prevailing trophic conditions remain consistent with Lake Erie's favored fish communities.

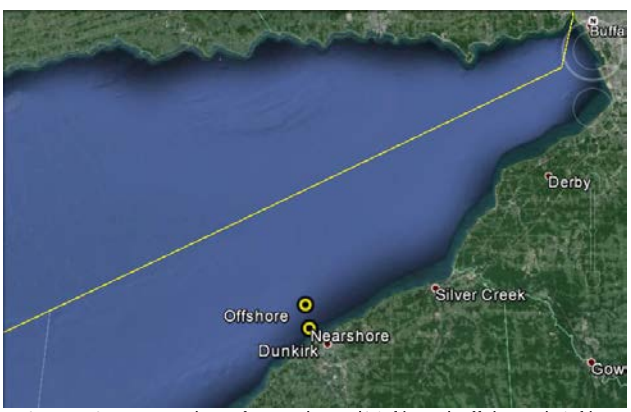


FIGURE O.1. Location of nearshore (36 ft) and offshore (70 ft) lower trophic sampling sites monitored by the NYSDEC's Lake Erie Unit between May and September annually.

Methods

Samples are collected at fixed shallow (11 m or 36 ft) and deep (21.3 m or 70 ft) sites adjacent to Dunkirk every two weeks from May through September, totaling 12 sampling periods annually. During each site visit, water depth, date, and time of day are recorded along with basic sampling conditions such as cloud cover and wind speed. Water transparency to the nearest 0.5 meter is determined using a Secchi disk. A HydroLab meter is used to record 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 samples. A 0.5 m (1.6 ft), 64 µm conical plankton net is lowered and retrieved vertically from one meter off the bottom, or above the thermocline (epilimnion), to the surface to obtain a zooplankton sample. Zooplankton, chlorophyll *a*, and phosphorus samples are outsourced for processing.

Results

A total of 11 of 12 pre-planned sampling dates were completed at both shallow and deep sites between 8 May and 23 September, 2014.

Surface Water Temperature

The average summer (June – August) surface water temperature, weighted by month, was calculated for the offshore station by year (Figure O.2). Summer water temperature should provides an index of relative system production and growth rate potential for fishes, assuming prey resources are not limiting. Average summer surface water temperatures ranged from 19.4 ºC (66.9 ºF) in 2000 to 22.7 ºC (72.8 ºF) in 2010. The warmest average summer water temperatures were measured in 2005, 2010, and 2011 and coolest temperatures in 2000 and 2004. The average summer surface water temperature in 2014 was 20.7 ºC (69.3 ºF), which was near the series average of 20.9 ºC (69.7 ºF).

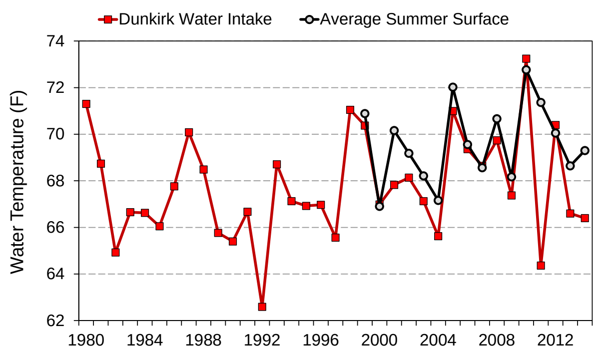


FIGURE O.2. Average summer (June – August) surface water temperature (ºF), weighted by month, at an offshore (70 ft) site at Dunkirk, NY in Lake Erie, 1999-2014, and at an intake pipe (29 ft) for the Dunkirk Water Treatment Plant, 1980-2014.

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 since 1927 (NOAA 2014). Water temperatures at this site are taken at the entrance to the Upper Niagara River at 9.1 m (30 ft) depths. An archived water temperature series is also available from the Dunkirk City Water Treatment Plant since 1980. Water temperatures from this site are taken from Lake Erie at 8.8 m (29 ft) depths. At both locations, daily water temperatures are the average of four separate measurements over a 24-hour period.

In 2014, the mean summer water temperature (June – August) at the Dunkirk Water Treatment Plant was 19.1 ºC (66.4 ºF), which was lower than the series average of 19.9 ºC (67.8 ºF) (Figure O.2). With a few exceptions, water temperatures and general trends are similar between NYSDEC surface temperature observations and near bottom temperature measurements taken at the Dunkirk Water Treatment Plant between 1999 and 2014. At the Buffalo Water Intake, the mean summer water temperature in 2014 was 20.3 ºC (68.6 ºF), which was near the series summertime average of 20.2 ºC (68.3 ºF) (Figure O.3). Summertime water temperatures have been above average in nine of the past ten years, and 21 of the previous 28 years at the Buffalo site.

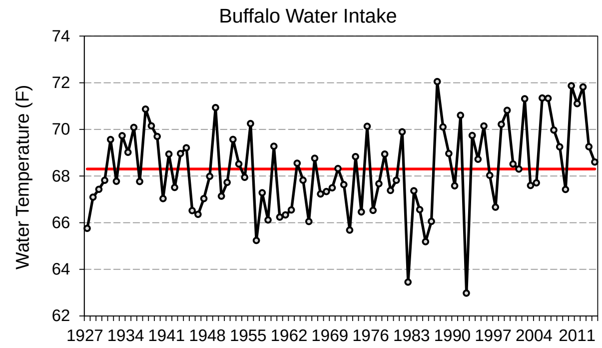


FIGURE O.3. Average summer (June – August) water temperature (ºF) recorded at the Buffalo Water Treatment Plant, 1927 – 2014. The intake pipe is located at a depth of 30 feet at the entrance to the Upper Niagara River. Time series average is also shown (red line).

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 the eastern basin due to greater water depths, a large hypolimnion, lower productivity, and cooler water temperatures (Forage Task Group 2014).

Dissolved oxygen measurements have only been recorded since 2007 at the Dunkirk site and some of those years have few observations due to equipment malfunctions (Figure O.4). No measurements were obtained during 2008 or 2014. Dissolved oxygen measures have never been below the 2.0 mg/L level at our offshore sampling site during the five previous sampling years. The lowest DO reading recorded was 4.3 mg/L in 2009.

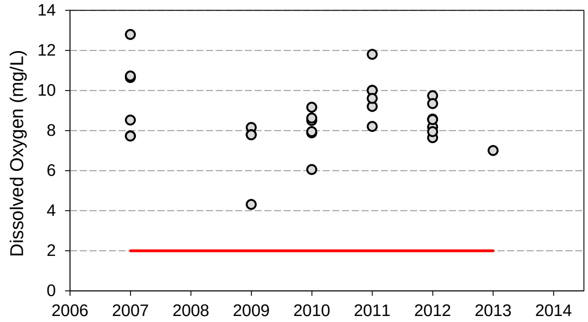
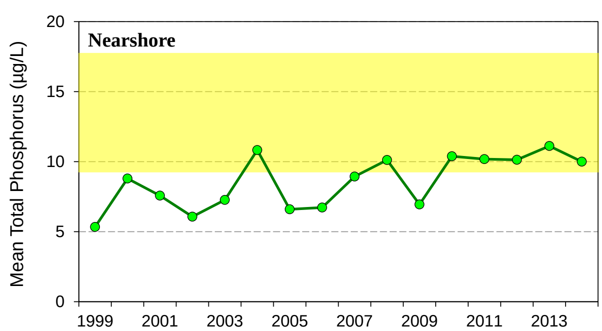


FIGURE O.4. Summer (June – August) bottom dissolved oxygen (mg/L) readings at an offshore (21.3m or 70 ft) site at Dunkirk, NY in Lake Erie, 2006-2014. 2.0 mg/L line represents the level at which oxygen becomes limiting for many temperate fishes.

Phosphorus

Total phosphorus (TP) levels across Lake Erie have generally increased over the past decade, particularly in the Western Basin (Forage Task Group 2014). At New York's nearshore site off Dunkirk, mean annual TP levels were generally below values typical of the mesotrophic target range (9-18 µg/L) but exhibited a gradually increasing trend and have been in the target range in recent years (Figure O.5). In 2014, mean nearshore TP levels were 10.0 µg/L, which was within the target mesotrophic range.

In offshore waters, total phosphorus levels have been stable and within the targeted oligotrophic range (< 9 µg/L) until recently (Figure O.5). Mean offshore TP levels slightly declined in 2014 (10.5 µg/L) but still exceeded the target oligotrophic range for the third consecutive year. Compared to other portions of the lake, phosphorus levels in the east basin have remained generally stable over the past decade (see Forage Task Group 2014).



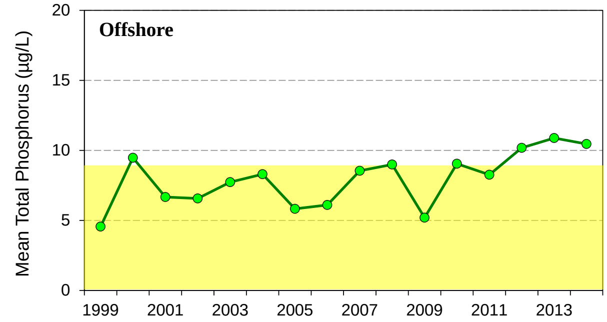


FIGURE O.5. Mean total phosphorus (µg/L), weighted by month, at nearshore (11 m or 36 ft) and offshore (21.3 m or 70ft) sites at Dunkirk, NY in Lake Erie, 1999-2014. Shaded areas represent trophic state targets.

Transparency

Transparency has been measured since the original 1983 survey in nearshore waters, and since 1988 in offshore waters. This long-term data series documents changes in water transparency that accompanied the invasion of dreissenids into eastern Lake Erie in 1990. In nearshore waters, summer water transparency increased into the oligotrophic range by 1992 and remained on the threshold between this trophic state and the targeted mesotrophic range until the late 2000s (Figure O.6). In more recent years, transparency decreased as pelagic productivity increased, and is now firmly within the mesotrophic range (3.0-6.1 m or 10-20 feet) favorable for stable percid communities. The mean summer Secchi depth reading at the nearshore site decreased in 2014 to 4.5 m (14.9 ft) and remains within the target range.

In offshore waters, water transparency increased to the targeted oligotrophic range during the dreissenid invasion, and remained within that range until recent increases in pelagic productivity (Figure O.6). Similar to nearshore waters, summer water transparency in offshore waters decreased from 2008-2012 and was no longer in the targeted oligotrophic range (> 6.1 m or 20 ft) favorable for salmonid communities. Transparency increased somewhat in 2013, but then decreased again in 2014 to 5.8 m (19.0 ft) which was slightly below the oligotrophic target.

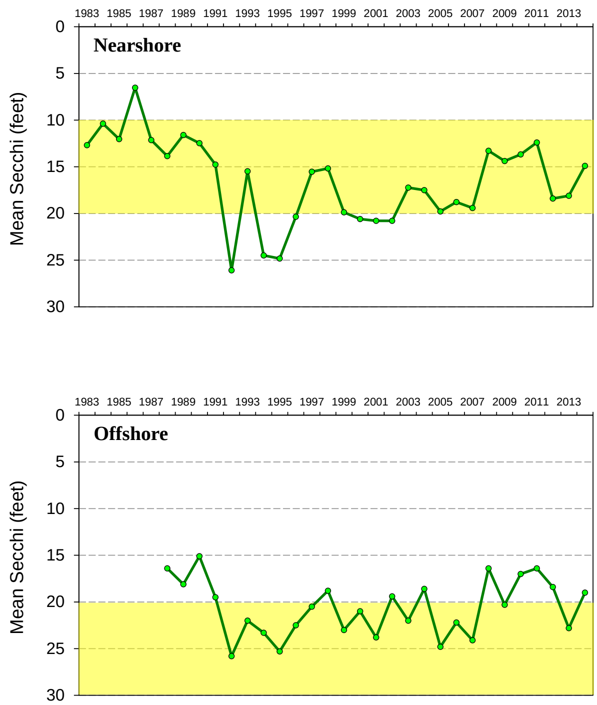


FIGURE O.6. Mean summer (June – August) Secchi depth (feet), weighted by month, at nearshore (11m or 36ft) and offshore (21.3 m or 70 ft) sites at Dunkirk, NY in Lake Erie, 1983-2014. Shaded areas represent trophic state targets.

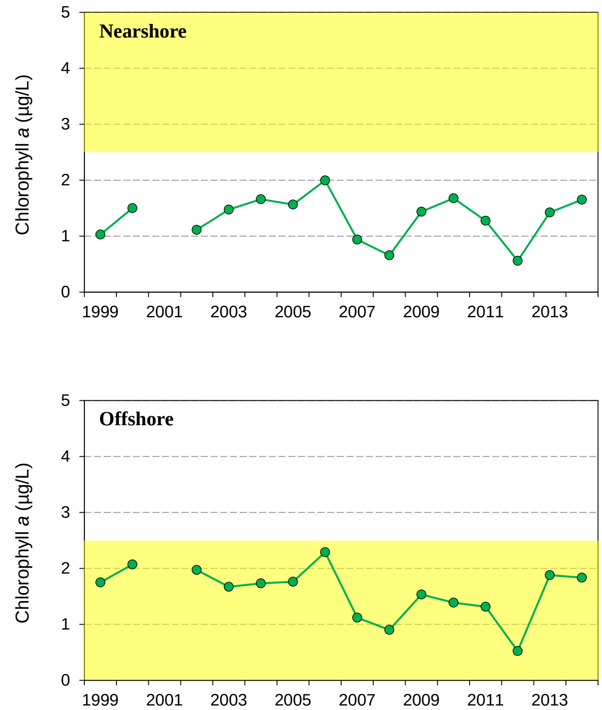


FIGURE O.7. Mean chlorophyll *a* (µg/L), weighted by month, at nearshore (11 m or 36ft) and offshore (21.3 m or 70 ft) sites at Dunkirk, NY in Lake Erie, 1999-2014. Shaded areas represent trophic state targets.

Chlorophyll *a*

Chlorophyll *a* concentrations indicate phytoplankton biomass, ultimately representing production at the lowest level. Chlorophyll *a* levels in nearshore waters have been below the targeted mesotrophic level (2.5 – 5.0 µg/L) for the entire time series (Figure O.7). Conversely, chlorophyll *a* levels in offshore waters remain in the targeted oligotrophic range (< 2.5 µg/L) (Figure O.7). Both the nearshore and offshore chlorophyll *a* measures are likely depressed by high levels of grazing by dreissenids (Nicholls and Hopkins 1993). In 2014, chlorophyll *a* concentrations increased for the second consecutive year at the nearshore (1.65 µg/L) site, but decreased slightly at the offshore (1.84 µg/L) site. Despite the increase, nearshore measurements were still below mesotrophic target ranges while offshore levels remained within the targeted oligotrophic range.

Zooplanktivory Index

Planktivorous fish are size-selective predators, removing larger prey with a resultant decrease in the overall size of the prey community that reflects feeding intensity (Mills et al. 1987). Johannsson et al. (1999) estimated that a mean zooplankton length of 0.57 mm or less sampled with a 64-µm net reflects a high level of predation by fish. Based on these parameters, the zooplanktivory index has been generally stable at the Dunkirk sampling sites over the entire time series (Figure O.8). Fish predation was considered less intense in 2000 and 2003, but otherwise the index has been near the critical 0.57 threshold for all other years in the time series. Zooplankton data for 2012-2014 are still being processed and results are not yet available.

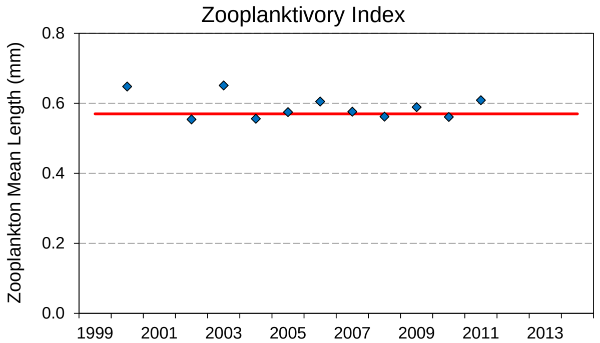


FIGURE O.8. Mean length (mm) of crustacean zooplankton sampled with a 63 µm plankton net in the epilimnion at nearshore (11 m or 36 ft) and offshore (21.3 m or 70 ft) sites (combined) at Dunkirk, NY in Lake Erie, 1999-2011. The threshold line (0.57 mm) represents the size at which predation by fish is considered less intense (above the line) or more intense (below the line) (Mills et al. 1987; Johannsson et al. 1999). 2012 -2014 data are not yet available.

Discussion

Sixteen years of sampling has shown general stability for the lower trophic level portion of the eastern basin of Lake Erie ecosystem. With a few exceptions, average summer water temperatures have ranged within a few degrees over the time series, but with an overall slightly increasing trend, and dissolved oxygen is not limiting as fish habitat. In nearshore waters, measures of total phosphorus and water transparency describe targeted mesotrophic conditions according to Leach et al. (1977), while chlorophyll *a* measures remain below targets. In offshore waters, total phosphorus measures were slightly higher and water transparency slightly lower than the targeted oligotrophic trophic range while chlorophyll *a* was within the target range. Overall, the nearshore waters in New York's portion of the eastern basin of Lake Erie remains near targeted trophic conditions for the desired fish communities in 2014 while the offshore waters were slightly more productive than desired. Nevertheless, these sites remain more stable compared to measures for other basins of Lake Erie (Forage Task Group 2014).

Profound effects of dreissenids are evident in the nearshore waters of the eastern basin. Dreissenids invaded the eastern basin in the early 1990s and water transparency increased sharply in both nearshore and offshore sites. Transparency more recently has gradually declined. However, grazing pressure on phytoplankton remains high in the nearshore waters, and in some recent year's offshore waters, as indicated by lower measures of chlorophyll *a*. Dreissenid mussels may be the dominant source of grazing in infected waters (Nichols and Hopkins 1993). In 2002, dreissenid biomass was highest in the eastern basin with quagga mussels displacing zebra mussels in all basins (Patterson et al. 2005). Recent measures of chlorophyll *a* indicate that dreissenids continue to be a major influence on the eastern basin ecosystem.

Overall productivity has gradually increased in the eastern basin, especially in the nearshore waters. Oligotrophic conditions that were present nearshore in the 1990s and early 2000s have shifted to targeted mesotrophic conditions, and this increase in lower trophic productivity and more stability is evident in responses by the eastern basin percid community. Yellow perch abundance and biomass has been at higher levels in the east basin through recent years and recruitment has been generally stable through the past decade. Walleye recruitment in New York's portion of Lake Erie has also been above the long term average measure in six of the past eleven years. Similarly, the offshore waters of the eastern basin remains a suitable environment for salmonid species based on these lower trophic indicators.

References

Craig, J.K. 2012. Aggregation on the edge: effects of hypoxia avoidance on the spatial distribution of brown shrimp and demersal fishes in the Northern Gulf of Mexico. Marine Ecology Progress Series 445: 75-95.

Eby, L.A., and L.B. Crowder. 2002. Hypoxia-based habitat compression in the Neuse River Estuary: context-dependent shifts in behavioral avoidance thresholds. Can. J. Fish. Aquat. Sci. 59:952-965.

Forage Task Group. 2014. Report of the Lake Erie Forage Task Group, March 2014. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Johannsson, O.E., C. Dumitru, and D. Graham. 1999. Estimation of zooplankton mean length for use in an index of fish community structure and its application to Lake Erie. J. Great Lakes Res. 25: 179-186.

Leach, J.H., M.G. Johnson, J.R.M. Kelso, J. Hartman, W. Numan, and B. Ents. 1977. Responses of percid fishes and their habitats to eutrophication. J. Fish. Res. Board. Can. 34:1964-1971.

Mills, E.L., D.M. Green, and A. Schiavone. 1987. Use of zooplankton size to assess the community structures of fish populations in freshwater lakes. N. Am. J. Fish. Manage. 7: 369-378.

NOAA. 2014. Historical Lake Erie water temperatures. Online 5 March 2014 at: http://www.erh.noaa.gov/buf/laketemps/laketemps.php.

Nicholls, K.H., and G.J. Hopkins. 1993. Recent changes in Lake Erie (north shore) phytoplankton: cumulative impacts of phosphorus loading reductions and the zebra mussel introduction. J. Great Lakes Res. **19**: 637-647.

Patterson, M.W.R., J.J.H. Ciborowski, and D.R. Barton. 2005. The distribution and abundance of *Dreissena* species (Dreissenidae) in Lake Erie, 2002. J. Great Lakes Res. **31**(Suppl. 2): 223-237.

Ryan, P.A., R. Knight, R. MacGregor, G. Towns, R. Hoopes, and W. Culligan. 2003. Fish-community goals and objectives for Lake Erie. Great Lakes Fish. Comm. Spec. Publ. 03-02. 56 p.

P. PUBLIC INFORMATION AND EXTENSION

Michael T. Todd

Lake Erie Fishing Hotline

DEC's Lake Erie Fishing Hotline provides a very popular service to both open lake and tributary anglers. The hotline was started in 1985 to provide up-to-date fishing information for anglers seeking tips about Lake Erie's fishing opportunities. The hotline is updated each Friday, and anglers can access the report by phone or on the DEC website.

Automated answering systems provide a recording of the weekly fishing hotline to Buffalo area anglers at (716-855-FISH) and Dunkirk/Fredonia area anglers at (716-679-ERIE). The total number of calls to the Buffalo line was 16,112 in 2014 (Figure P.1). Buffalo call counts have remained relatively steady since 2009. Angler call counts were not available for the Buffalo line between 1991 and 2008. Due to a system change, call totals have not been available for the Dunkirk line since 2013. The average number of calls to the Dunkirk line was 6,544, and calls to this line had been above average in the last seven years call totals were available.

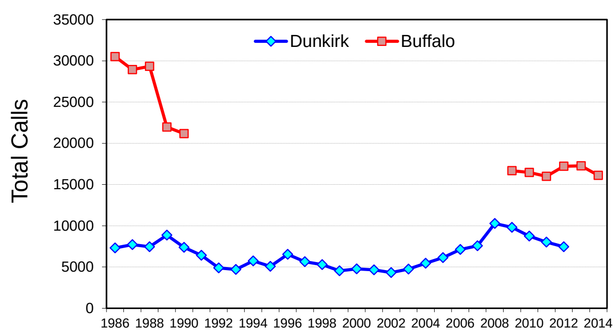


FIGURE P.1. Annual phone calls to the Buffalo and Dunkirk numbers of the Lake Erie/Upper Niagara River fishing hotline, 1986-2014. Estimates were made for months where call totals were missing, substituting averages from the previous two years. Call totals were not available for the Dunkirk line in 2013 and 2014, and from the Buffalo line from 1991-2008.

Since 1999, the Lake Erie Fishing Hotline has also been available on the NYSDEC's website at www.dec.ny.gov/outdoor/9217.html and receives the bulk of angler visits. During 2014, the hotline page had 93,738 total visits (Figure P.2), which is the second highest annual total recorded to date. This is a slight decrease of 935 (1%) visits compared to 2013. The Lake Erie Fishing Hotline continues to be one of the more popular pages on the DEC website, consistently ranking in the top 10 fisheries pages by page views. The hotline page also appears to be bookmarked by many anglers. For instance, the hotline page is one of the top "single access" pages, a page where the user only visits that single page on a visit to the DEC website. Altogether, anglers accessed the Lake Erie Fishing Hotline by phone or internet a total of 109,850 times in 2014 (not including the Dunkirk line).

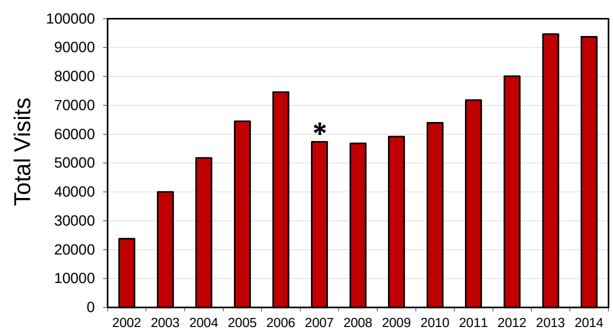


FIGURE P.2. Annual number of visits to the Lake Erie Fishing Hotline on the NYSDEC website, 2002-2014. ***** - A web page navigation and URL locator change was made on 27 April, 2007 that impacted the visits to the website.

Additional Online Resources

Public Fishing Rights (PFR) maps for Chautauqua, Canadaway, Cattaraugus and Eighteenmile Creeks are available for printing from the DEC website at www.dec.ny.gov/outdoor/44879.html. The PFR maps are intended to aid anglers in locating public fishing and angler parking areas on the popular Lake Erie tributaries.

Species specific fishing information is also available on the DEC website for Lake Erie and tributary anglers. Lake Erie smallmouth bass and steelhead fishing pages can be accessed on the website at www.dec.ny.gov/outdoor/47535.html. These pages describe the excellent fishing opportunities for these popular sportfish, as well as providing information on techniques, equipment, fishing locations and seasonal movements.

Current and past DEC Lake Erie Annual Reports are available for download from the Lake Erie Fisheries Research page at www.dec.ny.gov/outdoor/32286.html. Links to interagency Lake Erie reports are also provided.

Great Lakes Fishing Brochure

Developed in 2013, the *I FISH NY Guide to Great Lakes Fishing* is a useful publication available to anglers. The guide highlights the diverse, world-class fishing opportunities of Lakes Erie, Ontario and their tributary streams, Niagara River and St. Lawrence River. Informative content includes what to fish for, when to fish, where to fish (including maps), special fishing techniques and where to stay. To request a free copy, send an email to *fwfish9@dec.ny.gov* with your name and mailing address. Be sure to type Great Lakes Brochure in the subject line. Please allow 3 weeks for delivery.

Fishing Education & Outreach

Region 9 and Lake Erie Unit fisheries staff annually provide a variety of extension services, such as participation in DEC exhibits at county fairs and sportsman shows. Staff also routinely speak at meetings of conservation and service organizations, and host an annual Lake Erie and Upper Niagara River Fisheries Outreach Workshop each spring.

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*
Common 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*
Sand Shiner	*Notropis stramineus*
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*