REPORT OF THE
LAKE ERIE
COLDWATER TASK GROUP

28 March 2018

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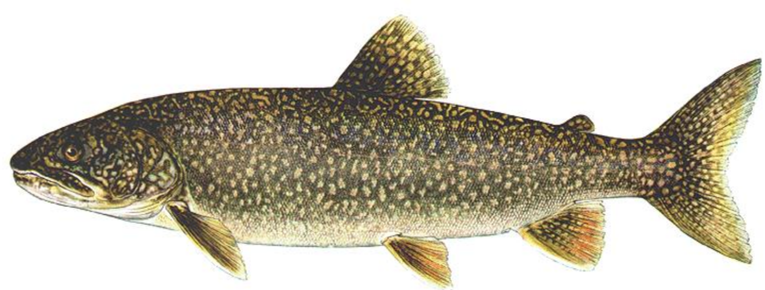
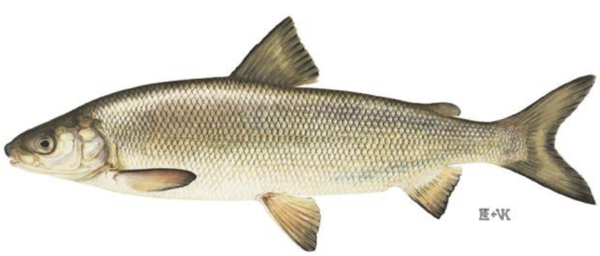
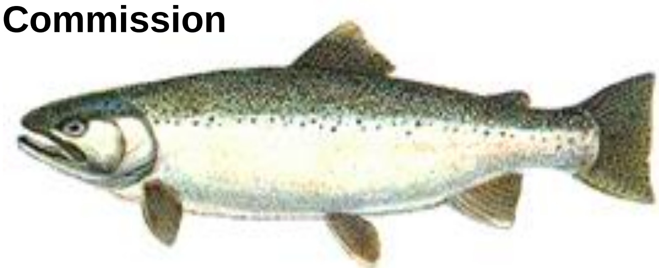




Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

Protocol for Use of Coldwater Task Group Data and Reports

The Lake Erie Coldwater Task Group (CWTG) uses standardized methods, equipment, and protocols as much as possible; however, data sampling and reporting methods do vary across agencies. The data are based upon surveys that have limitations due to gear, depth, time, and weather constraints that are variable from year to year. Any results or conclusions must be treated with respect to these limitations. Caution should be exercised by outside researchers not familiar with each agency's collection and analysis methods to avoid misinterpretation.

The CWTG strongly encourages outside researchers to contact and involve the CWTG members in the use of any specific data contained in this report. Coordination with the CWTG can only enhance the final output or publication and benefit all parties involved. Any CWTG data or findings intended for outside publication **must** be reviewed and approved by the CWTG members. Agencies may require written permission for external use of data, please contact the agencies responsible for the data collection.

Citation:

Coldwater Task Group. 2018. Report of the Lake Erie Coldwater Task Group, March 2018. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Markham, Ontario, Canada.

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Reporting of 2017 – 2018 Coldwater Task Group Charges

Background

The Coldwater Task Group (CWTG) is one of several technical groups under the Lake Erie Committee (LEC) that addresses specific charges related to the fish community. The group was originally formed in 1980 as the Lake Trout Task Group with its main functions of coordinating, collating, analyzing, and reporting of annual Lake Trout assessments among Lake Erie's five member agencies, and assessing the results toward rehabilitation status. Restoration of Lake Trout into its native eastern basin Lake Erie habitat began in 1978, when 236,000 surplus yearlings were obtained from a scheduled stocking in Lake Ontario. Similar numbers of yearlings were also available for Lake Erie in 1979. In 1982, the U.S. Fish and Wildlife Service (USFWS), in cooperation with the Pennsylvania Fish and Boat Commission (PFBC) and the New York State Department of Environmental Conservation (NYSDEC), committed to annually produce and stock at least 160,000 yearlings in Lake Erie and monitor Lake Trout restoration in the eastern basin.

A formal Lake Trout rehabilitation plan was developed by the Lake Trout Task Group in 1985 (Lake Trout Task Group 1985) that defined goals and specific quantitative objectives for restoration. A draft revision of the plan (Pare 1993) was presented to the LEC in 1993, but the revision was never formally adopted by the LEC because of a lack of consensus regarding the position of Lake Trout in the Lake Erie fish community goals and objectives (FCGOs; Cornelius et al. 1995). A revision of the Lake Erie FCGOs was completed in 2003 (Ryan et al. 2003) and identified Lake Trout as the dominant predator in the profundal waters of the eastern basin. A subsequent revision of the Lake Trout Rehabilitation Plan was completed by the task group in 2008 (Markham et al. 2008).

The Lake Trout Task Group evolved into the CWTG in 1992 as interest in the expanding Burbot and Lake Whitefish populations, as well as predator/prey relationships involving salmonid and Rainbow Smelt interactions, prompted additional charges to the group from the LEC. Rainbow/Steelhead Trout fishery and population dynamics were entered into the task group's list of charges in the mid 1990s, and a new charge concerning Cisco rehabilitation was added in 1999. Continued assessments of coldwater species' fisheries and biological characteristics has added new depth to the understanding of how these species function in the shallowest and warmest lake of the Great Lakes.

This report is designed to address activities undertaken by the task group members toward each charge in this past year and is presented orally to the LEC at the annual meeting, held this year on 27-28 March 2014 in Windsor, Ontario Canada. Data have been supplied by each member agency, when available, and combined for this report, if the data conform to standard protocols. Individual agencies may still choose to report their own assessment activities under separate agency reporting processes.

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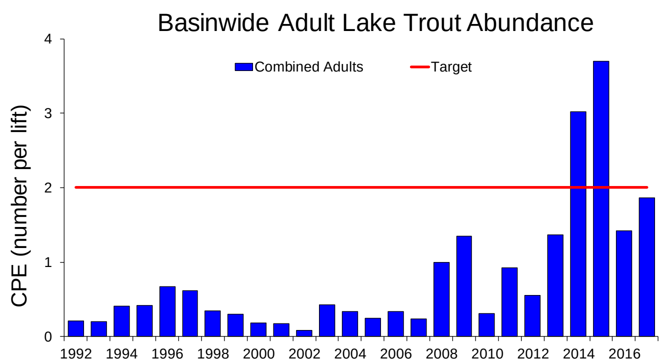
Introduction

This year's Lake Erie Committee (LEC) Coldwater Task Group (CWTG) has produced an Executive Summary Report encapsulating information from the CWTG annual report. Eight charges were addressed by the CWTG during 2017-2018: (1) Lake Trout assessment in the eastern basin; (2) Lake Whitefish fishery assessment and population biology; (3) Burbot fishery assessment and population biology; (4) Participation in Sea Lamprey assessment and control in the Lake Erie watershed; (5) Maintenance of an electronic database of Lake Erie salmonid stocking information; (6) Steelhead fishery assessment and population biology, (7) Development of a Cisco impediments document and (8) Prepare a report addressing the current state of knowledge of Lake Whitefish populations in Lake Erie. The complete report is available from the Great Lakes Fishery Commission's Lake Erie Committee Coldwater Task Group website at http://www.glfc.org/lakecom/lec/CWTG.htm, or upon request from an LEC or CWTG representative.

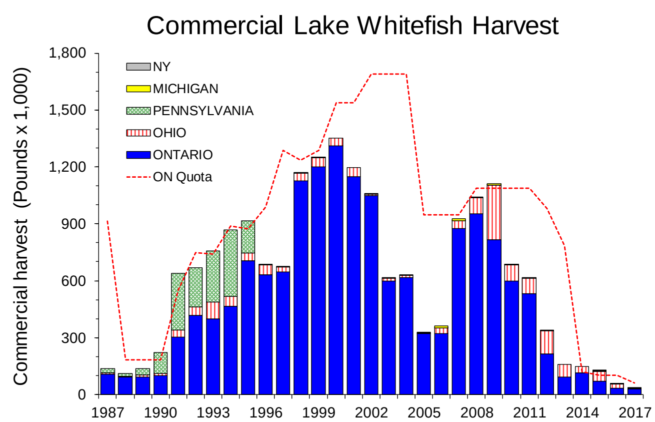
Lake Trout

A total of 368 Lake Trout were collected in 120 unbiased gill net lifts across the eastern basin of Lake Erie in 2017. Basin-wide Lake Trout abundance (weighted by area) was 2.5 fish per lift, which is near average for the time series but well below the rehabilitation target of 8.0 fish/lift. However, adult abundance (ages 5+) was at its third highest measure in the time series and slightly below the target of 2.0 fish/lift. Lake Trout ages 5 and 7-9 were the dominate cohorts with Lake Trout older than age-10 only sporadically caught. Finger Lakes and Lake Champlain strain Lake Trout comprise the majority of the population. The Lake Erie Lake Trout population continues to be supported by binational stocking efforts; natural reproduction has not been documented in Lake Erie despite more than 30 years of restoration efforts.



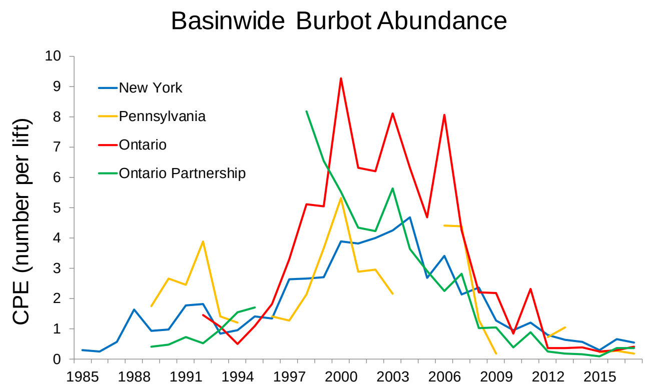
Lake Whitefish

Lake Whitefish harvest in 2017 was 31,539 pounds, distributed among Ontario (98%), Ohio (2%) and Pennsylvania (<1%). Lake Whitefish were not targeted by any fisheries in 2017. Gillnet fishery age composition ranged from 2 to 25. The 2015 year class (age 2) comprised the largest fraction (59%) of the Lake Whitefish gill net fishery. Gill net surveys caught Lake Whitefish from age 1 to 25, with age 2 most abundant. Lake Whitefish population growth is anticipated with additional contribution from the 2015 year class in 2018. Conservative harvest of Lake Whitefish is recommended until Lake Whitefish spawner biomass improves.



Burbot

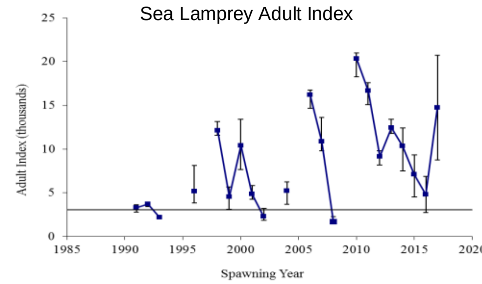
Total commercial harvest of Burbot in Lake Erie in 2017 was 1,408 pounds (638 kg), of which 65% came from Ontario waters. Burbot abundance and biomass indices from annual Coldwater and Ontario Partnership Gillnet Assessments remained at low levels in all jurisdictions in 2017, continuing a downward trend since the early-2000s. Agency catch rates in Coldwater Assessments averaged 0.5 Burbot per lift and Ontario Partnership Assessments 0.4 Burbot per lift, representing a 95% decline from mean catch rates observed in 2000-2004. Burbot in Coldwater Assessments ranged from 1 to 22 years of age in 2017. Burbot age-4 and younger made up 40% of the fish caught, showing evidence of recruitment not seen recently. Round Goby and Rainbow Smelt continue to be the dominant prey items in Burbot diets.



Sea Lamprey

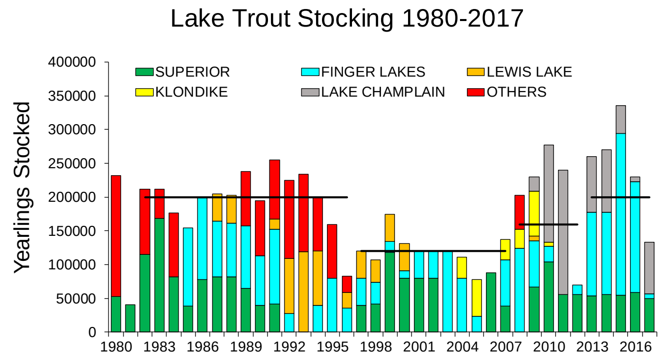
The A1-A3 wounding rate on Lake Trout over 532 mm was 17.3 wounds per 100 fish in 2017. This was higher than the 10-year

wounding rate (12.7 wounds/100 fish) and over 3 times the target rate of 5.0 wounds per 100 fish. Wounding rates have been above target for 21 of the past 22 years. Large Lake Trout over 635 mm continue to be the preferred targets for Sea Lamprey in Lake Erie. The estimated number of adult Sea Lamprey (14,743) was the fourth highest in the series and represents a substantial increase compared to recent estimates and well above the target population of 3,039. Comprehensive stream evaluations continued in 2017, including extensive detection surveys around the basin to inventory all sources contributing to the Lake Erie population.



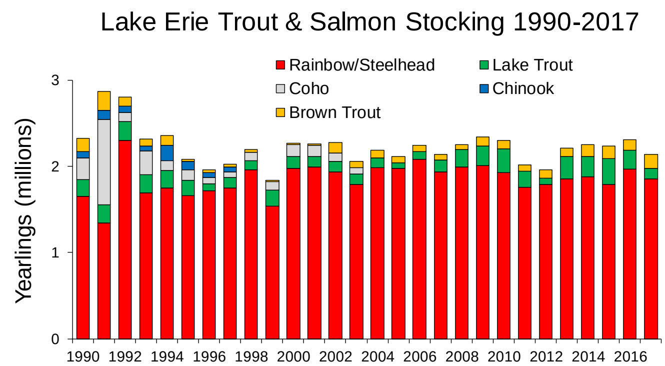
Lake Erie Salmonid Stocking

A total of 2,149,376 salmonids were stocked in Lake Erie in 2017, which was 4% below the long-term average (1990-2016). Lake Trout stocking was below targets for the first time in the past five years due to a large-scale mortality event at the Allegheny National Fish Hatchery. By species, there were 127,439 yearling Lake Trout stocked in all three basins of Lake Erie, 159,666 Brown Trout stocked in New York and Pennsylvania waters, and 1,862,271 Steelhead/Rainbow Trout stocked across all five jurisdictional waters.



Steelhead

All agencies stocked yearling Steelhead in 2017. The summary of Steelhead stocking in Lake Erie by jurisdictional waters for 2017 is: Pennsylvania (1,032,421; 56%), Ohio (442,228; 24%), New York (267,166; 14%), Michigan (60,706; 3%) and Ontario (59,750; 3%). Total Steelhead stocking in 2017 (1.862 million) was near the long-term average. Annual stocking numbers have been consistently in the 1.7-2.0 million fish range since 1993. The summer open lake Steelhead harvest was estimated at 9,047 Steelhead across all US agencies in 2017, about an 87% increase compared to 2016 estimates and 5% higher than average harvest of 8,600 steelhead from 2007-16. Overall open lake catch rates remain near the long-term average, but reported effort remains small relative to percids. Tributary angler surveys, representing the majority (>90%) of the targeted fishery effort for Steelhead, found average catch rates of 0.35 fish/hour between 2009 and 2016.



Cisco

Historically Cisco played an important ecological role as the primary planktivorous prey fish in Lake Erie, and once supported a large commercial fishery. The population collapsed in the mid-1920s with a limited fishery persisting into the 1950s. The desirability of this species, both as a stabilizing influence on the coldwater food web and as a support for Lake Trout restoration, has been recognized in fishery objectives and management documents. To inform management decisions about the feasibility of re-establishing Cisco in Lake Erie, a technical document, "Impediments to the Rehabilitation of Cisco (*Coregonus artedi*) in Lake Erie" (The Impediments Document), was completed by the CWTG in April 2017. It outlines perceived risks, benefits, and impediments to rehabilitation and attempts to describe the current status of Lake Erie Cisco. Generally described as extirpated in Lake Erie, in recent decades this status has been confounded by regular observations of small numbers (1-7) annually recovered from commercial trawl and gillnet fisheries. The Impediments Document, citing morphometric and genetic analyses of contemporary and historic samples collected from Lake Erie, Lake Huron, and in the connecting Huron-Erie Corridor (HEC), concludes that remnant Lake Erie stocks of historic *Coregonus artedi* likely no longer exist. Contemporary observations do not represent a pre-collapse archetype, specifically adapted to the lake, but rather an amalgam of sources and morphotypes, including possible hybridization. Subsequent genetic analysis in 2017 (Stott et al., 2018) supports this conclusion. Further, it determined that most contemporarily obtained individuals from Lake Erie and the HEC are not in fact *C. artedi*, but are actually Bloater (*C. hoyi*), resembling a Lake Huron population. Despite resolving questions about the existence of a remnant Lake Erie stock, the Impediments Document makes clear that management decisions about Cisco rehabilitation in Lake Erie currently must still contend with a variety of unknowns concerning the feasibility of success.

Charge 1: Coordinate annual standardized Lake Trout assessments among all eastern basin agencies and update the status of Lake Trout rehabilitation

James Markham (NYSDEC), Andy Cook (OMNRF), Chelsea May (OMNRF), Chuck Murray (PFBC), and Chris Vandergoot (USGS)

Methods

A stratified, random design, deep-water gill net assessment protocol for Lake Trout has been in place since 1986. The sampling design divides the eastern basin of Lake Erie into eight sampling areas (A1-A8) defined by North/South-oriented 58000-series Loran C Lines of Position (LOP). The entire survey area is bound between the 58435 LOP on the west and the 58955 LOP on the east (Figure 1.1). New York is responsible for sampling areas A1 and A2, Pennsylvania A3 and A4, and USGS/OMNRF A5 through A8.

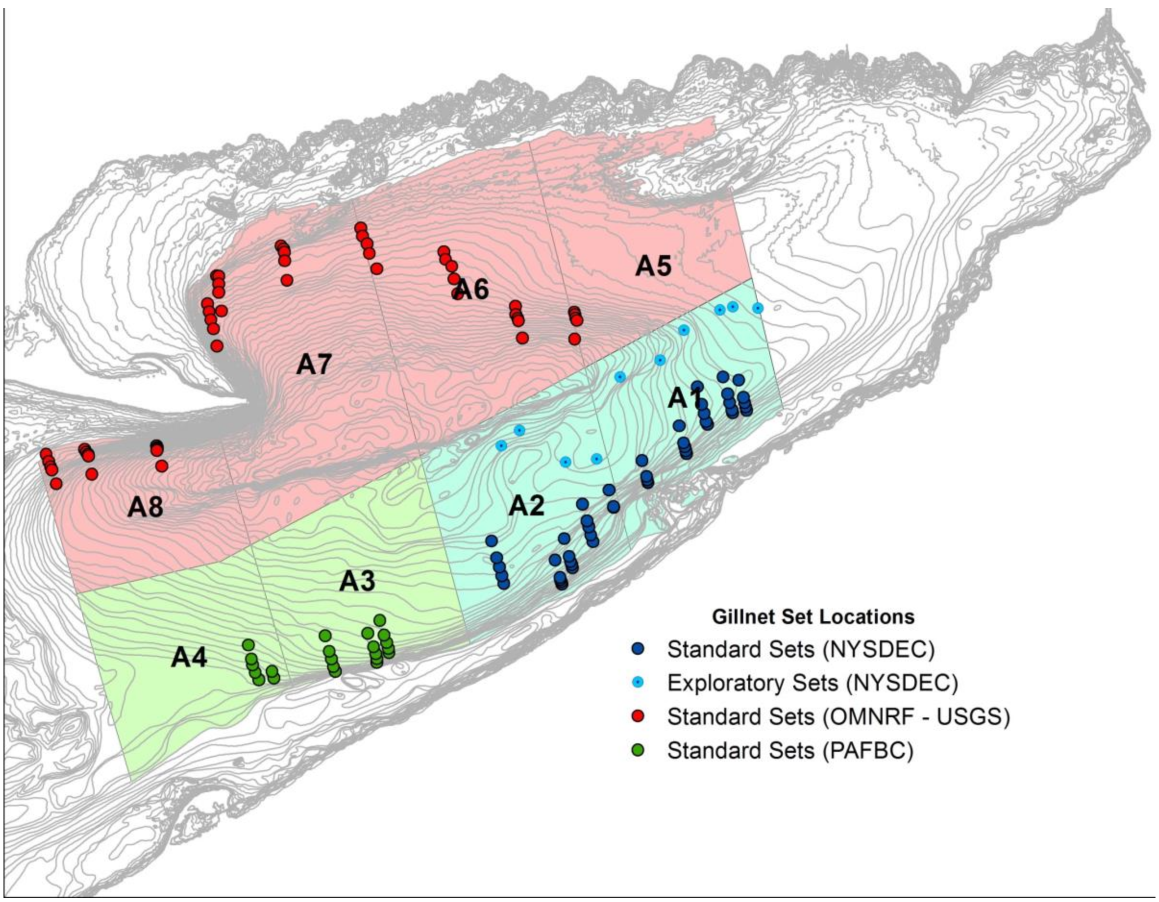


FIGURE 1.1. Standard sampling areas (A1-A8) used for assessment of assessment of coldwater species in the eastern basin of Lake Erie, 2017. Colored circles represent the location of all nets set in each sampling area.

Each area contains 13 equidistant north/south-oriented LOPs that serve as transects. Up to six transects are randomly selected for sampling in each area. A1 and A2 have been the most consistently sampled areas across survey years while effort has varied in all other areas. Area A4 is infrequently sampled due to the lack of enough cold water to set gill nets according to the sampling protocol.

Ten gill net panels, each 15.2 m (50 ft) long, are tied together to form 152.4-m (500-ft) gangs. Each panel is constructed of diamond-shaped mesh in one of 10 size categories ranging from 38-152 mm on a side in 12.7-mm increments stretched measure (1.5-6.0 inches; in 0.5-inch increments). Panels are arranged randomly in each gang. A series of five gangs per transect are set overnight, on the lake bottom, along the contour and perpendicular to a randomly selected north/south-oriented transect during the month of August or possibly early September, prior to fall turnover. New York State Department of Environmental Conservation (NYSDEC) personnel modified the protocol in 1996 using nets made of monofilament mesh instead of the standard multifilament nylon mesh. This modification was made following two years of comparative data collection and analysis that detected no significant difference in the total catch between the two net types (Culligan et al. 1996). In 1998 and 1999, all Coldwater Task Group (CWTG) agencies except the Pennsylvania Fish and Boat Commission (PFBC) switched to standard monofilament assessment nets to sample eastern basin Lake Trout. Personnel from the PFBC switched to monofilament mesh in 2006.

Sampling protocol requires the first gang in each five net series to be set along the contour where the 8° to 10°C isotherm intersects with the bottom. The top of the gang must be within this isotherm. The next three gangs are set in progressively deeper/ colder water at increments of either 1.5 m depth (5 feet) or a 0.8 km (0.5 miles) distance from the previous (shallower) gang, whichever occurs first along the transect. The fifth and deepest gang is set 15 m (50 feet) deeper than the shallowest net (number 1) or at a maximum distance of 1.6 km (1.0 miles) from net number 4, whichever occurs first. NYSDEC and PFBC have been responsible for completing standard assessments in their jurisdictional waters since 1986 and 1991, respectively. The Sandusky office of the U.S. Geological Survey (USGS) initially assumed responsibility for standard assessments in Canadian waters beginning in 1992. The Ontario Ministry of Natural Resources and Forestry (OMNRF) began coordinating with USGS in 1998 to complete standard assessments in Canadian waters. Total effort for 2017 by the combined agencies was 120 unbiased standard Lake Trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 48 lifts by the NYSDEC, 22 by the PFBC, and 50 by USGS/OMNRF. NYSDEC moved 10 of their standard 60 lifts to new locations beginning in 2016 to determine the extent of the Lake Trout distribution in offshore portions of the eastern basin that are outside of the standard sampling program. These results will not be reported here, but can be found in the NYSDEC Lake Erie annual report (Markham 2018).

All Lake Trout are routinely examined for total length, weight, sex, maturity, fin clips, and wounds by Sea Lamprey. Snouts from each Lake Trout are retained and coded-wire tags (CWT) are extracted in the laboratory to accurately determine age and genetic strain. Otoliths are also retained when the fish is not adipose fin-clipped. Stomach content data are usually collected as on-site enumeration or from preserved samples.

Klondike strain Lake Trout (KL) are an offshore form from Lake Superior and are thought to behave differently than traditional Lean Lake Trout strains (*i.e*. Finger Lakes (FL), Superior (SUP), Lewis Lake (LL) strains). They were first stocked in Lake Erie in 2004. In some analysis, Klondikes are reported as a separate strain for comparison with Lean-strain Lake Trout.

Results and Discussion

Abundance

Sampling was conducted in all eight of the standard areas in 2017 (Figure 1.1), collecting a total of 418 Lake Trout in 120 unbiased lifts. Areas A1 and A2 again produced the highest catch per unit effort (CPE) values, coinciding with areas of higher yearling Lake Trout stocking over an extensive period of years. Comparatively, Lake Trout catches were much lower in Ontario waters (A5-A8), where stocking did not commence until 2006. The large disparity in Lake Trout catches among east basin survey areas may indicate a lack of movement away from the stocking area or a lower survival rate in Ontario waters.

Lake Trout ranging from ages 1 to 31 were captured in 2017 and represented twenty-one age-classes (Table 1.1). Adult cohorts ages 5 and 7-9 were the most abundant and represented 70% of the total catch in standard assessment nets (Figure 1.2). Lake Trout older than age-10 remain in relatively low abundance, comprising 7% of the overall catch. Particularly noteworthy in the sample were a 31 year-old female, one of the oldest lake trout captured in this survey, and a 26 year-old male over 1000 mm (nearly 40 inches) in length and weighing nearly 13,500 grams (30 pounds). This was the largest lake trout ever sampled in this assessment survey.

TABLE 1.1. Number, sex, mean length (mm), mean weight (g), and percent maturity, by age class, of Lean strain (A) and Klondike strain (B) Lake Trout collected in assessment gill nets from the eastern basin of Lake Erie, August 2017.

A) Lean Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (grams)	PERCENT MATURE
1	Combined	2	289	340	0
2	Male	14	419	793	7
	Female	11	402	727	0
3	Male	10	579	2551	100
	Female	7	533	2086	14
4	Male	13	635	3208	100
	Female	4	657	3528	67
5	Male	27	673	3620	100
	Female	38	695	4274	97
6	Male	2	677	3798	100
	Female	0	---	---	---
7	Male	59	749	5353	100
	Female	32	737	5215	100
8	Male	49	758	5635	100
	Female	27	750	5360	100
9	Male	19	772	5758	100
	Female	27	770	5937	100
10	Male	19	787	5949	100
	Female	8	782	6120	100
11	Male	4	781	5771	100
	Female	5	822	6886	100
12	Male	0	---	---	---
	Female	2	832	7173	100
14	Male	3	817	7043	100
	Female	2	892	9525	---
15	Male	0	---	---	---
	Female	5	827	7305	100
16	Male	1	820	7454	100
	Female	0	---	---	---
17	Male	0	---	---	---
	Female	1	874	8178	---
18	Male	1	871	6620	100
	Female	0	---	---	---
21	Male	0	---	---	---
	Female	1	871	8628	100
26	Male	1	1003	13494	100
	Female	0	---	---	---
29	Male	0	---	---	---
	Female	1	942	8232	100
31	Male	0	---	---	---
	Female	1	888	9716	100

B) Klondike Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (grams)	PERCENT MATURE
9	Male	4	717	5286	100
	Female	2	711	4191	100
10	Male	0	---	---	---
	Female	1	748	5778	100
11	Male	0	---	---	---
	Female	1	675	4332	100

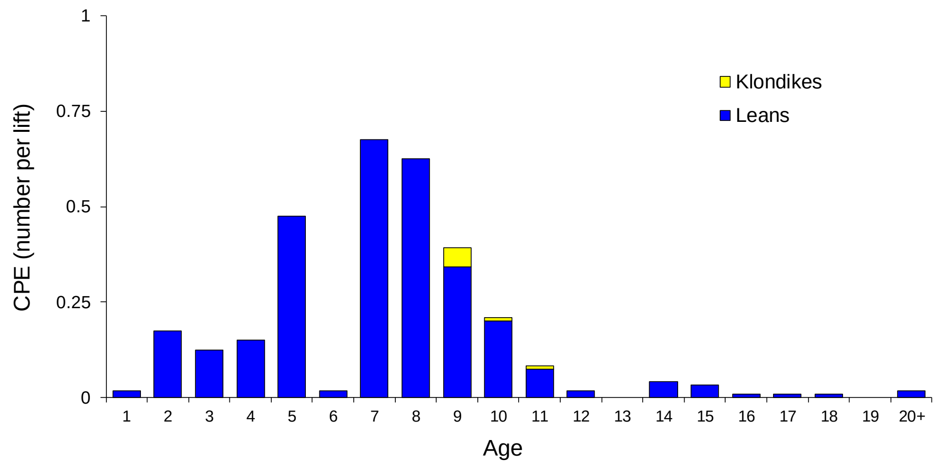


FIGURE 1.2. Relative abundance (number per lift) at age of Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, August 2017.

The overall trend in area-weighted mean CPE of Lake Trout caught in standard nets in the eastern basin slightly increased in 2017 to 2.5 fish per lift (Figure 1.3). This was above the time series average (2.3 fish per lift) but remains well below the rehabilitation target of 8.0 fish/lift (Markham et al*.* 2008).

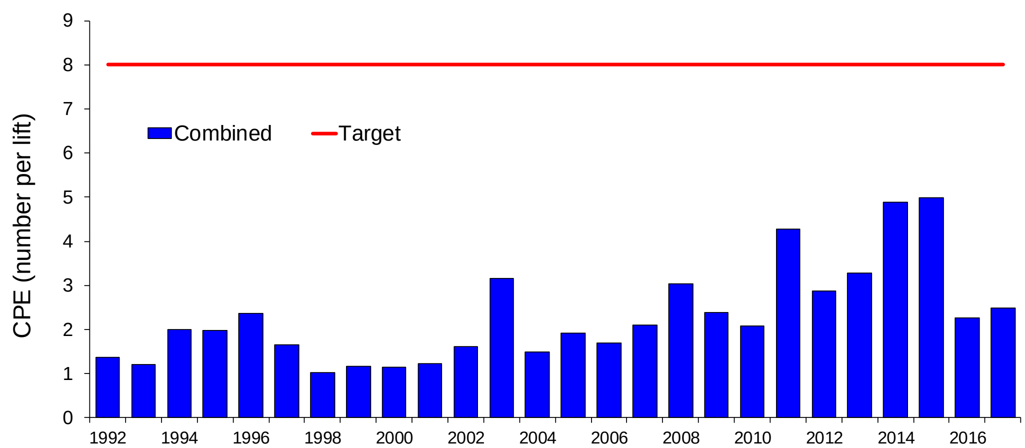


FIGURE 1.3. Mean combined CPE (number per lift, weighted by area) for Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2017. The red solid line represents the rehabilitation target of 8.0 fish per lift for all ages.

The OMNRF Partnership Index Fishing Program provides another data source for assessing Lake Trout abundance in Ontario waters that includes suspended and bottom set gill net catches. A total of ten (10) Lake Trout were caught in Partnership index gear distributed among surveys in the Pennsylvania Ridge (2) and the east basin (8). Lake Trout indices in the east basin (0.13 fish/lift) and Pennsylvania Ridge area (0.06) were below their time series means 0.39 and 0.19 fish/lift respectively (Figure 1.4). Coded-wire tags were retrieved from 6/10 Lake Trout, revealing the following strains: Slate Island (4), Finger Lakes (1) and Lake Champlain (1). Six of nine Lake Trout examined had adipose fin clips, while three fish lacked clips. Two additional Lake Trout were caught in auxiliary 50 mesh deep, 121 mm suspended gill nets in the west-central basin (1) and east-central basin (1). These two Lake Trout had adipose clips, and coded wire tags from Lake Champlain and Finger Lakes strains. Variability of abundance estimates in this survey is high due to lower sample sizes in hypolimnetic waters, especially in the Pennsylvania Ridge area.

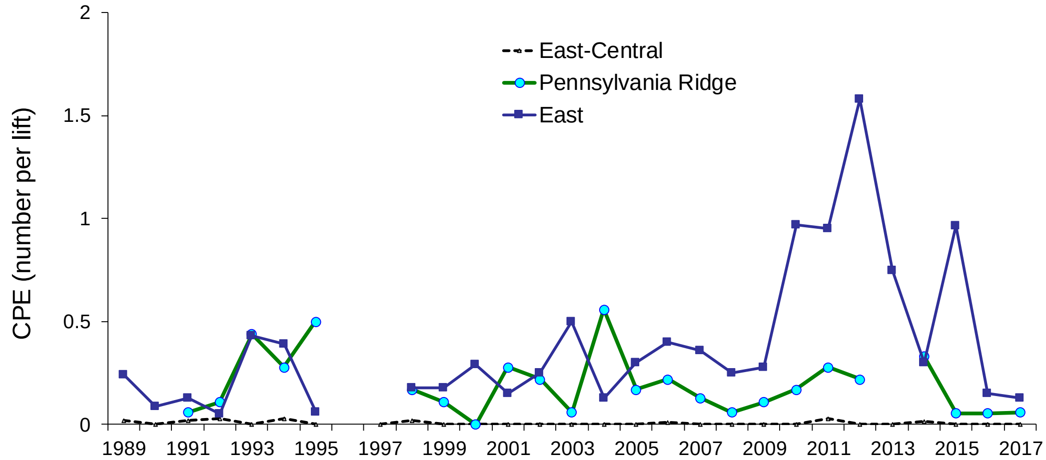


FIGURE 1.4. Lake Trout CPE (number per lift) by basin from the OMNRF Partnership Index Fishing Program, 1989-2017. Includes canned (suspended) and bottom gill net sets, excluding thermocline sets.

The relative abundance of adult (age-5 and older) Lake Trout caught in standard assessment gill nets (weighted by area) in the Coldwater Assessment Survey serves as an indicator of the size of the Lake Trout spawning stock in Lake Erie. Adult abundance increased in 2017 to 1.9 fish per lift, mainly due to recruitment of the 2012 cohort (age-5) into this metric, and ranked as the third highest in the 26-year time series (Figure 1.5). Adult abundance was slightly below the basin-wide rehabilitation target of 2.0 fish/lift.

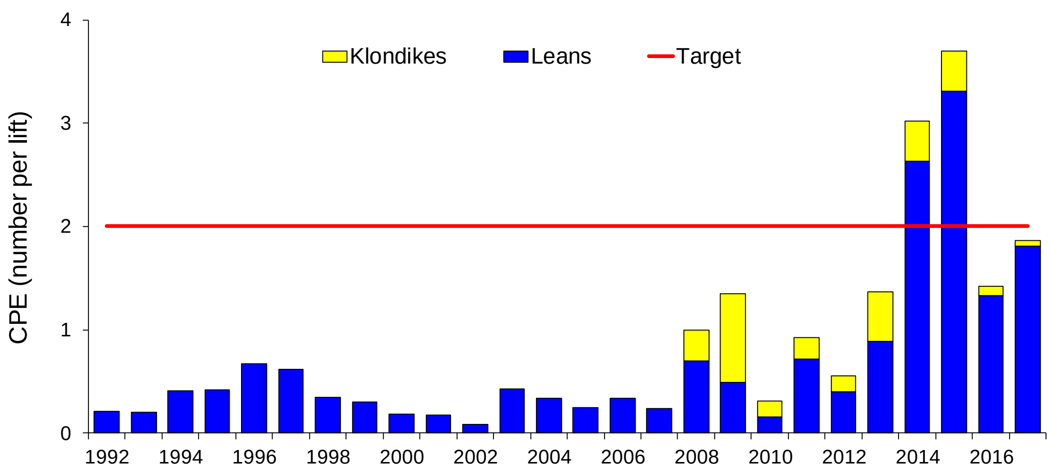


FIGURE 1.5. Relative abundance (number per lift, weighted by area) of age-5-and-older Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2017. The red solid line represents the adult rehabilitation target of 2.0 fish per lift.

Strains

Five different Lake Trout strains were found in the 403 fish caught with either hatchery-implanted coded-wire tags (CWTs) or fin-clips in 2017 (Figure 1.6). The majority of the trout (96%) were comprised of the Lake Champlain (LC; 58%) and Finger Lakes (FL; 38%) stains. These have been the most stocked strains in Lake Erie over the past ten years. Klondike (KL) strain lake trout, which have been common in recent years, continue to decline in abundance and comprised only 2% of the catch. Despite extensive stocking in Ontario waters, the Slate Island comprised less than 1% of the catch. The Apostle Island (AI; <1%) strain was the only other strain sampled in 2017. Strain composition is not uniform throughout the east basin and regional differences from specific areas are apparent. The FL strain continues to show the most consistent returns at older ages; 96% (N=55) of Lake Trout age-10 and older were FL strain fish.

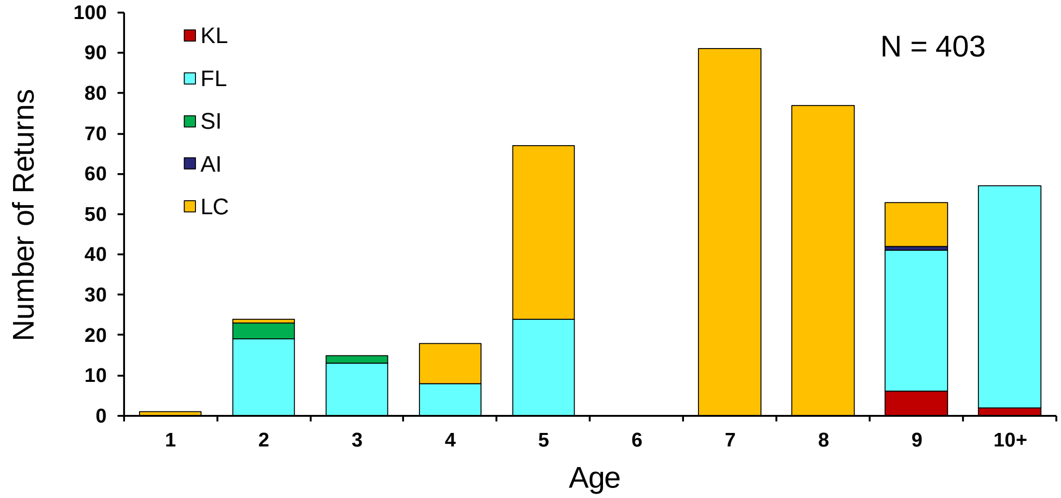


FIGURE 1.6. Number of Lake Trout by stocking strain and age collected in all gill nets from the eastern basin of Lake Erie, August 2017. Stocking strain codes are: KL = Klondike, FL = Finger Lakes, SI = Slate Island, AI = Apostle Island, LC = Lake Champlain.

Survival

Point estimates of annual survival (S) for individual cohorts of lake trout were calculated by strain and year class using a 3-year running average of catch per unit effort (CPE) with ages 4 through 11. A running average was used due to the high year-to-year variability in catches, particularly in the Finger Lakes strain. The Superior and Finger Lakes strains have been the most consistently stocked lake trout strains in Lake Erie and provide the best timeline of changes in lake trout survival during restoration efforts. Survival estimates for both of these strains were near or below the target survival rate of 60% or higher (Lake Trout Task Group 1985; Markham et al. 2008) prior to 1986 due to excessive mortality from a large, untreated sea lamprey population (Table 1.3). Substantial increases in survival occurred following the initial treatments of sea lamprey in Lake Erie in 1986. While survival estimates generally remained above targets for the Finger Lakes strain since this time, the Superior strain experienced very low survival for the 1997-2001 cohorts, presumably due to increased sea lamprey predation. Estimates of the 2003, 2004, and 2006 year classes of Klondike strain fish indicate very low survival rates comparable to Superior strain lake trout from the 1997-2001 year classes. Partial age estimates were also calculated for Lake Champlain strain lake trout to determine if their survival was comparable to Finger Lakes or Superior strain lake trout. Initial results indicate survival rates above the target rate for the 2008 and 2009 cohorts.

TABLE 1.3. 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, 1985–2017. Three-year running averages of CPE from ages 4–11 were used due to year-to-year variability in catches. Cells in red cells indicate survival estimates that fall below the 0.60 target rate. Asterisk (*) indicates years where only partial ages were available.

	STRAIN				
Year Class	**LC**	**SUP**	**FL**	**KL**	**ALL**
1983		0.687			0.454
1984		0.619	0.502		0.533
1985		0.543	0.594		0.578
1986		0.678			0.634
1987		0.712	0.928		0.655
1988		0.726	0.818		0.679
1989		0.914	0.945		0.766
1990		0.789	0.634		0.709
1991					0.615
1992					0.599
1993			0.850		0.646
1994					0.649
1995					0.489
1996			0.780		0.667
1997		0.404	0.850		0.549
1998		0.414			0.364
1999		0.323	0.76		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				0.485	0.420
2005			0.450		0.629
2006			0.827	0.58	0.770
2007*			0.818	0.589	0.801
2008*	0.665		0.828	0.489	0.756
2009*	0.688				0.801
MEAN	**0.677**	**0.575**	**0.745**	**0.477**	**0.614**

Growth and Condition

Mean lengths and mean weights of age-3 and age-5 Lean strain Lake Trout have remained near the series averages since 2008 (Figures 1.7 and 1.8). Mean lengths and weights were at or below average from 1986-1998, but increased above average from 1999-2008. The mean length and mean weight of age-3 Lake Trout were above the series average in 2017 and were slightly average for age-5 Lake Trout.

Mean coefficients of condition K (Everhart and Youngs 1981) were calculated for age-5 Lake Trout by sex and strain to determine time-series changes in body condition. Overall condition coefficients for age-5 Lake Trout were average for males and above average for females in 2017 (Figure 1.9). Condition coefficients for both sexes show an increasing trend from 1993-2000, and have remained high and relatively steady since.

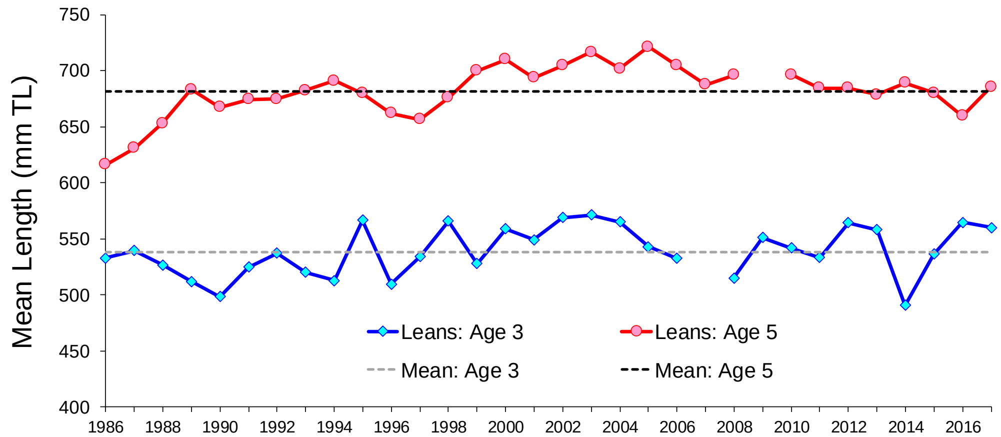


FIGURE 1.7. Mean length (mm TL) of age 3 and age 5 Lean strain Lake Trout sampled in assessment gill nets in the New York waters of Lake Erie, August, 1986-2017.

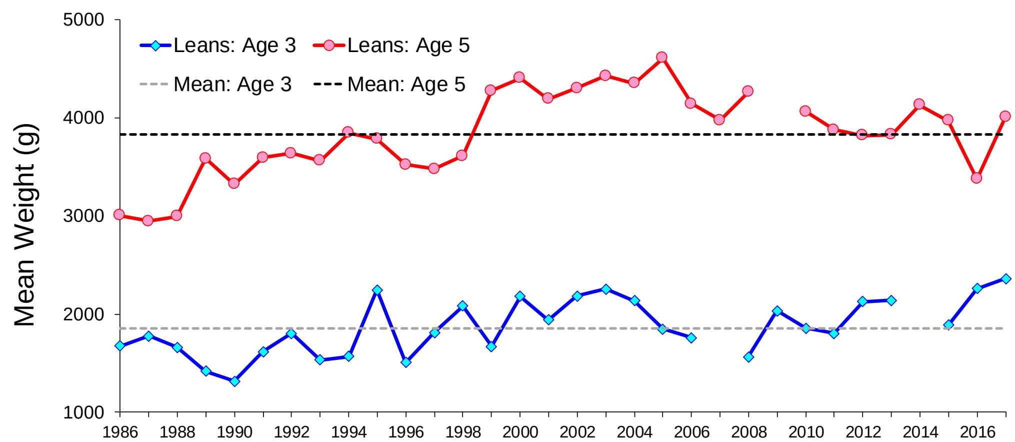


FIGURE 1.8. Mean weight of age-3 and age-5 Lean strain Lake Trout sampled in assessment gill nets in the New York waters of Lake Erie, August, 1986-2017.

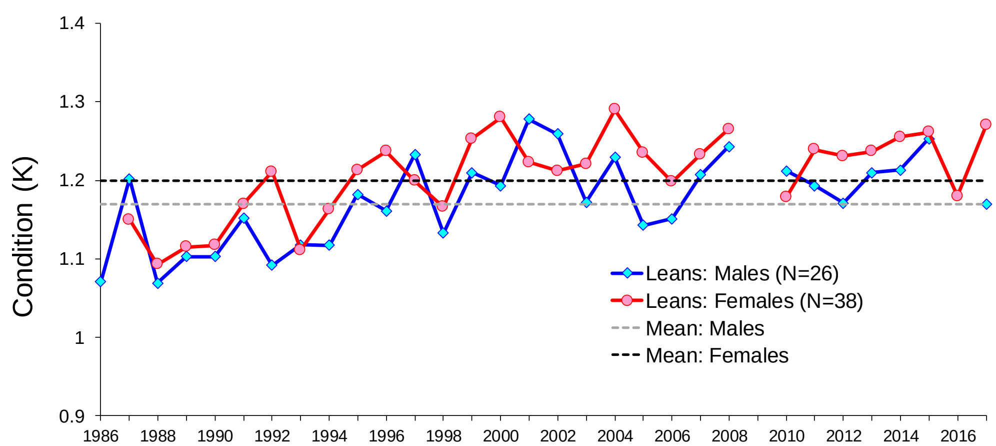


FIGURE 1.9. Mean coefficients of condition for age-5 Lean strain Lake Trout, by sex, collected in eastern basin assessment gill nets in Lake Erie, August 1986-2017.

Maturity

Maturity rates of Lean strain Lake Trout remain stable with nearly all males mature by age 4 and females by age 5 (Table 1.1A). Klondike strain Lake Trout appear to have similar maturity rates to Lean strain Lake Trout in Lake Erie (Table 1.1B).

Harvest

Angler harvest of Lake Trout in Lake Erie remains very low. An estimated 137 Lake Trout were harvested in New York waters out of an estimated catch of 640 in 2017; only an estimated 32 fish were caught and harvested in Pennsylvania waters (Figure 1.10).

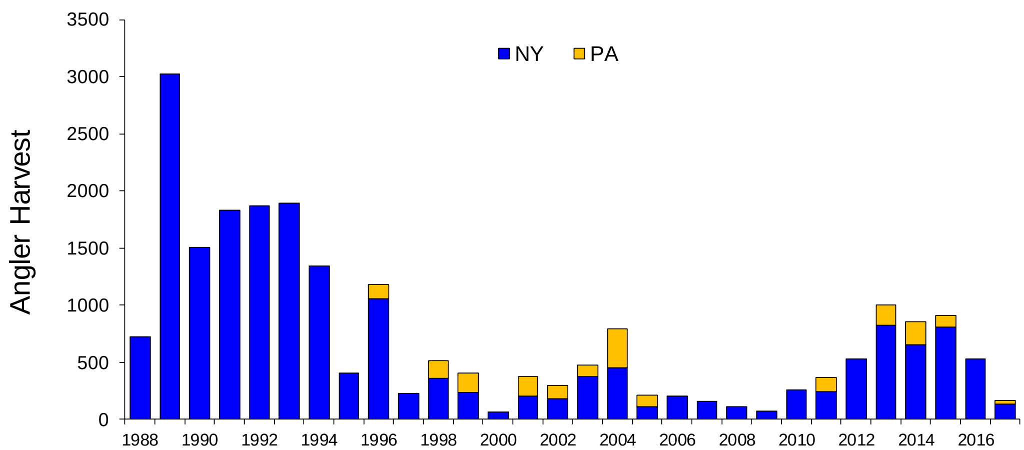


FIGURE 1.10. Estimated Lake Trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2017.

Natural Reproduction

Despite more than 30 years of Lake Trout stocking in Lake Erie, no naturally reproduced Lake Trout have been documented. Two potentially wild fish (no fin clips; no CWT's) were caught in eastern basin coldwater gill net surveys in 2017, representing less than 1% of the fish captured. Altogether, a total of 69 potentially wild Lake Trout have been recorded over the past 17 years. Rates of unmarked fish are similar to measures of unmarked fish in the hatchery. Otoliths are collected from Lake Trout found without CWTs or fin-clips and will be used in future stock discrimination studies.

Lake Trout Population Model

The CWTG has assisted the Forage Task Group (FTG) in the past by providing a Lake Trout population model to estimate the Lake Trout population in Lake Erie. The model is a spreadsheet model, initially created in the late 1980's, and uses stocked numbers of Lake Trout and annual mortality to generate an estimated adult (age 5+) population. The Lake Erie CWTG has been updating and revising the model since 2005, incorporating new information on strain performance, survival, Sea Lamprey mortality, longevity, and stocking. The most recent working version of the model separates each Lake Trout strain to accommodate strain-specific mortality, Sea Lamprey mortality, and stocking. The individual strains are then combined to provide an overall estimate of the adult (ages 5+) Lake Trout population. Unlike previous versions, the current model's output now follows the general trends of the survey data and computes mortality estimates that are near levels measured from survey data. While the absolute numbers generated from model simulations are probably not comparable to the actual Lake Erie Lake Trout population, the model does provide a good tool for predicting trends into the future under various management and population scenarios.

The 2017 Lake Trout model estimated the Lake Erie population (all ages) at 302,758 fish and the adult (age-5 and older) population at 62,183 fish (Figure 1.11). The Strategic Plan for Lake Trout Restoration (Lake Trout Task Group 1985) suggested that successful Lake Erie rehabilitation required an adult population of 75,000 Lake Trout. Model projections using low and moderate rates of Sea Lamprey mortality and proposed stocking rates show that the adult Lake Trout population is suppressed by one-third over the next decade with moderate mortality compared to low mortality. Model simulations indicate that both stocking and Sea Lamprey control are major influences on the Lake Erie Lake Trout population.

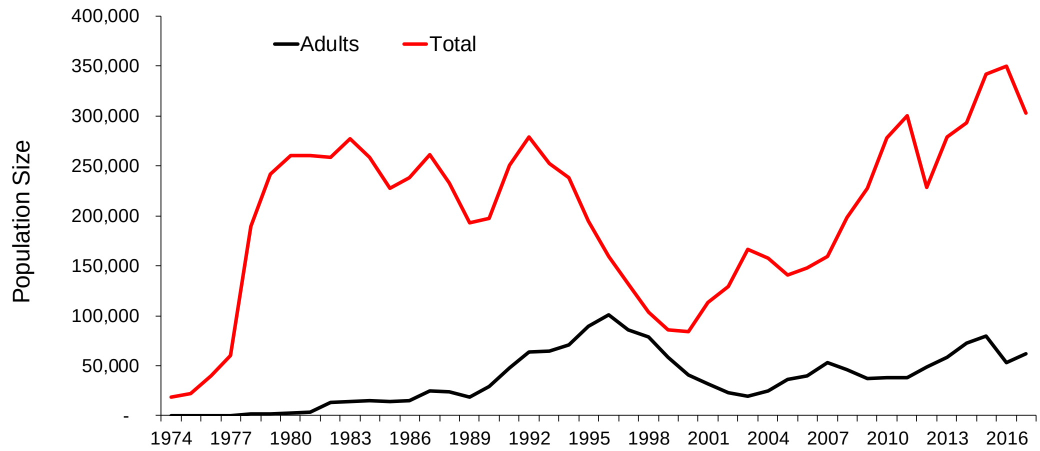


FIGURE 1.11. Projections of the Lake Erie total and adult (ages 5+) Lake Trout population using the CWTG Lake Trout model. Future projections for 2018 were made using low rates of Sea Lamprey mortality with proposed stocking rates. The model estimated the lakewide Lake Trout population in 2017 at 302,758 and the adult population at 62,183.

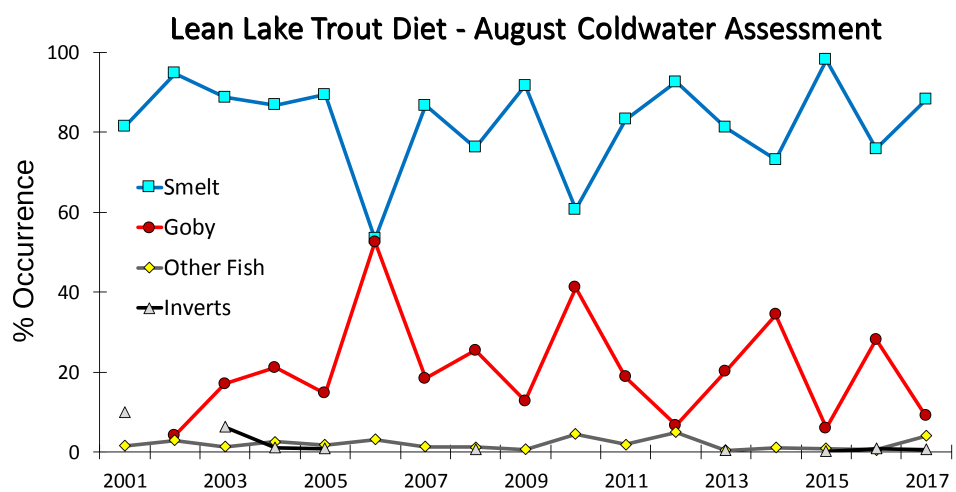
Diet

Seasonal diet information for Lake Trout is not available based on current sampling protocols. Diet information was limited to fish caught during August 2017 in the coldwater gill net assessment surveys in the eastern basin of Lake Erie. Rainbow Smelt were the most prevalent diet item for Lean strain Lake Trout in 2017, occurring in 88% of the stomachs (Table 1.4). Round Goby (9%), Yellow Perch (3%) and Gizzard Shad (<1%) were also identified as prey items. Rainbow Smelt were the only fish species found in Klondike strain Lake Trout in 2017, albeit with a very small sample size (N=4).

Rainbow Smelt have been the long-term main prey item for Lake Trout, historically comprising over 90% of Lake Trout diet items. However, Round Goby have become a common prey item since they invaded the east basin of Lake Erie in the early 2000s (Figure 1.12). In years of lower adult Rainbow Smelt abundance, Lake Trout appear to prey more on Round Goby. Klondike strain Lake Trout have typically shown a higher incidence of Round Goby in stomach contents compared to Lean Lake Trout strains.

TABLE 1.4. Frequency of occurrence of diet items from non-empty stomachs of Lean (N=178) and Klondike (N=4) strain Lake Trout collected in gill nets from eastern basin waters of Lake Erie, August 2017.

PREY SPECIES	Lean Lake Trout (N=178)	Klondike Lake Trout (N=4)
Rainbow Smelt	157 (88%)	4 (100%)
Round Goby	16 (9%)	
Gizzard Shad	1 (<1%)	
Yellow Perch	6 (3%)	
Invertebrates	1 (<1%)	
Unknown Fish	5 (3%)	
Number of Empty Stomachs	163	2



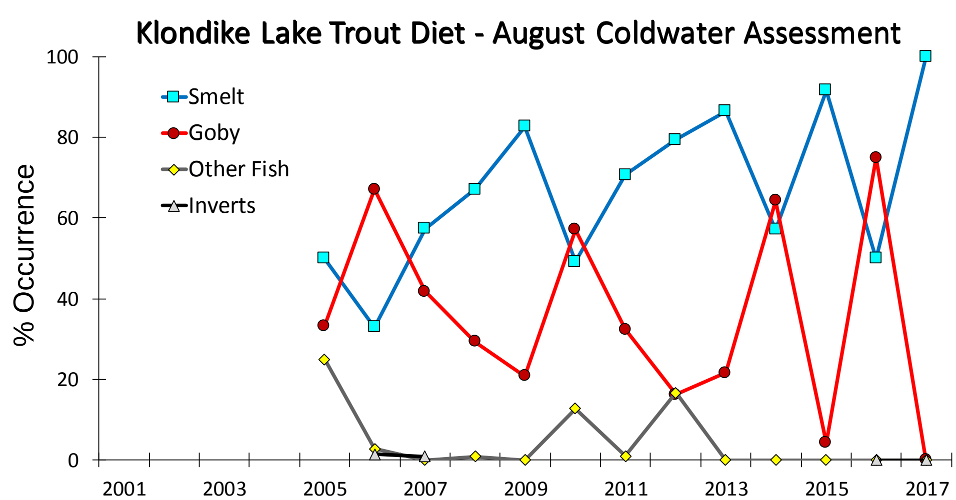


FIGURE 1.12. Percent occurrence in diet of Rainbow Smelt, Round Goby, all other fish species, and invertebrates from non-empty stomachs of Lean strain (top) and Klondike (bottom) strain Lake Trout caught in eastern basin assessment gill nets, August, 2001-2017.

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Charge 2: Continue to assess the Lake Whitefish population age structure, growth, diet, seasonal distribution and other population parameters.

Andy Cook (OMNRF), Chris Vandergoot (USGS) and John Deller (ODW)

Commercial Harvest

The total harvest of Lake Whitefish in Lake Erie during 2017 was 31,539 pounds (Figure 2.1). Ontario accounted for 98% of the lake-wide total, harvesting 30,826 pounds, followed by Ohio (2%; 701 pounds). Nominal commercial harvest occurred in Pennsylvania (12 pounds) and no Lake Whitefish harvest was observed in New York and Michigan (Figure 2.2). Total harvest in 2017 was 44% lower than the total harvest in 2016. Lake Whitefish harvest decreased in Ontario and Ohio by 3% and 97% respectively.

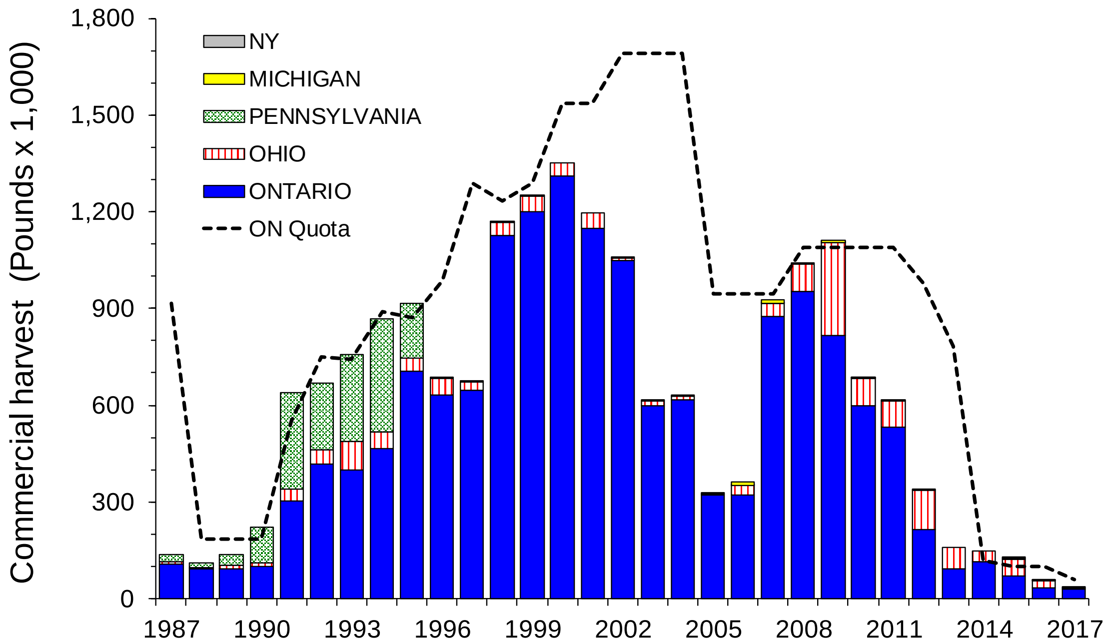


FIGURE 2.1. Lake Whitefish total harvest from 1987-2017 by jurisdiction in Lake Erie. Pennsylvania ceased gill netting in 1996, and Michigan resumed commercial fishing using trap nets in 2006, excluding 2008. Ontario quota is presented as a dashed line.

Ontario's harvest in 2017 represented 51% of their quota (60,000 pounds). The majority (93%) of Ontario's 2017 Lake Whitefish harvest was taken in gill nets. The remaining harvest of 2,054 pounds was caught in trawls targeting Rainbow Smelt. The largest fraction of Ontario's Whitefish harvest (70%) was caught in the west basin (Ontario-Erie Unit OE-1) followed by OE-2 (19%), with the remaining harvest distributed eastward among units OE-3 (2%), OE-4 (7%) and OE-5 (2%; Figure 2.2). Maximum harvest in 2017 was distributed west and south of Pelee Island (Figure 2.2). Harvest in OE-1 from October to December represented 67% of Ontario's Lake Whitefish harvest. Peak harvests occurred in OE-1 during November (10,347 pounds) and December (9,074 pounds); only 3% of OE-1 harvest occurred from February to May. Fall harvest (Oct-Dec) in the central basin (OE-2 and OE-3) represented 14% whereas Whitefish harvest from January to May accounted for 6% of Whitefish harvest in Ontario waters during 2017. Of the 2,689 pounds of Lake Whitefish landed in eastern Lake Erie (OE-4 and OE-5) during 2017, the largest fraction (76%) was caught in commercial trawls fishing Rainbow Smelt while the remaining 24% was caught in commercial gill nets. There was no reported effort targeting Lake Whitefish during 2017 in Ontario waters of Lake Erie. Lake-wide, Ontario's Lake Whitefish harvest came from fisheries targeting Walleye (87%), Rainbow Smelt (7%), White Bass (3%), White Perch (2%) and Yellow Perch (1%).

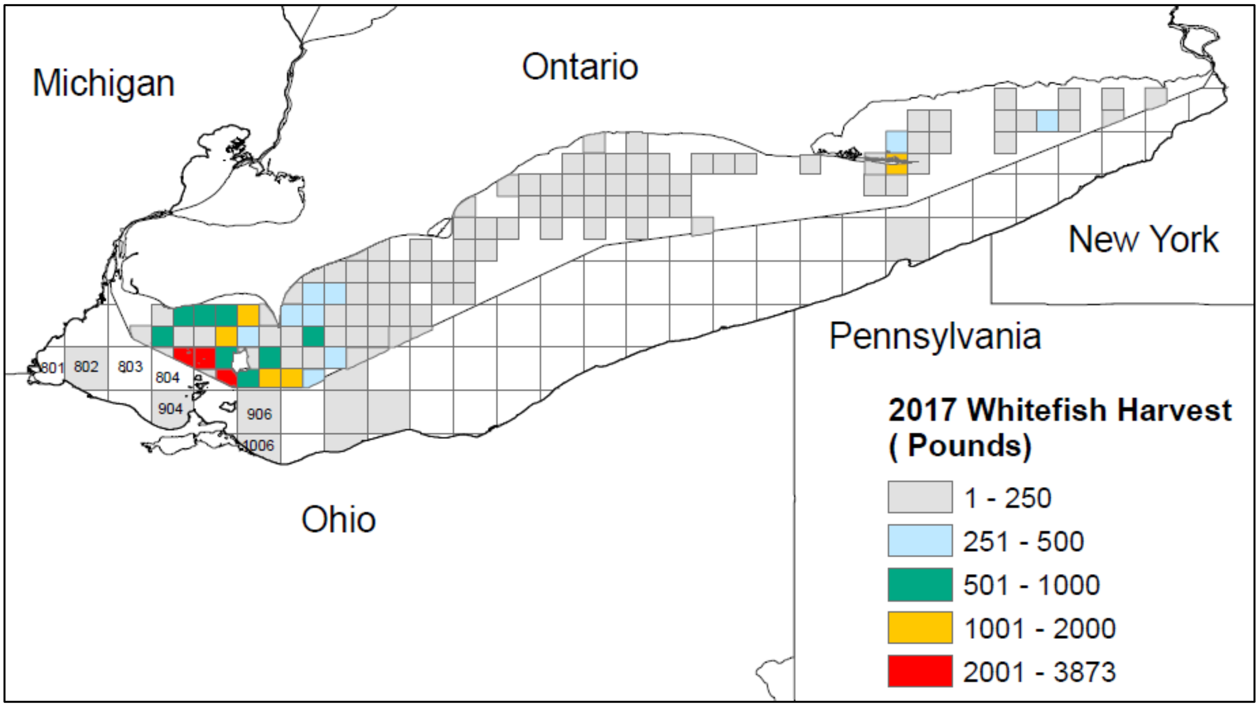


FIGURE 2.2. Commercial harvest of Lake Whitefish in Lake Erie during 2017 by 5-minute (Ontario) and 10-minute (U.S.) grids (some grid numbers visible for reference). Total harvest in 2017 = 31,539 pounds.

As there was no reported targeted gill net harvest or effort in 2017, Ontario annual lake-wide commercial catch rates are presented in three forms (Figure 2.3). Along with a time series of targeted catch rates (kg/km) lacking 2014-2017 data, catch rates are presented based on all large mesh (>=76 mm or 3") gill net effort (kg/km) and large mesh gill net effort with Lake Whitefish in the catch (kg/km; the latter excludes zero catches). Catch rates based on all large mesh effort declined 2% from 2016, whereas catch rates based on effort with Lake Whitefish in the catch declined 10%. In both cases, 2017 catch rates were the lowest in their respective 1998-2017 time series.

All Lake Whitefish harvested in Ohio waters during 2017 came from commercial trap nets targeting yellow perch and other species. Ohio Lake Whitefish harvest (701 pounds) in 2017 was distributed among the west (O-1 39%) and central basins (O-2 35%; O-3 27%). Lake Whitefish were harvested from 516 trap net lifts in 2017, with lifts distributed among District 1 (O-1) (34%), District 2 (O-2) (49%) and District 3 (O-3) (17%), respectively. More Lake Whitefish were caught in the central basin from April to August (430 pounds) than in the west basin during fall (179 pounds, Figure 2.2). Ohio trap net catch rates (pounds / lift with Whitefish in the catch) in 2017 (1.4 lbs/lift) decreased 91% from 2016 (14.8 lbs/lift) as Lake Whitefish harvest was not targeted in 2017 (Figure 2.4).

Ohio's Lake Whitefish trap net fishery often targets Lake Whitefish during the spawning season, during November-December, but harvest was negligible in 2017 (Figure 2.5). In years when Lake Whitefish were targeted, harvest was significant in OH grids 801, 802 and 804. The catch rate in OH grid 802 was very low in 2017 (1.3 lbs/lift) and no Lake Whitefish were landed in OH grids 801 and 804 (Figures 2.2, 2.6).

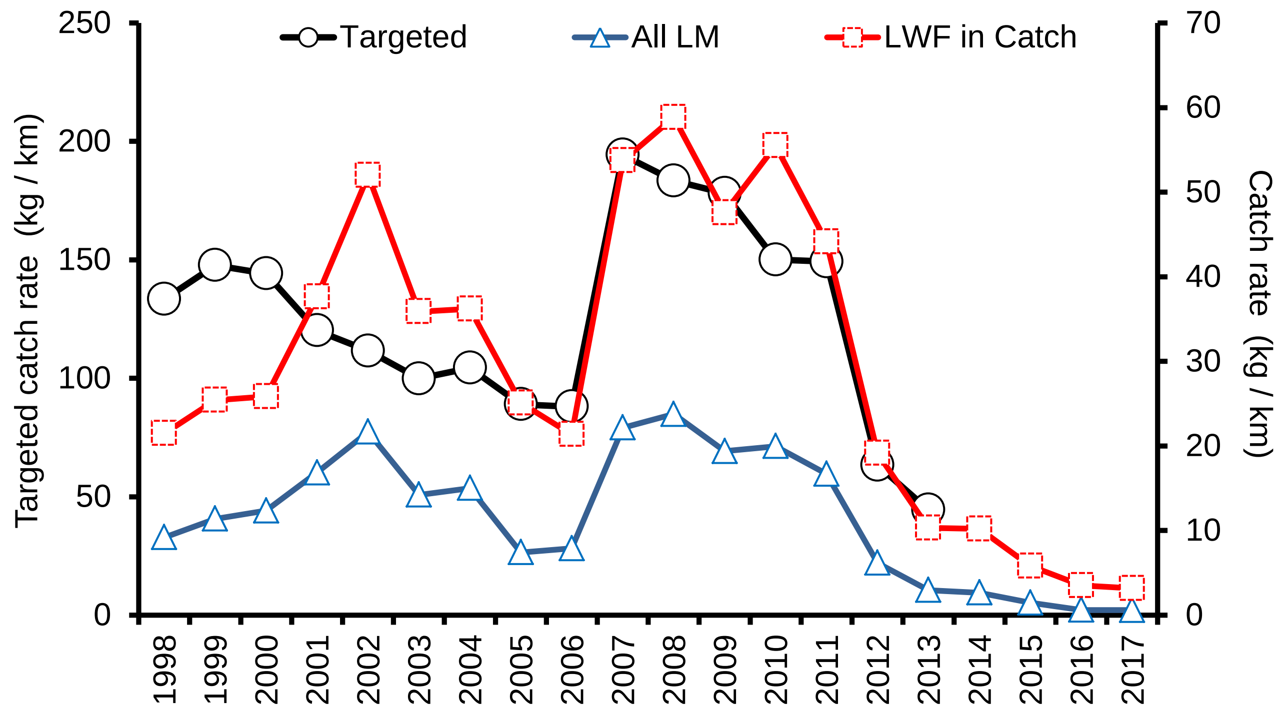
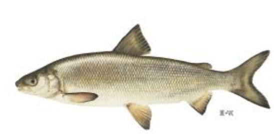


FIGURE 2.3. Lake-wide Ontario annual commercial large mesh gill net catch rates according to three forms of effort. Targeted Lake Whitefish catch rate (kg/km; left axis), catch rate relative to all large mesh gillnet fished (kg/km; right axis), and catch rates from large mesh effort with Lake Whitefish in the catch (kg/km; right axis). No targeted Lake Whitefish effort or harvest was reported in 2014 - 2017.

Ontario's west basin fall Lake Whitefish fishery in 2017 was dominated by younger fish, mainly ages 2 and 3, for the first time in over a decade (Figure 2.7). The age composition of Lake Whitefish harvest from Ontario is presented by fishery target species using otoliths and scales (N=218; Figure 2.8). Based on standard harvest monitoring, Ontario's Whitefish gill net harvest in 2017 consisted of Lake Whitefish from ages 2 to 25. The 2015 cohort (age 2) was most abundant, representing 71% of the Lake Whitefish sampled from large mesh gill nets targeting Walleye or 59% of Whitefish sampled from large mesh gill net harvest (targeting Walleye and White Bass)(Figure 2.8). Age 3 Whitefish (2014 cohort) accounted for 27% of Whitefish sampled from nets targeting Walleye and 8% of nets targeting White Bass, and 24% of Whitefish sampled from large mesh gill net catches. One Lake Whitefish collected from a commercial Rainbow Smelt Trawl was age 0 (Figure 2.8).

The age composition of Lake Whitefish harvested in Ohio during 2017 was not assessed due to the minimal harvest.

The landed value of Whitefish in 2017 as $41 thousand or $ 1.33 / lb CDN. The landed weight of roe from Ontario's 2017 Lake Whitefish fishery was 26 pounds, which came from OE1 and OE-2 in October and November. The approximate landed value of the roe was $ 55.80 or 2.11 / lb CDN.



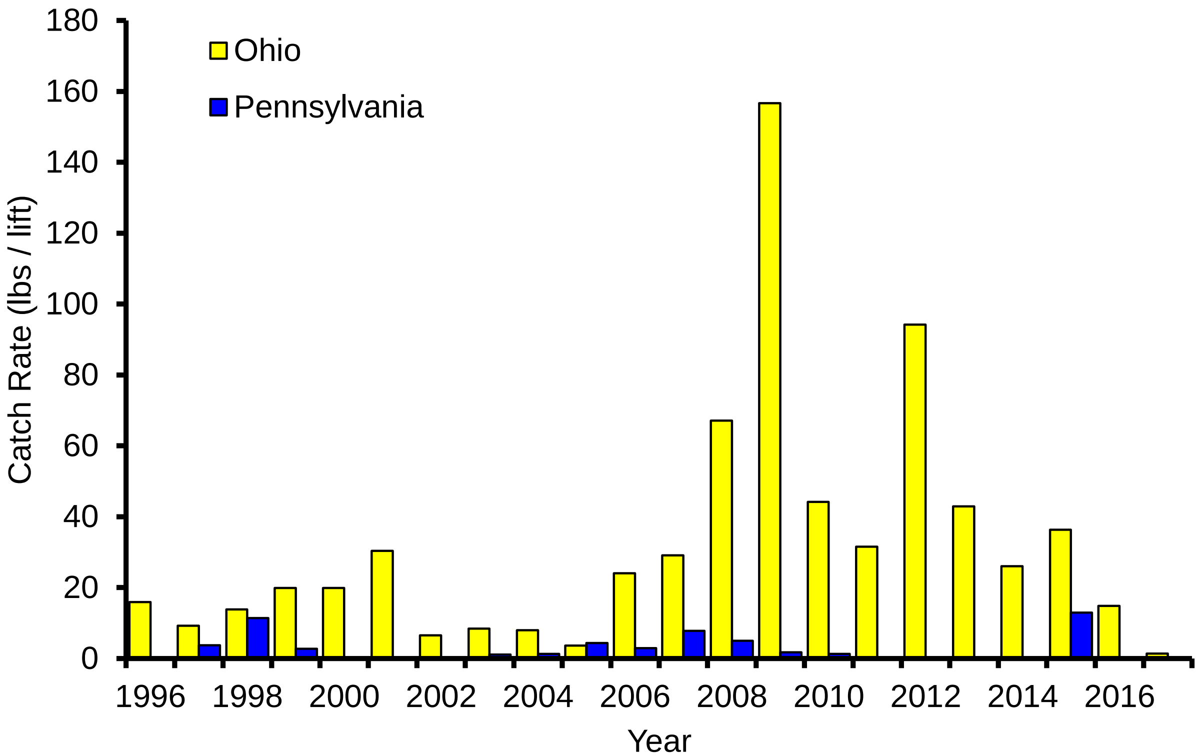


FIGURE 2.4. Lake Whitefish commercial trap net catch rates in Ohio and Pennsylvania (pounds per lift), 1996-2017. Zero harvest for PA in 2011-2014. PA trap net catch rates in 2017 were from incidental harvest.

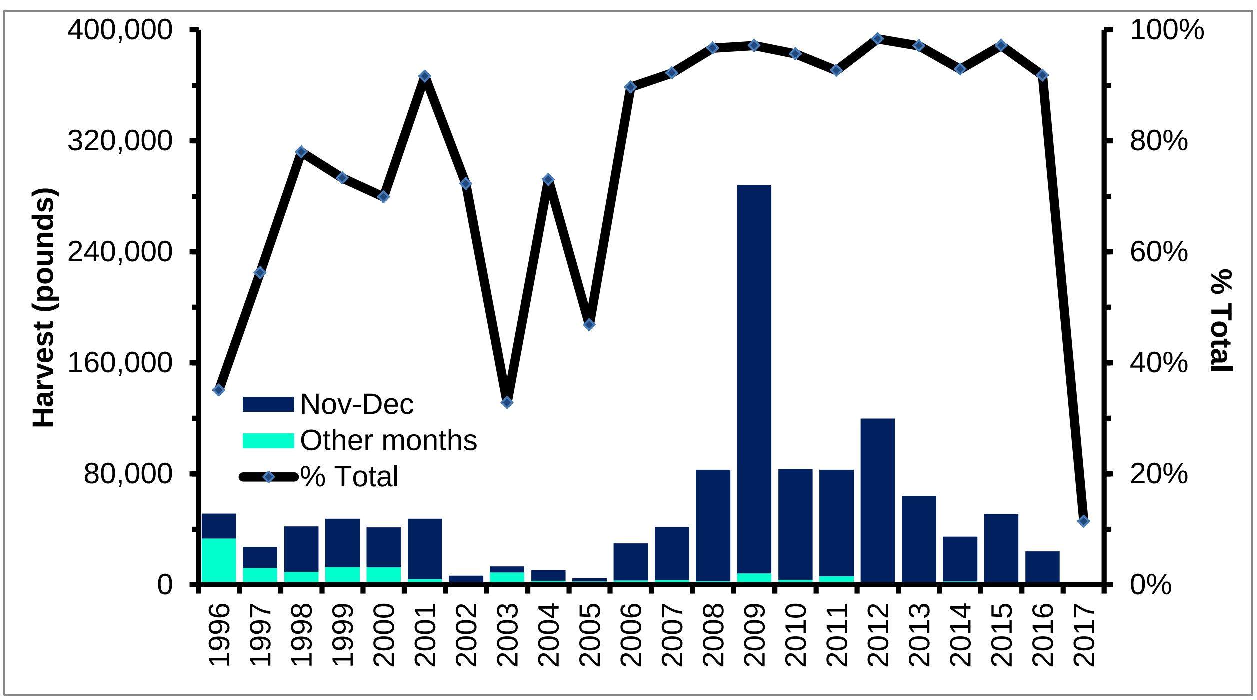


FIGURE 2.5. November and December harvest of Lake Whitefish in Ohio waters of Lake Erie, 1996-2017.

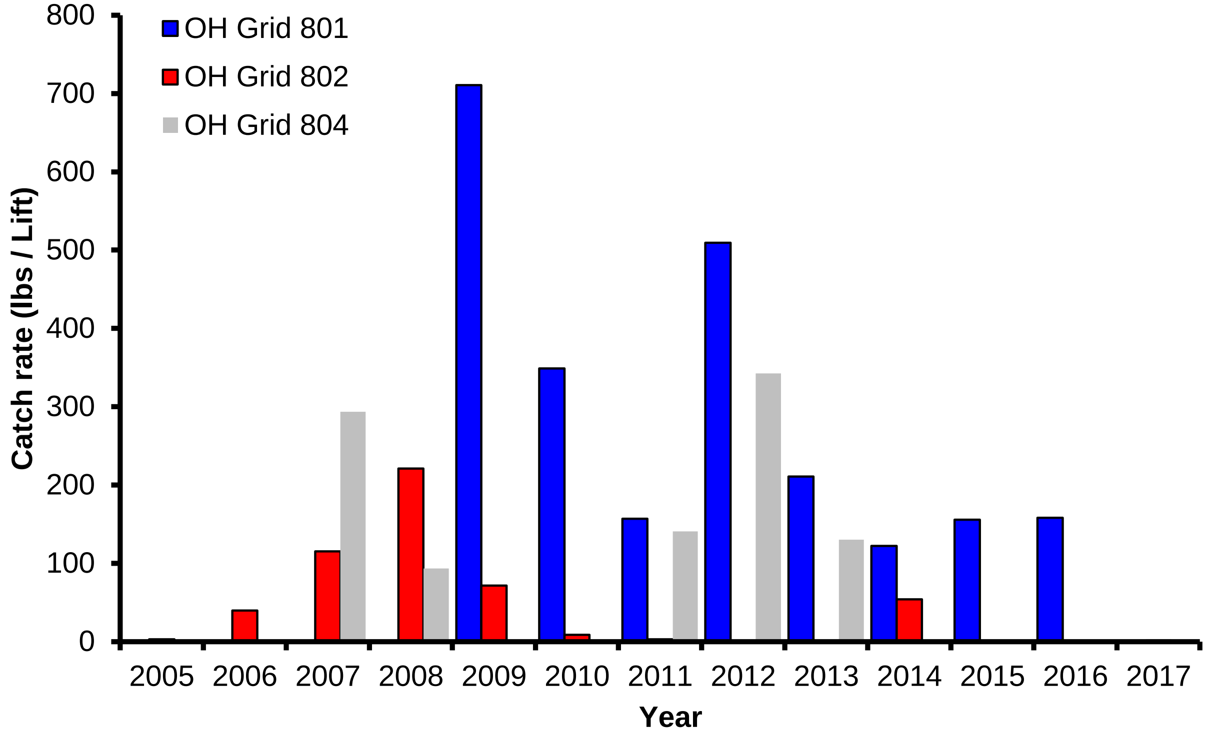


FIGURE 2.6. Ohio Lake Whitefish commercial trap net catch rates (lbs/lift) by grid in western Lake Erie. No harvest from grids 802 and 804 in 2015 - 2016. No Whitefish harvest from grids 801 and 804 in 2017. Grid 802 catch rate in 2017 1.3 lbs/lift.

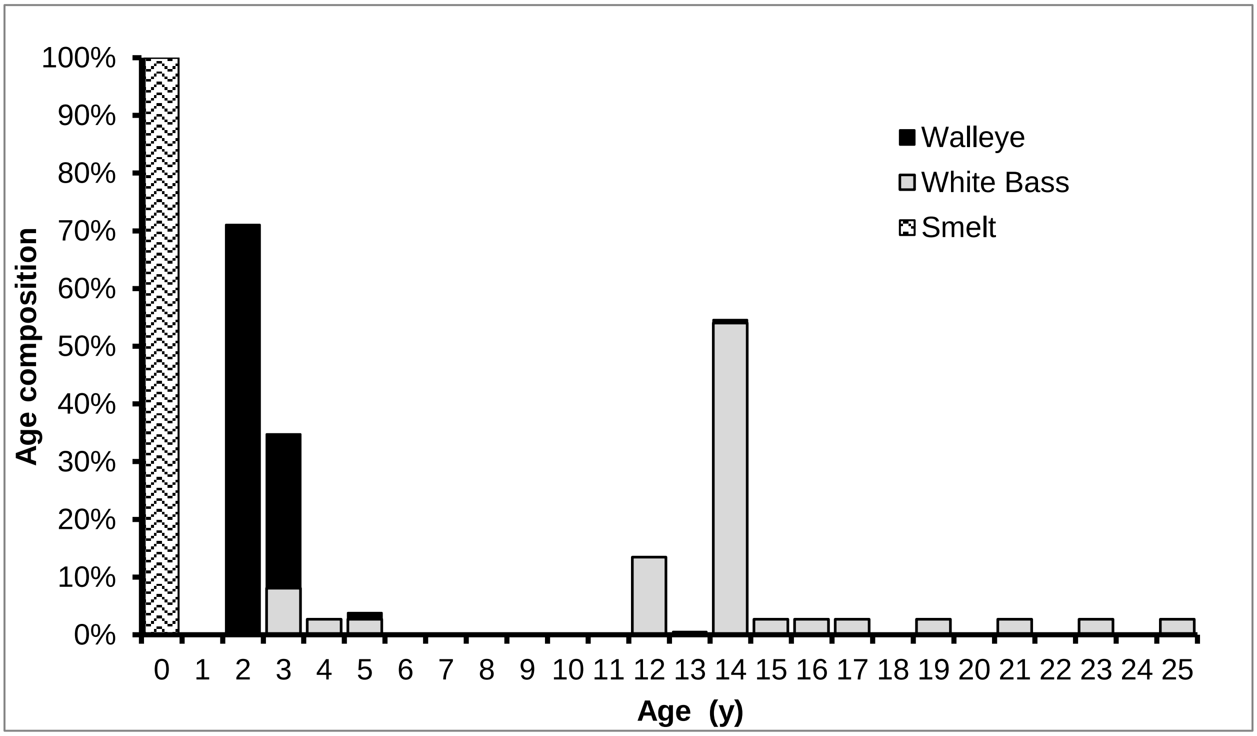


FIGURE 2.7. Ontario fall commercial Lake Whitefish harvest age composition in statistical district 1, 1986-2017, from effort with gill nets ≥3 inches, October to December. N=160 in 2017.

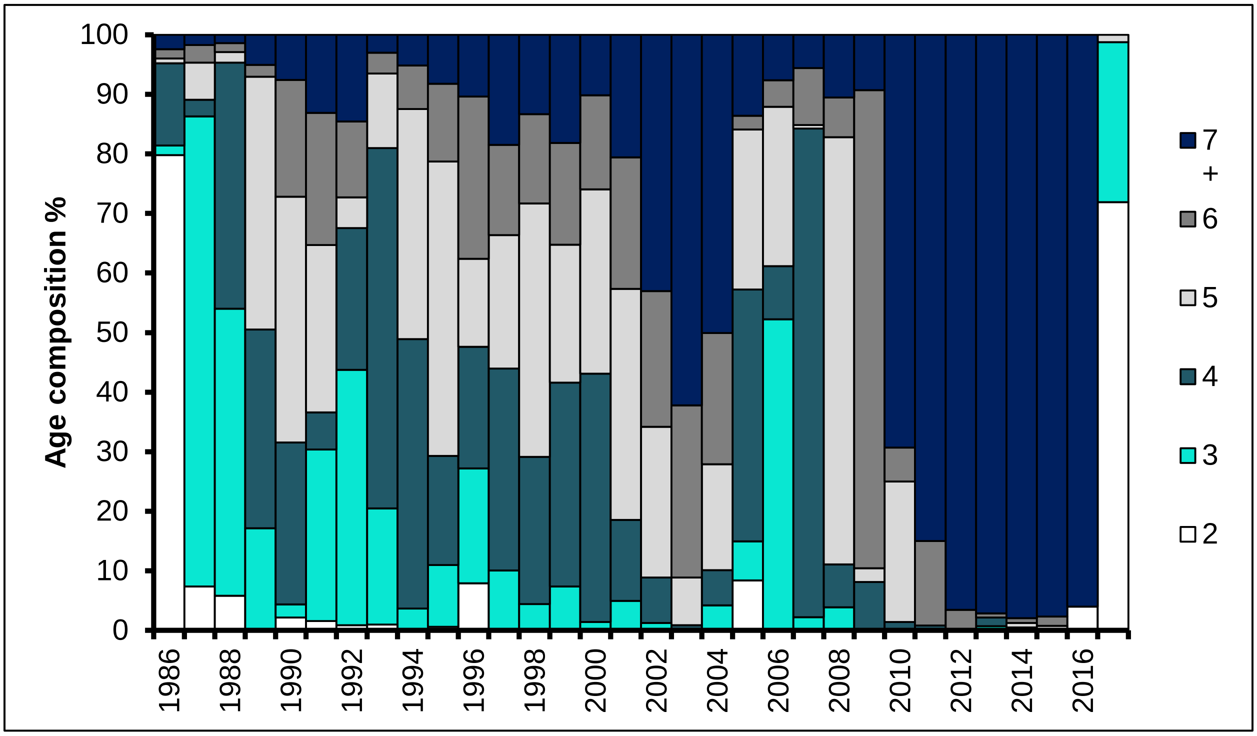


FIGURE 2.8. Age composition (otoliths, scales) of Lake Whitefish caught commercially in Ontario waters of Lake Erie in 2017 by other target species fisheries: Walleye (N=180), White Bass (N=37) and Smelt (N=1). Sex Composition: Male 85%, Female 15%, Unknown (<1%) N=218.

Assessment Surveys

Lake Whitefish gill net indices presented include east basin Cold Water Assessment (CWA) netting for Lake Trout (Charge 1) conducted in New York, Ontario and Pennsylvania waters and also Ontario's central and east basin Partnership gill net surveys combined. Partnership survey catch rates were pooled despite differences in thermal stratification, and migratory behavior when east and central basin surveys occur. The combined Partnership surveys increase sample size and catches at the expense of introducing bias associated with temporal and spatial differences in catchability. The necessity of combining the Partnership surveys arises from variable, low catches observed among all basin-specific surveys. Partnership catch rates in 2017 are based on 111 sites with 222 gangs fished on bottom and at standard canned depths.

Lake Whitefish catch rates in CWA nets fished on bottom (120 lifts) during 2017 (0.57 LWF/lift) decreased from 2016 (0.78 LWF/lift) and was ranked as the 25th percentile over the 33 year time series 1985-2017 (Figure 2.9). Among CWA surveys in 2017, catch rates in NY during 2017 were highest (1.19 LWF/lift), followed by ON (0.16 LWF/lift) and Pennsylvania waters (0.14 LWF/lift). Six percent (6/105) of Lake Whitefish examined had type A4 lamprey wounds.

Partnership catch rates of Lake Whitefish ages 0 to 2 was 0.21 LWF/gang in 2017, an increase from 0.03 in 2016 (Figure 2.9). Catch rates for age-3 and older Lake Whitefish caught in 2017 Partnership surveys increased to 0.11 LWF/gang from 0.05 LWF/gang in 2016. Whitefish were caught in all areas of Lake Erie in 2017 except the west basin survey. In addition to 71 Lake Whitefish caught in Partnership Index gear in 2017, one additional Lake Whitefish was caught in auxiliary 121-mm canned nets fished in the west-central basin. The age composition of Lake Whitefish caught in Partnership Index gear ranged from ages 1 to 14, with ages 2 (61%; 2015 year class) and 3 (31%; 2014 year class; Figure 2.10) most abundant. Age 14 (2003 cohort) accounted for 4% of Lake Whitefish caught in index gear. Lake Whitefish mean age in Partnership gear was 2.8 reflecting recruitment of younger fish in the population. The Lake Whitefish caught in auxiliary gear was age 14. Of 72 Lake

Whitefish examined, none had Sea Lamprey scars or wounds in 2017.

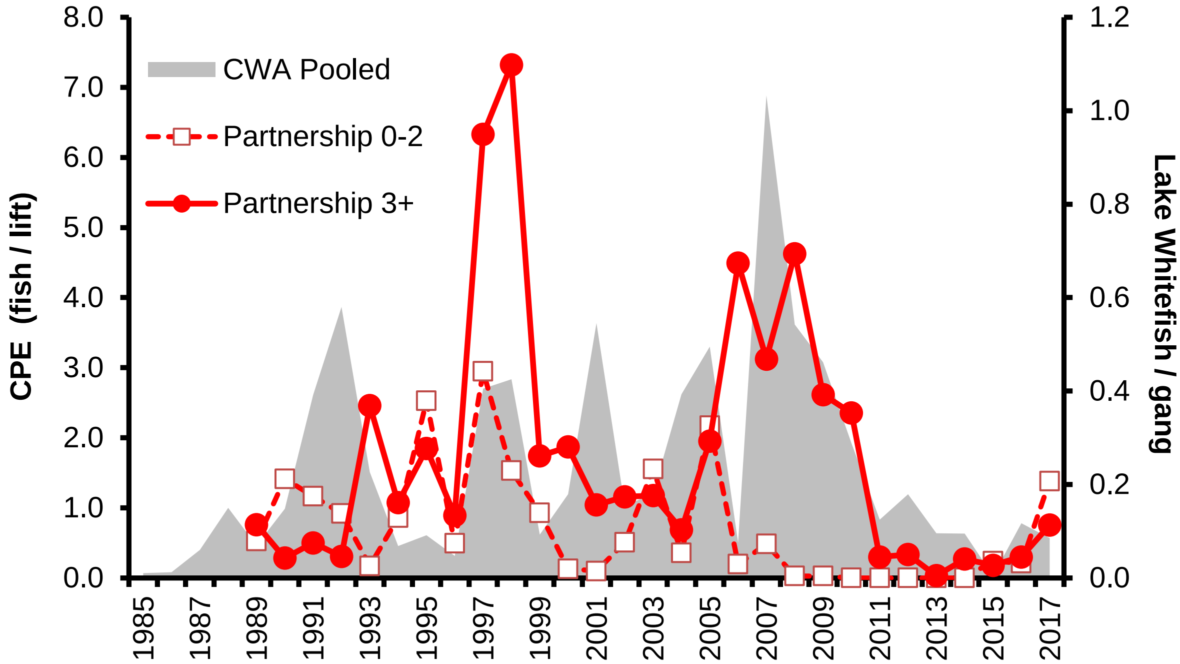


FIGURE 2.9. Catch per effort (number fish/lift) of Lake Whitefish caught in standard coldwater assessment gill nets (CWA) in New York, Ontario and Pennsylvania waters, weighted by number of lifts (grey area), 1985-2017. Partnership index catch rates (WF/gang) for ages 0-2 (dots) and ages 3 and older (squares) (second axis), 1989-2017.

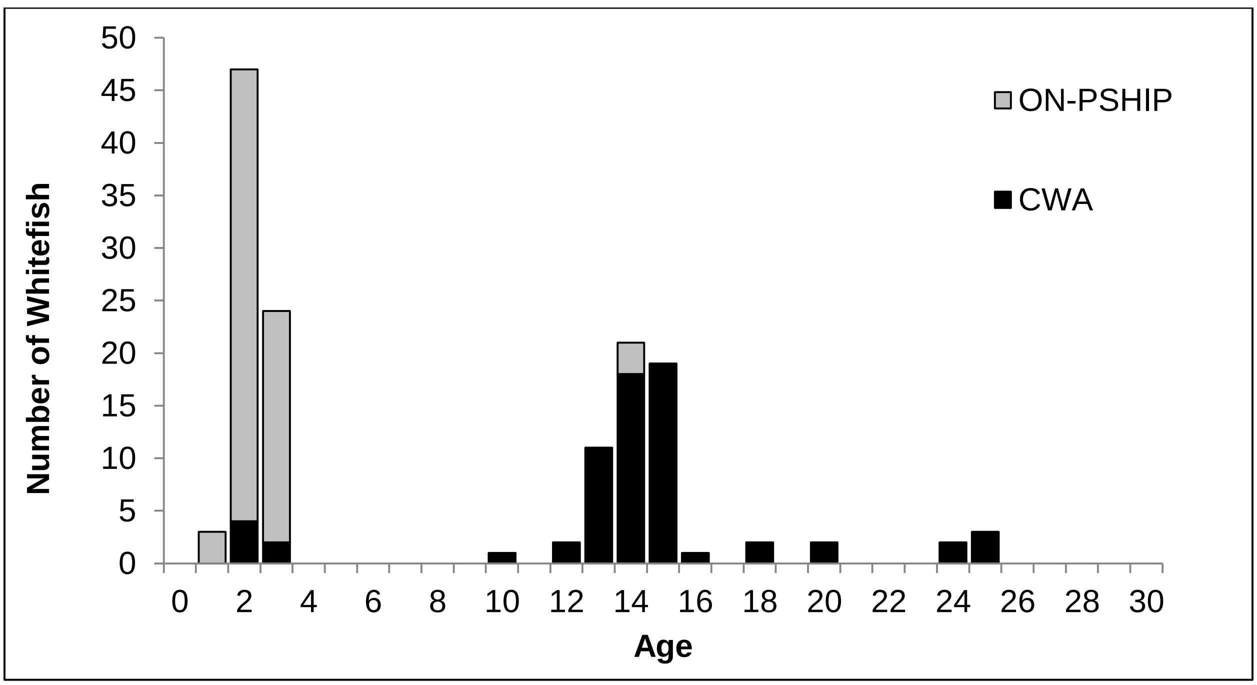


FIGURE 2.10. Age-frequency of Lake Whitefish collected from Cold Water Assessment (CWA) gill net surveys and Ontario Partnership index, 2017 (N=138).

Lake Whitefish captured in CWA surveys by all agencies ranged in age from 2 to 25. Ages 13 - 15 were most abundant (72%) whereas other age groups comprised 6% or less of the catch (Figure 2.10). Mean age of Lake Whitefish caught in CWA nets was 14.1 years. The older age composition of Lake Whitefish caught in CWA nets compared to the Partnership Index may be due to differences in study design. The CWA nets were fished exclusively in the east basin hypolimnion whereas Partnership nets were fished above and below the thermocline in Pennsylvania Ridge and east basin surveys and at all depths after fall turnover in the central basin.

Trawl surveys in Ohio waters of the central basin of Lake Erie (Ohio Districts 2 and 3 combined) encounter juvenile Lake Whitefish. June and October catch rates are presented in Figure 2.11 as indicators of year class strength. In 2017, age 0 Lake Whitefish catches were average in June trawls (0.26 LWF/ha) but were absent in October trawls (Figure 2.11). Yearling Lake Whitefish were caught in October trawls (0.02 fish/ha) in 2017, but yearlings were not caught during June trawls in central (O-2, O-3) Lake Erie (Figure 2.12).

Pennsylvania bottom trawl surveys from May to November also describe year class strength of juvenile Lake Whitefish. Assessment in 2016 and 2017 resulted in 0 YOY Lake Whitefish / ha (Figure 2.11). Yearling Lake Whitefish were caught in 2016 (0.24 YRL Lake Whitefish / ha) but the catch of yearlings was zero in 2017 (Figure 2.12). While the PA trawl survey detected the presence of the 2015 year class as YOY and yearlings and the 2014 cohort as yearlings, these catch rates fell below those of strong cohorts observed in the late 1980s and early 1990s (Figures 2.11 and 2.12).

The New York east basin trawl survey indicated the presence of age 0 Lake Whitefish in 2017 (0.15 LWF/ha) (Figure 2.11). Historically, few Lake Whitefish have been encountered in deep, offshore fall bottom trawl assessment in Outer Long Point Bay. Offshore bottom trawling did not collect any Lake Whitefish in 2017.

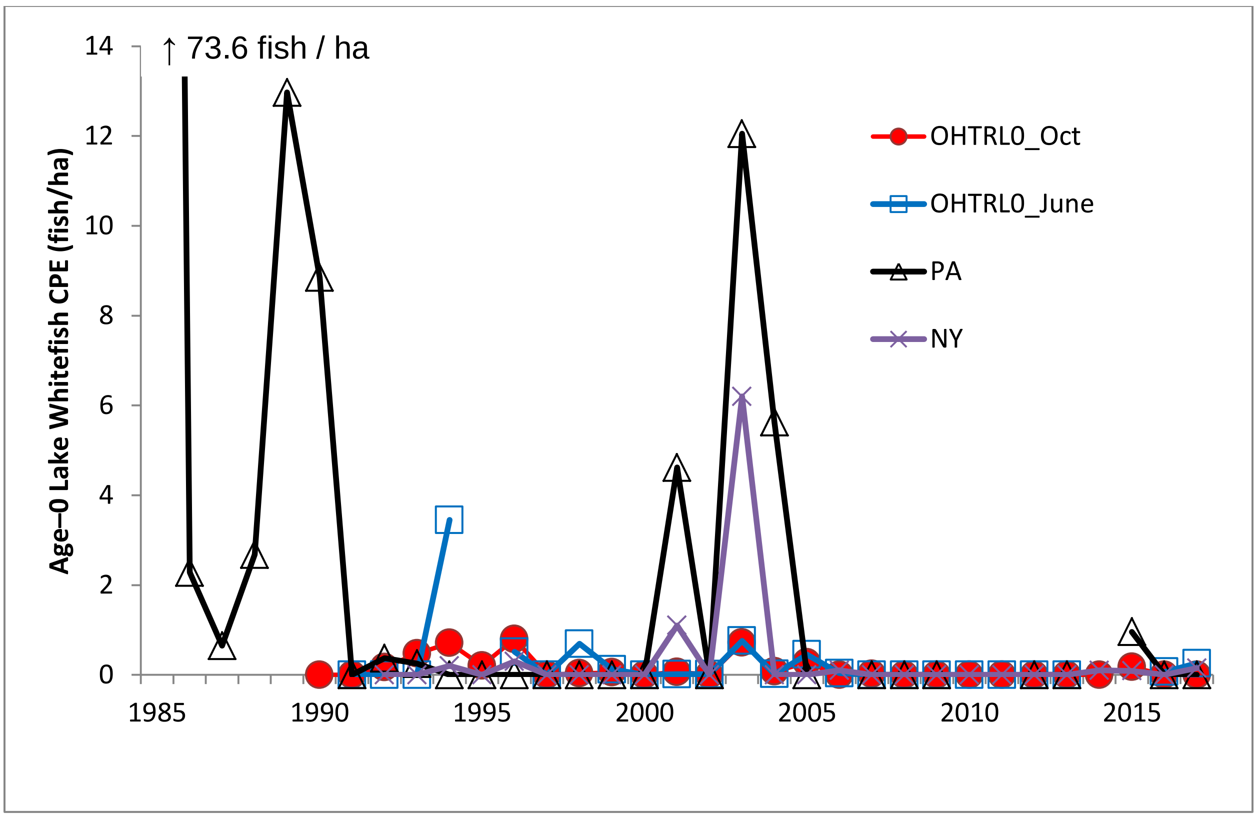


FIGURE 2.11. Mean age-0 Lake Whitefish catch per hectare in Ohio (central basin during June, October), Pennsylvania and New York fall assessment trawls, 1985-2017. Ohio data are means for October trawls in District 2 and 3. Age-0 catch rate for Pennsylvania in 1985 (73.6 fish/ha) exceeds axis range.

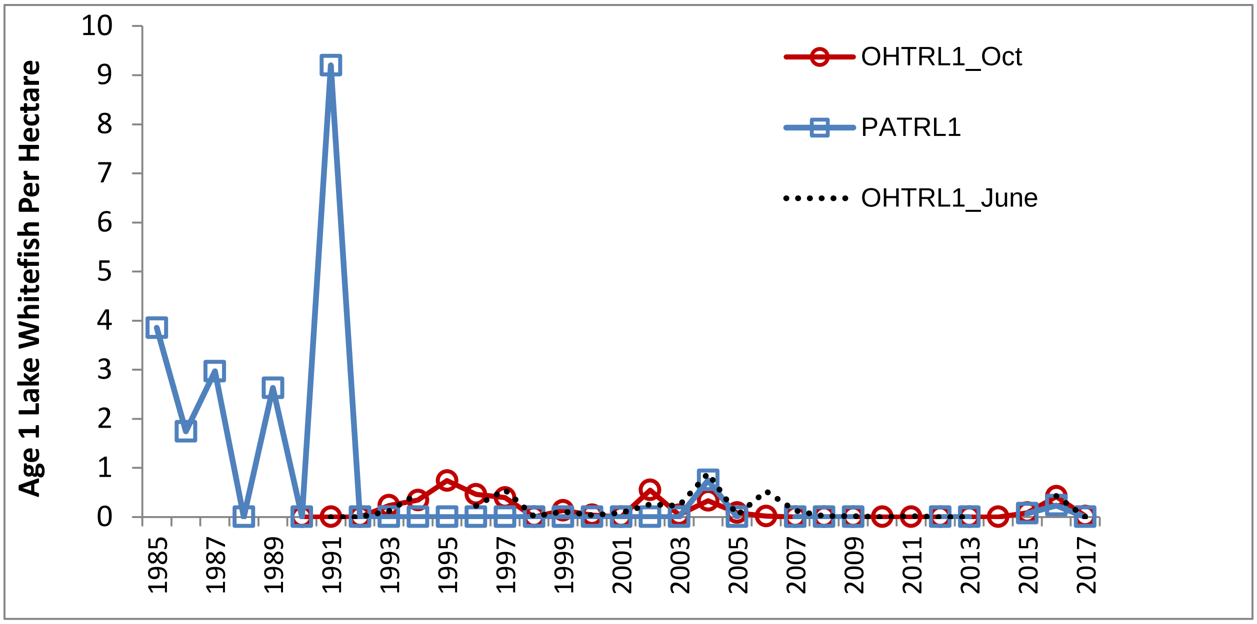


FIGURE 2.12. Age 1 Lake Whitefish trawl catch rates (number per ha) in Pennsylvania (PA) (squares) and Ohio waters during June (dotted line) and October (circles), 1985-2017.

Growth and Diet

Trends in condition are usually presented for Lake Whitefish sampled by ODNR and Ontario MNRF in relation to historic Lake Whitefish condition reported by Van Oosten and Hile's (1947). In 2017, sample sizes for Lake Whitefish condition and growth were low and most Whitefish sampled did not meet criteria for inclusion for condition analyses (ages 4 and older collected from Oct-Dec, excluding spawning and spent fish).

Stomach contents from 28 Lake Whitefish caught in Ohio waters of Lake Erie were examined in 2017. Of these, 27 adult Whitefish collected in June (25), July (1) and September (1) contained prey. Across the central basin, Lake Whitefish diets were primarily Isopods (49.8%) and Chironomids (40.4%). Bosmina (6.1%) and Daphnia (2.5%) comprised the remaining diet items. Two Lake Whitefish collected in eastern Lake Erie contained Chironomid pupae and adult Copepods. In addition, an adult Lake Whitefish harvested from OE-2 on March 29, 2017, contained numerous Round Gobies.

Summary

Lake Whitefish fishery indicators were poor or data deficient in 2017 albeit with significant incidental harvest of age2 and 3 fish that are less vulnerable to commercial gear. Total Lake Whitefish harvest in 2017 (31,539 pounds) was the lowest in 31 years. Ontario's incidental harvest in 2017 attained 51% of Lake Whitefish quota (60,000 pounds) with no targeted harvest of Lake Whitefish in 2017. Ohio trapnet harvest (701 pounds) in 2017 was also non-targeted. Lake Whitefish catch rates from gillnet surveys during 2017 ranged from low (CWA) to moderate or higher depending on age groups represented (ON Partnership); the latter higher rates were mainly due to recruitment of young Whitefish from the 2015 and 2014 cohorts. Trawl assessments also forecasted recruitment from the 2014 and 2015 year classes based on the presence of YOY and yearlings in central and east basin areas. These cohorts dominated incidental fisheries in 2017 and are expected to contribute to Lake Whitefish spawner biomass and fisheries in 2018 and later. Ontario's 2018 quota was set initially at 60,000 pounds, but is subject to change during the year as assessment information accumulates. Continued conservative harvests are recommended until spawner biomass improves.

Biological reference points applications for management are subjects in the CWTG Charge 8 report. The final version of the Charge 8 report is anticipated in 2018. For information about work with the Data Deficient Working Group and Marine Stewardship Certification, refer to Charge 8 of this report.

Charge 3: Continue to assess the Burbot fishery, age structure, growth, diet, seasonal distribution and other population parameters.

Chelsea May (OMNRF), Chris S. Vandergoot (USGS), Andy Cook (OMNRF), Jim Boase (USFWS), Justin Chiotti (USFWS), Ed Roseman (USGS)

Commercial Harvest

The commercial harvest of Burbot (*Lota lota*) by the Lake Erie jurisdictions was relatively insignificant through the late 1980s, generally remaining under 5,000 pounds (or 2,268 kg; Table 3.1). Burbot harvest began to increase in 1990, coinciding with an increase in abundance and harvest of Lake Whitefish. Most Burbot commercial harvest occurs in the eastern end of the lake, with minimal harvest occurring in Ohio waters and the western and central basins of Ontario waters.

Historically, Burbot harvest was highest in Pennsylvania waters of Lake Erie. However, harvest decreased in Pennsylvania waters after 1995 following a shift from a gill net to a trap net commercial fishery, resulting in a substantial decrease of commercial effort (CWTG 1997). In 1999, a market was developed for Burbot in Ontario, leading the industry to actively target this species during 1999 and a concomitant increase was observed. However, this opportunistic market did not persist, and declining annual harvests have been observed ever since. The Ontario harvest is now from by-catch in other fisheries.

The total commercial harvest for Lake Erie in 2017 was 1,408 pounds (638 kg) of which 65% came from Ontario waters (Table 3.1). Between 2011 and 2015, harvest was higher in New York waters than all the other jurisdictions combined. In 2016, New York Burbot harvest declined and in 2017, no Burbot were caught in New York waters. All jurisdictions recorded fewer than 1,000 lbs of commercial Burbot harvest in 2017.

Abundance and Distribution

Burbot are seasonally found in all the major basins of Lake Erie; however, the summer distribution of adult fish is restricted primarily to the 20-m and deeper thermally stratified regions of the eastern basin (Figure 3.1). Two Burbot assessments are conducted each year - the Ontario Partnership Index Fishing Program (hereafter referred to as "Partnership Survey") in Ontario waters, and the inter-agency summer (August) Coldwater Assessment (hereafter referred to as "Interagency CWA Survey") in New York, Ontario, and Pennsylvania waters. The Partnership Survey is a lakewide gill net survey of the Canadian waters that has provided a spatially robust assessment of fish species abundance and distribution since 1989. During the early 1990s, Burbot abundance was low throughout the lake; catch rates in the Partnership Survey averaged fewer than 0.5 Burbot/lift (Figures 3.2 and 3.3). Burbot abundance increased rapidly after 1993 in the eastern basin and Pennsylvania Ridge, reaching peaks of 4.0 and 4.2 Burbot/ lift in 1998 and 2003, respectively. Burbot numbers in the west-central and east-central basins also peaked in 1998, but at a much lower catch rate (0.5 Burbot/ lift) than observed in the eastern end of the lake. Catch rates in the Pennsylvania Ridge area during 1998 to 2004 remained high, but variable, ranging between 2.0 and 4.2 Burbot/ lift and then decreased to about 0.6 Burbot/lift in 2005-2006. Catch rates in the eastern basin since 1998 have been variable but exhibited an overall decreasing trend. Between 2012 and 2017, catches in the east basin were below 0.2 Burbot/lift whereas in Pennsylvania Ridge catches were higher in 2016 and 2017. The 2017 catch rate was 0.4 Burbot/lift.

In the Interagency CWA survey, Burbot catches have been consistently low since 2012, generally below 1 fish/lift. This trend continued in 2017 with a catch rate of 0.5 Burbot per lift across jurisdictions (Figure 3.4).

In 2015, juvenile and adult Burbot were detected for the first time during U.S. Fish and Wildlife Service (USFWS) and U.S. Geological Survey (USGS) fisheries assessments in the St Clair - Detroit rivers. Since 2003, the USFWS and USGS have conducted annual surveys using a variety of gears (setlines, gillnets, hoop nets, and minnow traps) in an effort to measure fish response to artificial reefs that have been constructed in the two river systems. Assessment surveys since 2003 have resulted in over 4,000 gear deployment units of effort. Prior to

2015, juvenile and adult Burbot were undetected within the two rivers and since 2015, 28 Burbot of varying sizes have been captured. To date over 16 acres of artificial reefs have been constructed in these two river systems, and although not conclusive, 24 of the 28 Burbot were captured either on or near the artificial reefs.

Pelagic larval Burbot continue to be collected in the St. Clair and Detroit rivers. Densities peaked earlier (mid-May) and were higher in the St. Clair River than the Detroit River where peaks occurred later in May and June. Collections of Burbot persisted in both rivers until late July in most years (McCullough et al. 2015; Tucker et al. in press). Diets of pelagic Burbot collected from the St. Clair River during 2013 were examined to assess prey selection. In general, larval Burbot less than 10 mm TL consumed *Bosmina* and nauplii, fish between 10 and 15 mm TL consumed nearly equal proportions of calanoid and cyclopiod copepods and *Daphnia*, while larger (>15 mm TL) fish consumed a variety of zooplankton food items including *Bythotrephes* (McCullough et al. 2015).

In 2017, ten adult burbot (>330 mm TL) were outfitted with acoustic telemetry transmitters and released into the St. Clair River during spring and early summer to monitor movement patterns. Receivers were downloaded in August 2017, and these preliminary data show most tagged fish remained in the St Clair River during those few months after release with both upstream and downstream movements being detected (https://glatos.glos.us/home/project/SDBUT).

Table 3.1. Total Burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2017.

Table 3.1 Total burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2016.

Year	New York	Pennsylvania	Ohio	Ontario	Total
1980	0	2	0	0	2.0
1981	0	2	0	0	2.0
1982	0	0	0	0	0.0
1983	0	2	0	6	8.0
1984	0	1	0	1	2.0
1985	0	1	0	1	2.0
1986	0	3	0	2	5.0
1987	0	0	0	4	4.0
1988	0	1	0	0	1.0
1989	0	4	0	0.8	4.8
1990	0	15.5	0	1.7	17.2
1991	0	33.4	0	1.2	34.6
1992	0.7	22.2	0	5.9	28.8
1993	2.6	4.2	0	3.1	9.9
1994	3	12.1	0	6.8	21.9
1995	1.9	30.9	1.2	8.9	42.9
1996	3.4	2.3	1.2	8.6	15.5
1997	2.9	8.9	1.7	7.4	20.9
1998	0.2	9	1.5	9.9	20.6
1999	1	7.9	1.1	394.8	404.8
2000	0.1	3.5	0.1	30.1	33.8
2001	0.4	4.4	0	6.5	11.3
2002	0.9	5.2	0.1	3.4	9.6
2003	0.1	1.8	0.2	2.3	4.4
2004	0.5	2.4	0.9	5.4	9.2
2005	0.7	2.2	0.4	10	13.3
2006	0.9	1.7	0.3	2.4	5.3
2007	0.4	1.1	0.1	3.6	5.2
2008	0.2	0.3	0.0	1.2	1.7
2009	0.4	0.6	0.0	3.8	4.8
2010	1.4	0.1	0.0	1.8	3.2
2011	0.7	0.0	0.0	2.2	2.9
2012	0.7	0.2	0.2	0.2	1.3
2013	0.9	0.0	0.1	0.2	1.3
2014	1.9	0.1	0.1	0.6	2.7
2015	1.6	0.5	0.2	0.4	2.7
2016	0.4	0.1	0.2	0.6	1.3
2017	0.0	0.3	0.2	0.9	1.4

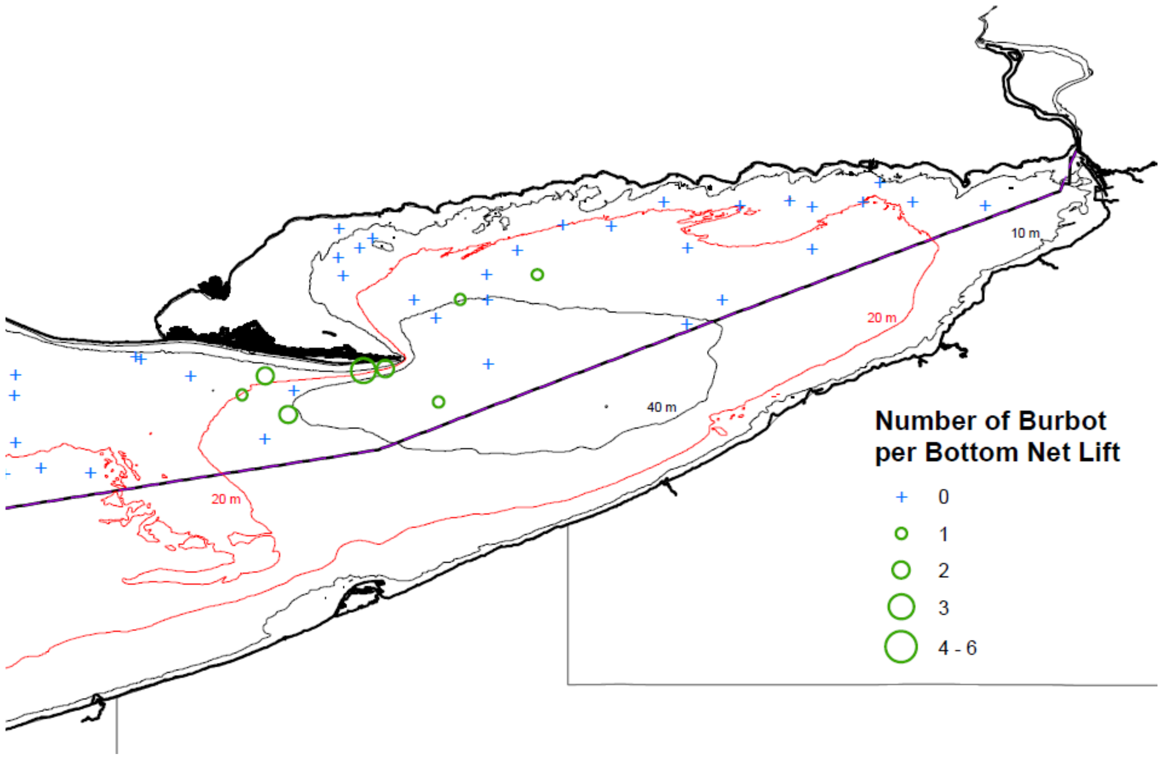


Figure 3.1. Distribution of Burbot catches (number per lift) in Ontario Partnership gill nets during September, 2017 in eastern basin and Pennsylvania Ridge surveys in Lake Erie.

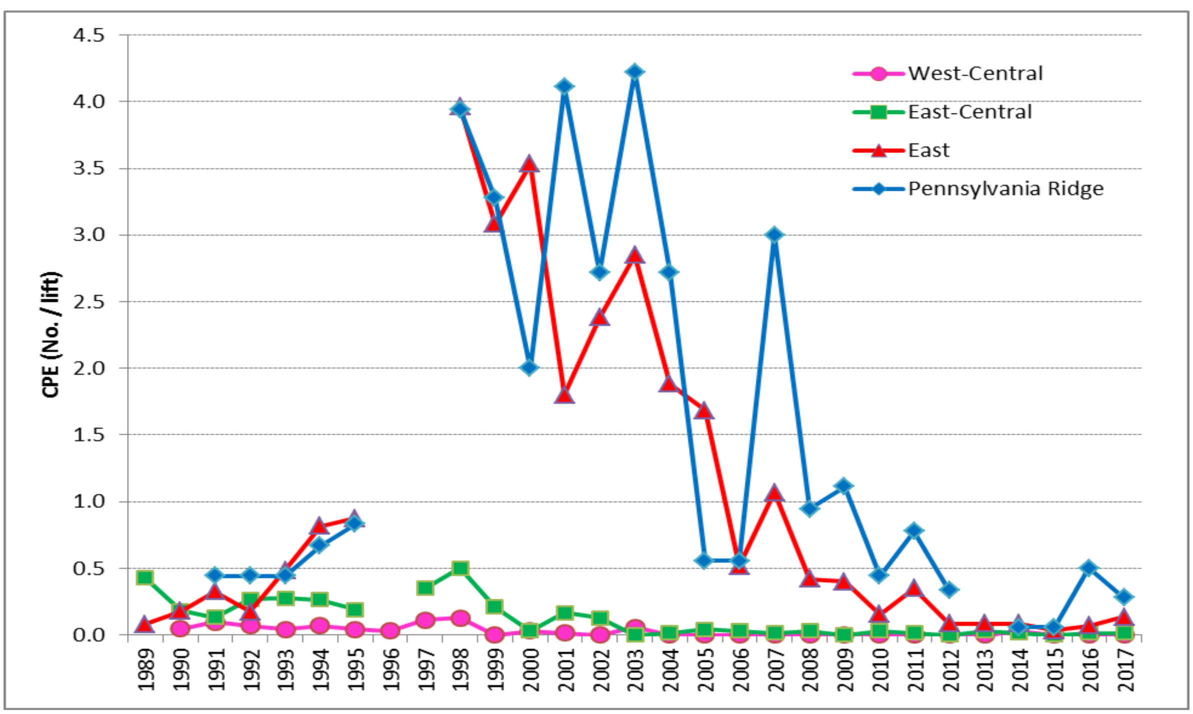


Figure 3.2. Burbot CPE (number per lift) by basin from the Ontario Partnership surveys 1989–2017 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets). East basin and Pennsylvania Ridge surveys were not fished during 1996 and 1997. Pennsylvania Ridge was not sampled in 2013.

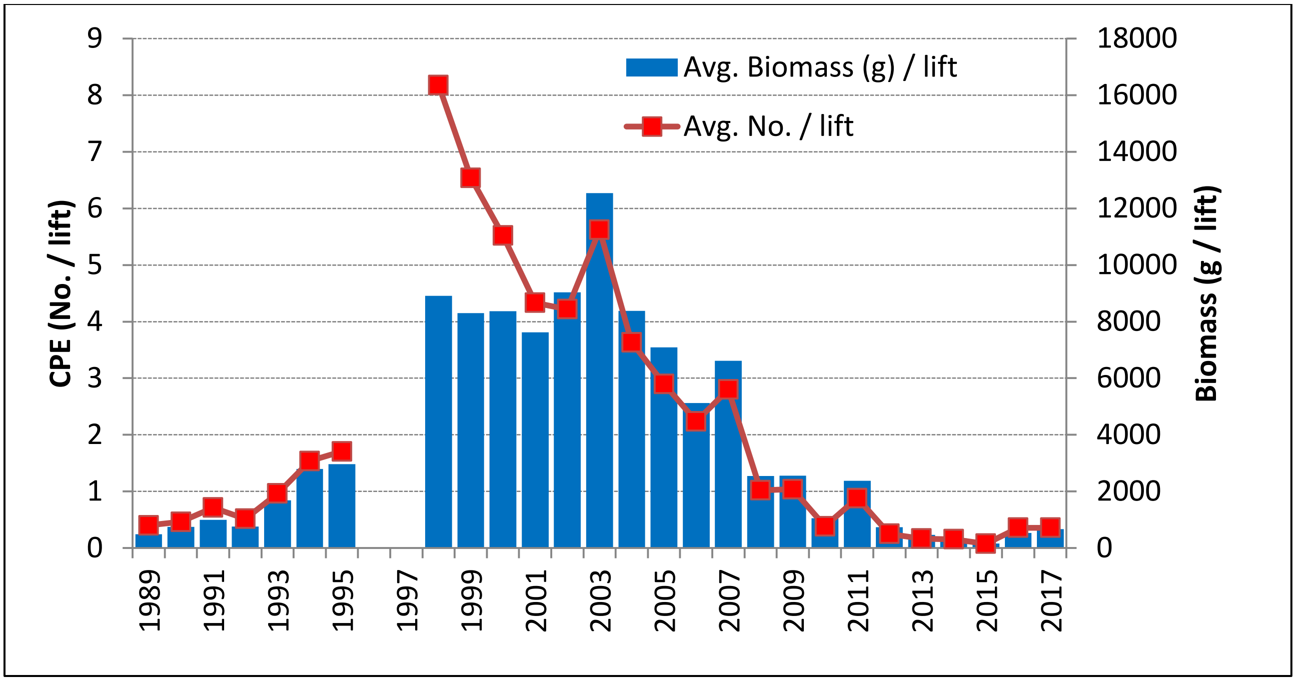


Figure 3.3. Average catch rate (CPE as number per lift) and biomass (grams per lift) of Burbot in Ontario waters of eastern Lake Erie, Ontario Partnership gill net survey 1989–2017 (includes only bottom sets, all mesh sizes; PA-ridge and eastern basin sample sites). East basin and Pennsylvania Ridge surveys were not fished during 1996 and 1997. Pennsylvania Ridge was not sampled in 2013.

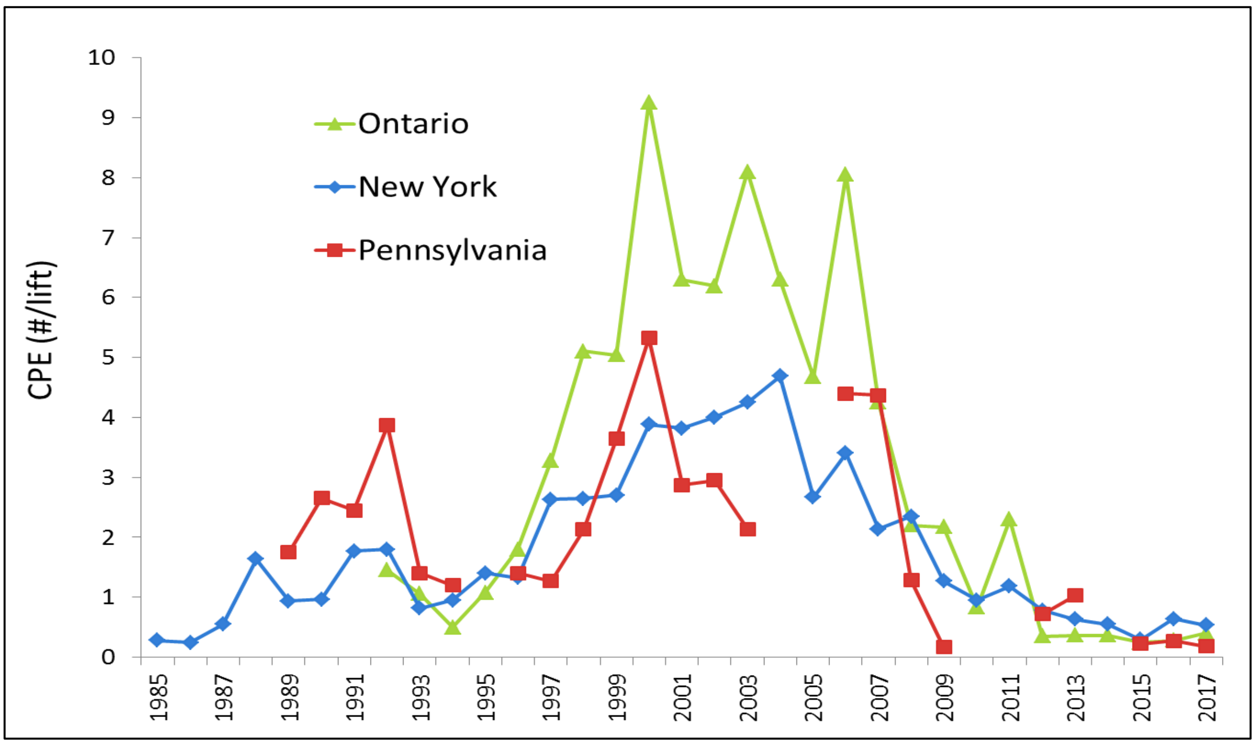


Figure 3.4. Average Burbot catch rate (number//lift) from multi-agency summer Coldwater Assessment gillnets by jurisdiction in eastern Lake Erie, 1985-2017.

Age and Recruitment

Burbot ages are estimated using otoliths for fish caught in Interagency CWA surveys. The use of otolith thin-sections is recommended as the best approach for accurate age determination of Burbot (Edwards et al. 2011). The Burbot catch ranged in age from 1 to 22 years in 2017 (Figure 3.5 and 3.6). Burbot ages 4 and younger made up 40% of the fish caught in 2017, showing evidence of recruitment that has not been seen recently (Figure 3.6). The mean age of sampled Burbot decreased to 8.3 years in 2017, down from 14.5 years in the 2016 survey (Figure 3.7).

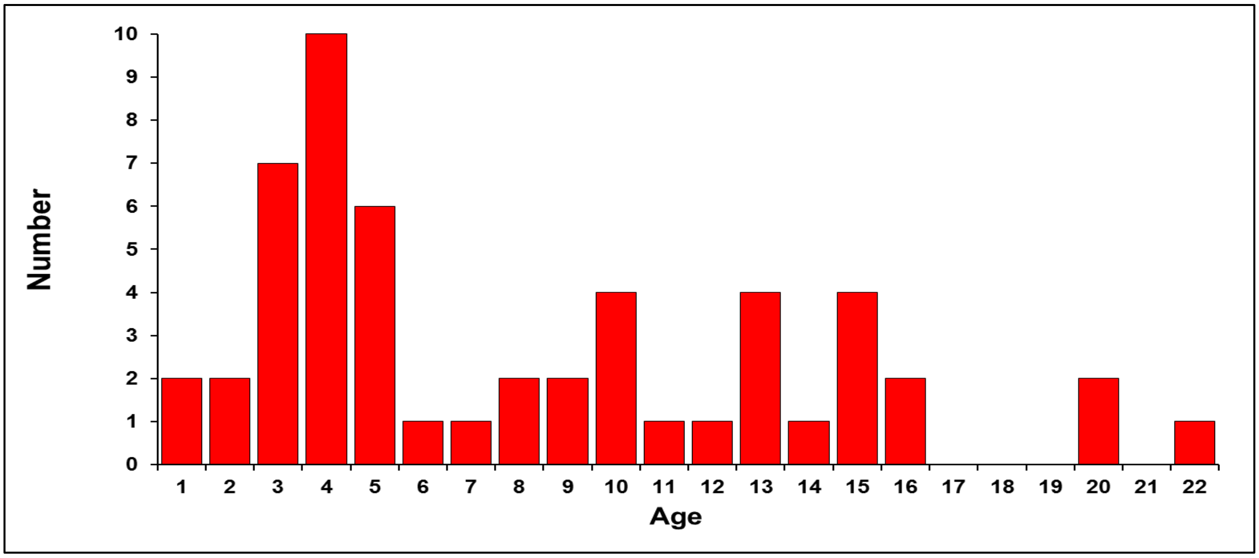


Figure 3.5. Age distribution of Burbot caught in multi-agency summer coldwater gill net assessment in eastern Lake Erie, 2017 (N=53).

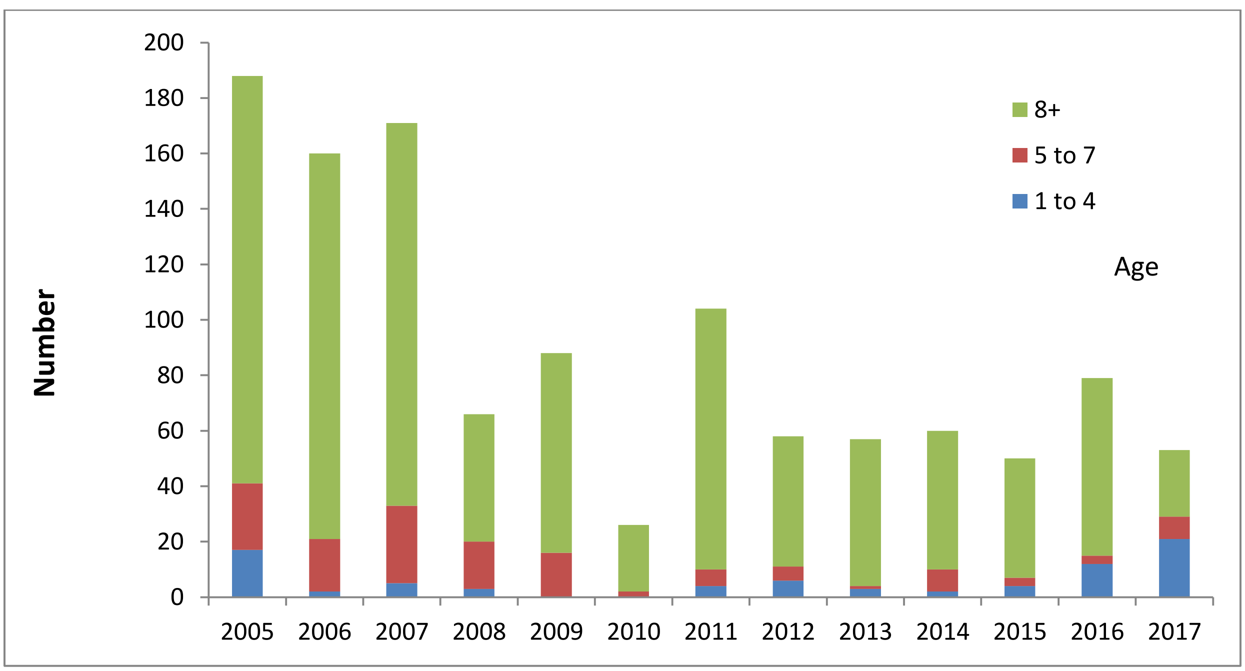


Figure 3.6. Age composition of Burbot caught in multi-agency summer coldwater gill net assessment eastern Lake Erie during 1997-2017, displayed by by 1 to 4, 5 to 7 and 8+ age groups.

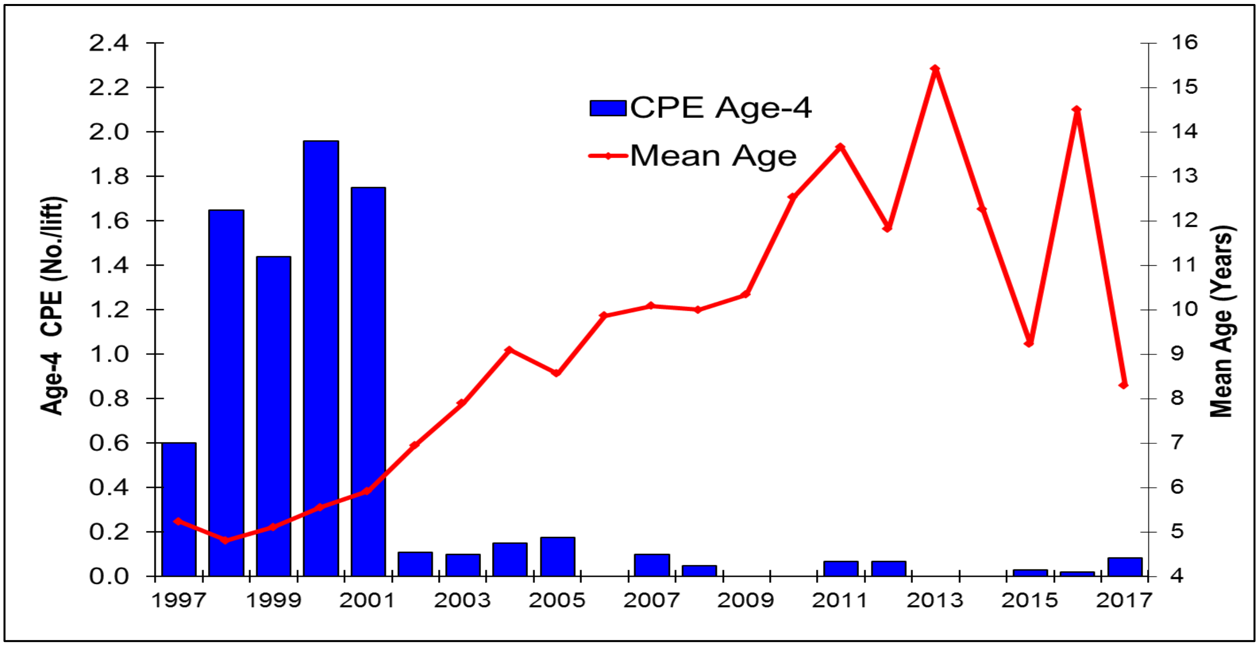


Figure 3.7. Mean age and average CPE of Age-4 Burbot caught in summer gillnet assessment in eastern Lake Erie during 1997-2017.

Diet

Diet information was limited to fish caught in Ontario and New York waters of Lake Erie during the 2017 Interagency CWA survey. Analysis of stomach contents revealed a diet made up mostly of fish, but with large unknown species content (Figure 3.8). As in previous years, Burbot diets continued to reflect a diversity in items consumed with four different identifiable fish species found in stomach samples. Round Goby was the dominant prey item, occurring in 43% of Burbot diet samples, followed by Rainbow Smelt (39%), Yellow Perch (18%) and Gizzard Shad (11%). Gizzard Shad was not detected in 2016 diets but was found in fish from both New York and Ontario in 2017.

Round Gobies have increased in the diet of Burbot since they first appeared in the eastern basin in 1999; however, in 2017, occurrence of Round Gobies decreased (Figure 3.9). Prior to 2001, Rainbow Smelt comprised approximately 70% of Burbot diets. However, the percentage has decreased in recent years.

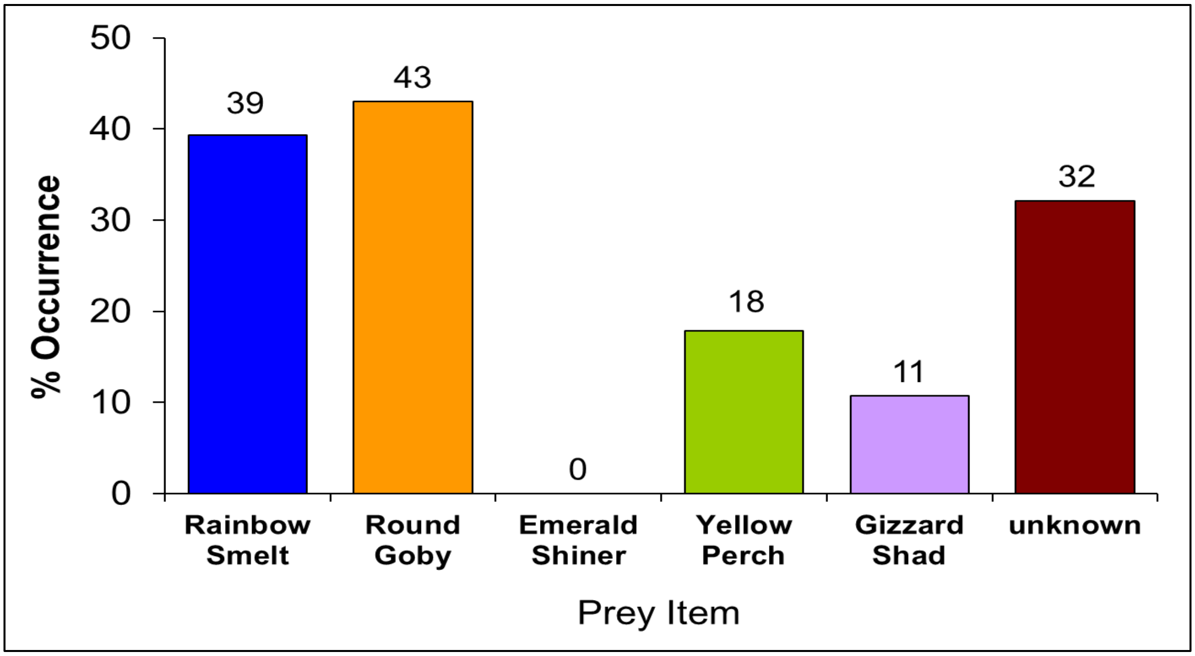


Figure 3.8. Frequency of occurrence (%) of diet items from non-empty stomachs of Burbot (N=28) sampled in multi-agency coldwater assessment gill nets from the eastern basin of Lake Erie, August 2017. Unknown includes fish remains that could not be identified to species.

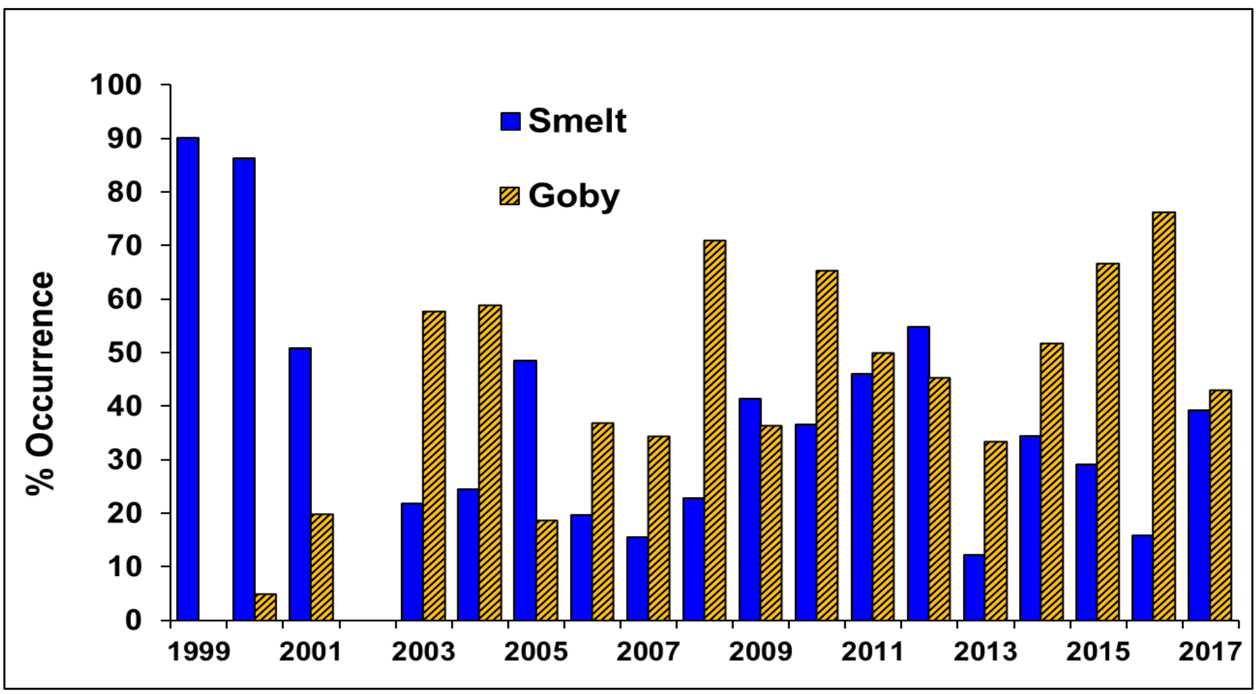


Figure 3.9. Frequency of occurrence of Rainbow Smelt and Round Gobies in the diet of Burbot caught in coldwater index gillnets set during August in the eastern basin of Lake Erie, 1999-2017.

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Charge 4: Continue to participate in the IMSL process on Lake Erie to outline and prescribe the needs of the Lake Erie Sea Lamprey management program.

Chris Eilers (USFWS), Kevin Tallon (DFO), and James Markham (NYSDEC)

The Great Lakes Fishery Commission and its control agents (U.S. Fish and Wildlife Service and Fisheries and Oceans, Canada) continue to apply the Integrated Management of Sea Lamprey (IMSL) program in Lake Erie including selection of streams for lampricide treatment and implementation of alternative control methods. The Lake Erie Coldwater Task Group has provided the forum for the assemblage of Sea Lamprey wounding data used to evaluate and guide actions related to managing Sea Lamprey and for the discussion of ongoing Sea Lamprey and fishery management actions that impact the Lake Erie fish community.

Lake Trout Wounding Rates

A total of 73 A1-A3 wounds were found on 422 Lake Trout greater than 532 mm (21 inches) total length in 2017 during coldwater assessment gill netting, equaling a wounding rate of 17.3 wounds per 100 fish (Table 4.1; Figure 4.1). This was higher than the average wounding rate from the previous 10 years (12.7 wounds/100 fish) and over three times the target rate of 5.0 wounds per 100 fish (Lake Trout Task Group 1985; Markham et al. 2008). Wounding rates have remained above target for 21 of the past 22 years. Large Lake Trout continue to be the preferred targets for Sea Lamprey; Lake Trout between 635 and 736 mm TL (25-29 inches) had the highest A1-A3 wounding rate (18.9 wounds/100 fish) while Lake Trout greater than 736 mm (29 inches) total length (TL) were slightly less (17.4 wounds/100 fish; Table 4.1). Small Lake Trout less than 532 mm (21 inches) are rarely attacked when larger Lake Trout are available.

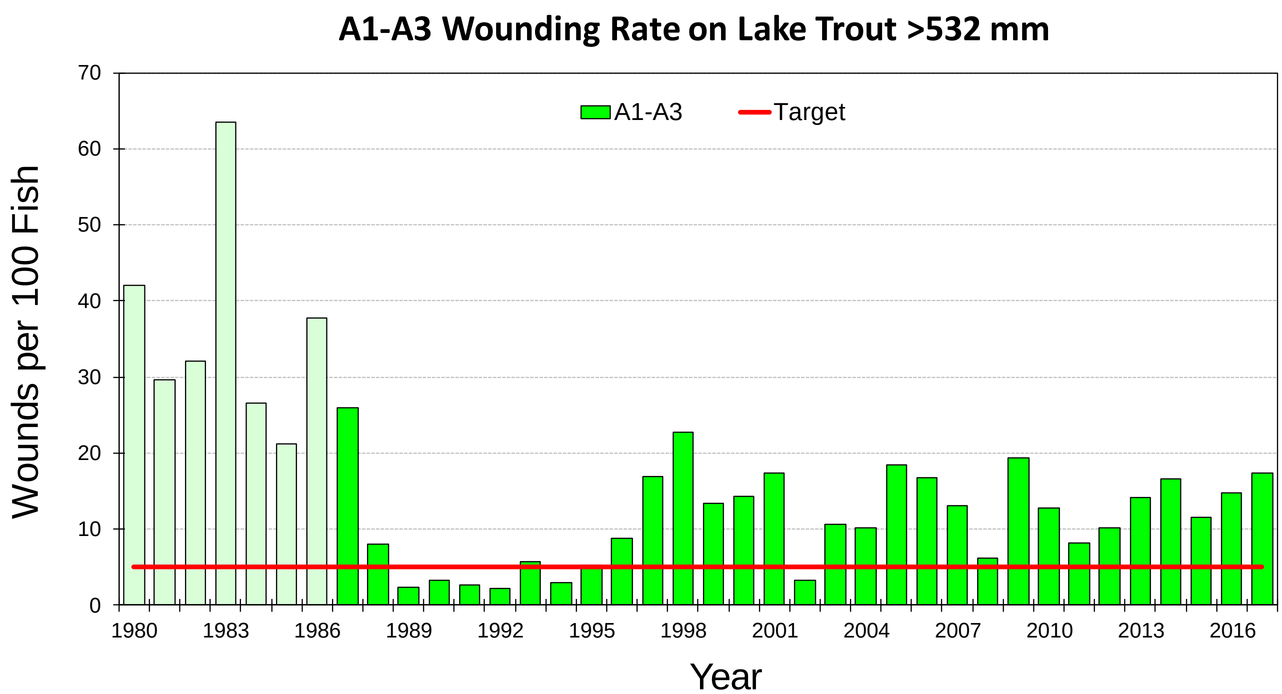

FIGURE 4.1. Number of fresh (A1-A3) Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2017. The target rate is 5.0 wounds per 100 fish. Lighter shading indicates pre-treatment years.

TABLE 4.1. Frequency of Sea Lamprey wounds observed on several standard length groups of Lake Trout collected from assessment gill nets in the eastern basin of Lake Erie, August 2017.

Size Class Total Length (mm)	Sample Size	Wound Classification				No. A1-A3 Wounds Per 100 Fish	No. A4 Wounds Per 100 Fish
		A1	A2	A3	A4		
432-532	10	0	0	0	0	0.0	0.0
533-634	22	0	1	0	3	4.5	13.6
635-736	159	1	12	17	67	18.9	42.1
>736	241	1	15	26	201	17.4	83.4
>532	422	2	28	43	271	17.3	64.2

Finger Lakes (FL) and Lake Champlain (LC) strain Lake Trout were the most sampled strains in 2017, and they accounted for the majority of the fresh (A1-A3) and healed (A4) Sea Lamprey wounds (Table 4.2). A1-A3 wounding rates were similar between these two strains in 2017 while FL strain lake trout had a higher A4 wounding rate, due to their longer stocking history and older ages present in the population. Lake Superior Lake Trout strains (Klondike (KL), Apostle Island (AI)) have higher wounding rates than FL and LC strain Lake Trout, indicative of higher susceptibility of these strains to Sea Lamprey attacks.

TABLE 4.2. Frequency of Sea Lamprey wounds observed on Lake Trout greater than 532 mm (21 inches), by strain, collected from assessment gill nets in the eastern basin of Lake Erie, August 2017. AI=Apostle Island, FL=Finger Lakes, KL=Klondike, LC=Lake Champlain, LL=Lewis Lake, SI = Slate Island.

Lake Trout Strain	Sample Size	Wound Classification				No. A1-A3 Wounds Per 100 Fish	No. A4 Wounds Per 100 Fish
		A1	A2	A3	A4		
AI	1	0	1	0	2	100.0	200.0
FL	128	0	8	11	93	14.8	72.7
KL	8	1	0	2	6	37.5	75.0
LC	231	1	15	22	128	16.5	55.4

Burbot Wounding Rates

The Burbot population, once the most prevalent coldwater predator in the eastern basin of Lake Erie, has declined over 90% (in relative abundance) since 2004 (see Charge 3). Coincidentally, both A1-A3 and A4 wounding rates on Burbot have increased since 2004 in eastern basin waters of Lake Erie (Figure 4.2). In 2017, there were no fresh (A1-A3) or healed (A4) wounds on the 37 Burbot sampled greater than 532 mm (21 inches) during coldwater assessment gill netting.

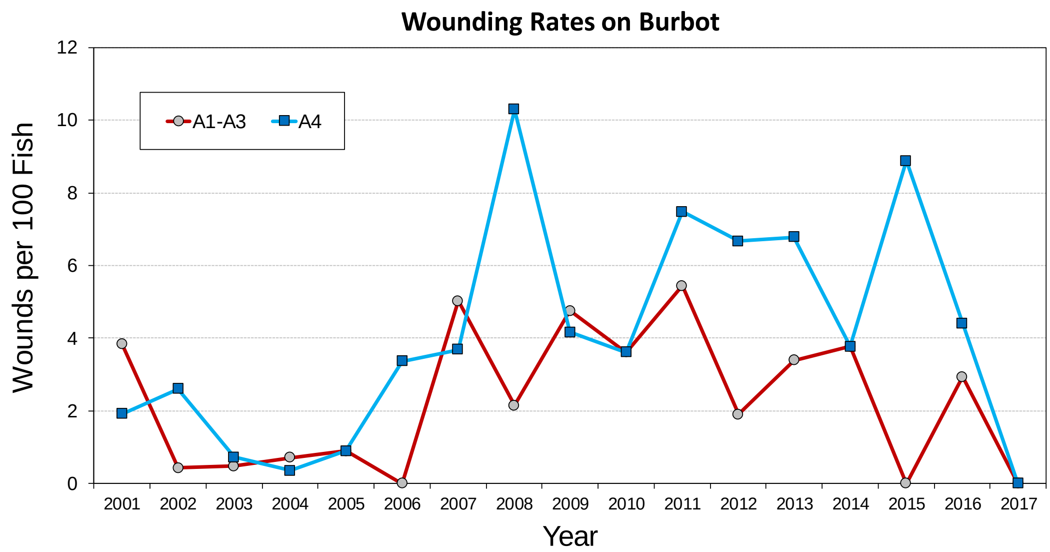

FIGURE 4.2. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Burbot greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2017.

Lake Whitefish Wounding Rates

Reliable counts of Sea Lamprey wounds on Lake Whitefish have only been recorded since 2001. Wounds on Lake Whitefish were first observed in 2003, coincident with depressed adult Lake Trout abundance (see Charge 1). A total of 83 Lake Whitefish greater than 532 mm (21 inches) were checked for evidence of Sea Lamprey attacks in 2017 assessment netting; none of these fish had A1-A3 wounds while 6 had A4 wounds (7.2 wounds/100 fish) (Figure 4.3). Wounding rates on Lake Whitefish have generally remained consistent over the previous six years with the exception of 2015 when only two fish were caught.

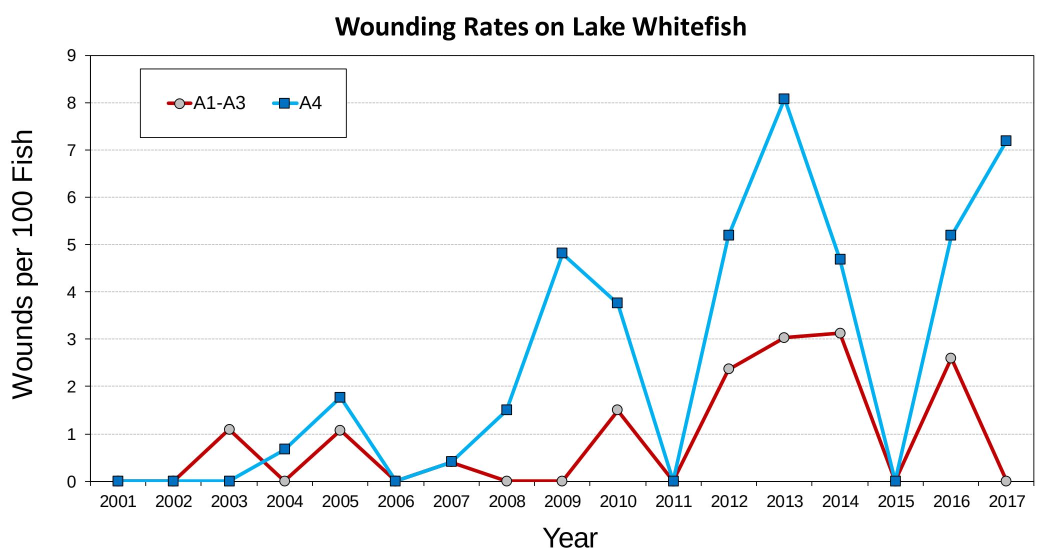

FIGURE 4.3. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Lake Whitefish greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2017.

Steelhead Wounding Rates

Similar to Burbot and Lake Whitefish, Sea Lamprey attacks on Steelhead have not been consistently recorded in Lake Erie until recently. Unlike other coldwater species, Steelhead are infrequently caught during August coldwater gill net assessment surveys, and observations of wounding must be derived from other sample collections such as tributary creel surveys, research projects, or disease surveillance collections (Table 4.3). Wounding rates on these surveys vary. In 2010, Pennsylvania began a more directed survey during their annual fall Steelhead run on Godfrey Run to address this data gap. Wounding data from this series indicates a declining trend in both fresh (A1-A3) and healed (A4+B type) through 2015, but an increase in 2016 (Figure 4.4). Wounding statistics on Steelhead were also recorded in 2017-18 during a research project being conducted on Chautauqua Creek, NY. Total wounding rates (A1-A4 + B wounds) on Steelhead from these surveys were 7.0 wounds/100 fish with the majority of the wounds (9 of 12; 75%) being A4 wounds.

TABLE 4.3. Frequency of Sea Lamprey wounds observed on Steelhead from various Lake Erie tributary surveys, 2003-2017.

Survey	State	Sample Size	Total # Wounds	A1-A3 Wounding Rate (%)	Total Wounding Rate (%)	Comments
2003-04 Tributary Creel Survey	NY	249	31	N/A	12.5	All wounds combined
2004-05 Tributary Creel Survey	NY	89	15	N/A	16.9	All wounds combined
2007-08 Tributary Creel Survey	NY	88	12	N/A	13.6	All wounds combined
2008-09 Tributary Creel Survey	OH	418	30	3.1	7.2	13 A1-A3; 17 A4
Fall 2009 Cattaraugus Creek	NY	50	15	8.0	30.0	4 A1-A3; 11 A4
Fall 2009 Chautauqua Creek	NY	50	20	14.0	40.0	7 A1-A3; 13 A4
2009-10 Tributary Creel Survey	OH	108	11	6.5	10.2	7 A1-A3; 4 A4
Spring 2010 Cattaraugus Creek	NY	50	9	8.0	18.0	4 A1-A3; 5 A4
Fall 2010 Directed Wounding Survey	PA	143	27	2.8	18.9	4 A1-A3; 5 A4; 18 B1-B4
Fall 2011 Directed Wounding Survey	PA	150	27	6.0	18.0	9 A1-A3; 2 A4; 16 B1-B4
2011-12 Tributary Creel Survey	NY	130	14	6.9	10.8	9 A1-A3; 5 A4
Fall 2012 Catt/Chautauqua Creek	NY	41	21	7.3	51.2	3 A1-A3; 11 A4; 7 B1-B4
Fall 2012 Directed Wounding Survey	PA	405	41	2.5	10.1	10 A1-A3; 9 A4; 22 B1-B4
Fall 2013 Directed Wounding Survey	PA	20	3	5.0	15.0	1 A1-A3; 1 A4; 1 B1-B4
Fall 2014 Directed Wounding Survey	PA	189	9	1.1	4.8	2 A1-A3; 2 A4; 5 B1-B4
2014-15 Tributary Creel Survey	NY	161	5	N/A	3.1	All wounds combined
Fall 2015 Directed Wounding Survey	PA	187	5	0.0	2.7	0 A1-A3; 1 A4; 4 B1-B4
Fall 2015 - Spring 2016 Chautauqua Creek	NY	191	21	1.6	11.0	3 A1-A3; 15 A4; 3 B1-B4
Fall 2016 Directed Wounding Survey	PA	125	17	4.0	13.6	5 A1-A3; 1 A4; 11 B1-B4
Fall 2016 - Spring 2017 Chautauqua Creek	NY	142	31	2.8	21.8	4 A1-A3; 24 A4; 3 B1-B4
Fall 2017 - Spring 2018 Chautauqua Creek	NY	172	12	1.7	7.0	3 A1-A3; 9 A4

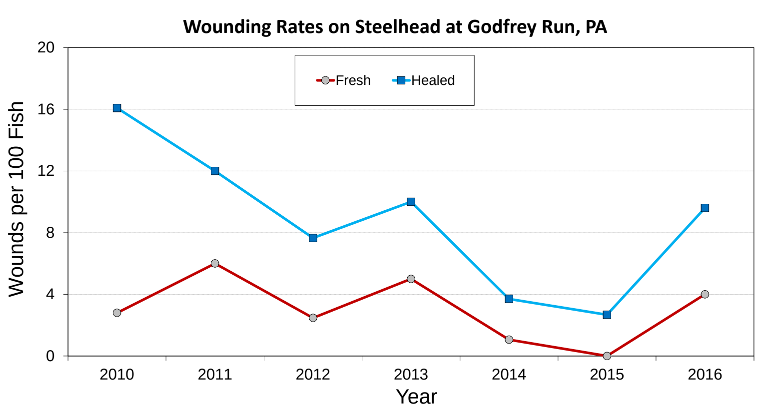

FIGURE 4.4. Number of fresh (A1-A3) and healed (A4+ B Type) Sea Lamprey wounds per 100 Steelhead sampled in Godfrey Run, PA, 2010-2016.

Ontario Partnership Program

The Ontario Partnership Index Fishing Program is an annual lake-wide gillnet survey of the Canadian waters of Lake Erie and provides an additional and spatially robust assessment of fish species abundance and distribution. Index gill nets were fished on bottom and suspended in the water column at 133 sites in 2017. Auxiliary gill nets (121 mm 50 meshes deep) were also fished suspended adjacent to index gear. Although Sea Lamprey wounds have been recorded on fish species since the survey began in 1989, detailed information on type and category of wound were not recorded until 2011.

A total of 12 Lake Trout (all sizes) were collected from index and auxiliary gear in 2017. No Lamprey wounds or scars were detected on Lake Trout. Similarly, no wounds or scars were detected on 71 Lake Whitefish, 13 Burbot, 7 Rainbow Trout or 4,784 Yellow Perch examined. Species with A1-3 wounds included Walleye (0.08 / 100 fish; N=3,890) and Smallmouth Bass (2.54 / 100 fish; N=118). A Common White Sucker had an A2 wound but the fraction of 338 White Suckers caught that were examined is unknown. The spatial distribution of fish with Sea Lamprey wounds and scars in 2017 is shown in Figure 4.5.

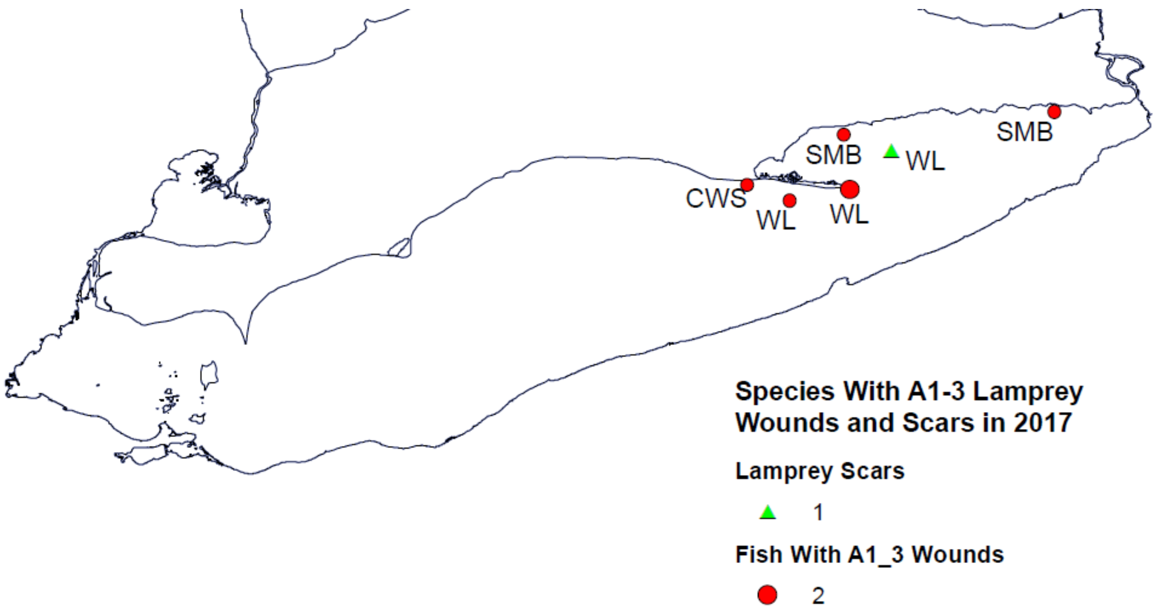

FIGURE 4.5. Number of fish with fresh (A1-A3; red circles) and B-type (green triangle) Sea Lamprey wounds during Lake Erie Partnership Index gill netting 2017. Includes index and auxiliary gear.

Summary of 2017 Actions and 2018 Plans for the Integrated Management of Sea Lampreys in Lake Erie

The Great Lakes Fishery Commission (Commission) and its control agents, the U.S. Fish and Wildlife Service (Service) and Department of Fisheries and Oceans, Canada (Department) continue to integrate the management of Sea Lamprey in Lake Erie including selection of streams for treatment, application of lampricides, implementation of alternative control methods such as low-head barriers and trapping to selected streams.

2017 Highlights

Lampricide Control

- Lampricide treatments were completed in three tributaries (one Canada, two U.S.).
- The Grand River (Ohio) was successfully treated after being deferred in 2016.
- Tributary #3 to Crooked Creek was treated to address a population of residual lampreys from the 2015 treatment.

Larval Assessment

- Larval assessments were conducted on 64 tributaries (27 Canada, 37 U.S.) and offshore of 2 U.S. tributaries.
- Surveys to detect new larval populations were conducted in 42 tributaries (18 Canada, 24 U.S.). A new Sea Lamprey population was discovered in the Huron River in Huron and Erie Counties, Ohio. The Huron River is scheduled for treatment in 2018.
- Post-treatment assessments were conducted in four tributaries (two Canada, two U.S.) to determine the effectiveness of treatments conducted during 2016 and 2017. Surveys indicated that all treatments were highly effective, precluding the need to consider re-treatment.
- Surveys to evaluate barrier effectiveness were conducted in two tributaries (one Canada, one U.S.). All barriers assessed were found to be effective in continuing to block Sea Lampreys.
- 2.6 ha of the St. Clair River was surveyed with granular Bayluscide (gB), including the upper river and the three main delta channels. Forty-nine Sea Lampreys were captured throughout the river with no additional areas of high density detected.
    - Larval assessment surveys were conducted in non-wadable lentic and lotic areas using 21 kg active ingredient of gB (8.96 Canada, 12.04 U.S.).

Juvenile Assessment

- Based on standardized fall assessment data, the marking rate during 2017 was 17.3 A1-A3 marks per 100 Lake Trout >532 mm, up from 14.8 in 2016. The five-year trend in marking rate is above target and steady.
- In cooperation with Walpole Island First Nation, the Commission and partners completed the third consecutive year of an annual index for out-migrating juvenile Sea Lampreys in the St. Clair River. Ten floating fyke nets were deployed on November 15, 2017. Due to complications surrounding U.S. Coast Guard aids to navigation and ice flow, the nets were retrieved on December 29, 2017. Over the collection period, 84 juvenile Sea Lampreys were captured.

Adult Assessment

- A total of 3,827 Sea Lampreys were trapped in 5 tributaries during 2017, all of which are index locations. Adult population estimates based on mark-recapture were obtained from each index location.

- The index of adult Sea Lamprey abundance was 14,743 (95% CI; 8,750 – 20,736), which was higher than the target of 3,039. The five-year trend in abundance is above target and steady (Figure 4.6).

- The adult Sea Lamprey migration was monitored in Cattaraugus Creek through a cooperative agreement with the Seneca Nation Tribe.

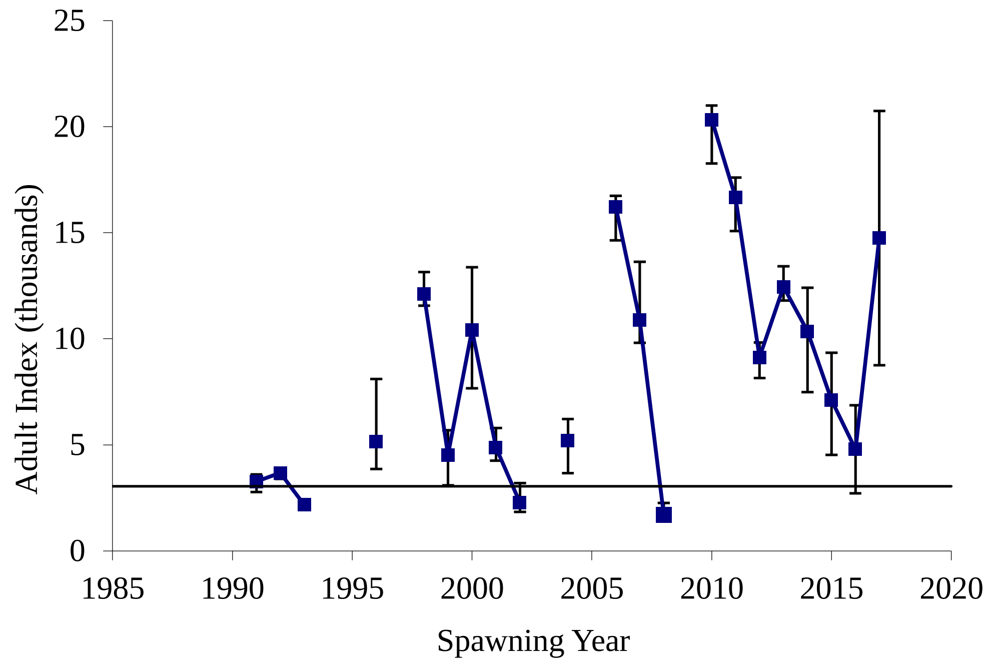

Figure 4.6. Index estimates with 95% confidence intervals (vertical bars) of adult Sea Lampreys. The adult index in 2017 was 14,743 with 95% confidence interval (8,750 – 20,736). The point estimate was above the target of 3,039 (horizontal line). The index target was estimated as the mean of indices during a period with acceptable marking rates (1991-1995).

Barriers

- Field crews visited one structure on tributaries to Lake Erie to assess Sea Lamprey blocking potential and to improve the information in the Barrier Inventory and Project Selection System (BIPSS) database.

- Routine maintenance, spring start-up, and safety inspections were performed on 11 barriers (7 Canada, 4 U.S.).

- Repairs or improvements were conducted on three Canadian barriers:

    - Big Otter Creek – Plans to rehabilitate the Black Bridge Dam on Big Otter Creek have been abandoned. The engineering consultant worked for detail design provided a Class A construction estimate that was more than twice the preliminary estimate, and the cost-benefit ratio relative to periodic treatment does not support rehabilitation of the dam.

    - Big Creek – Obermeyer Hydro Inc. has conducted a site visit to the Big Creek Barrier to evaluate the current operating system. A quote outlining their recommendations for upgrading the existing system to improve reliability was received.

- Little Otter Creek – Replacement of the existing sea lamprey trap to improve function and safety is underway at the Little Otter Creek barrier.

- Cattaraugus Creek **–** The United States Army Corps of Engineers (USACE), along with project partners Erie County and New York Department of Environmental Conservation (NYDEC) have approved the selected plan for the Springville Dam Ecosystem Restoration Project. The Project Partnership Agreement (PPA) was completed in July 2017 and upon receiving nonfederal funding from NYDEC the study team will move forward with the engineering and design phase of this project. The selected plan will lower the existing spillway from 38 to 13.5 feet to serve as a sea lamprey barrier. Requests from the National Historic Registry will be fulfilled by preserving a portion of the original spillway on both banks to show the original structure. A 15-foot wide rock riffle ramp with seasonal trapping and sorting operations is also included in the design. Construction is targeted for 2021 after the sea lamprey spawning run.

- Grand River – The USACE is the lead agency administering a project to construct a sea lamprey barrier to replace the deteriorated structure in the Grand River. Project partners include the Commission, Service, Ohio Department of Natural Resources, and Ashtabula County. The USACE has selected an onsite rebuild as the preferred alternative and has completed the detailed project report. The PPA is in review by the USACE and the allocation agreement between the Commission and Ashtabula County has been signed. Design considerations for the barrier include an 18-inch drop between crest height and tailwater elevations and tailwater velocities capable of preventing sea lamprey passage during flooding events. Barrier design is currently under review. A Value Added Engineering Workshop was completed in February 2017 and several cost saving measures were identified, including constructing the dam during one season. Construction is targeted for completion by the end of 2019.

- Consultation to ensure blockage at barriers was conducted with partner agencies for six sites in four streams during 2017 (Table 4.4).

Table 4.4. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Erie tributaries.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Position Rationale
Huron R.	-	FPPD[1]	Peninsular Paper Dam	Proposed	Upstream of blocking barrier
R. Raisin	S. Branch R. Raisin	Lenawee County Drain Commission	Tecumseh Dam	Concur	Upstream of blocking barrier
R. Raisin	-	City of Tecumseh	Standish Dam	Proposed	Negative stream
Euclid Cr.	-	US Army Corp of Engineers	East 185th Street Spillway	Pending	Decision forthcoming
Silver Cr.	-	CCSWCD[2]	Smiths Mills Reservoir Dam	Concur	Low chance of infestation
Silver Cr.	Walnut Creek trib.	CCSWCD[2]	Tupper Cr. culvert	Concur	Low chance of infestation

[1] Friends of Peninsular Park Dam
[2] Chautauqua County Soil and Water Conservation District

Risk Management

- The Risk Management Team participated with partner agencies and local community volunteers to conduct non-target surveys from Harpersfield Dam to Vrooman Road during the Grand River (Ohio) lampricide treatment.

- Toxicity tests were conducted (May 30 – June 8, 2017) to evaluate the toxicity of niclosamide to the Eastern pondmussel (*Ligumia nasuta*) and larval sea lampreys exposed to granular Baylucide. The work took place streamside in flow-through aquaria with St. Clair River (Michigan) water and sediment.

2018 Plans

Lampricide Control

- Lampricide treatments are planned for three tributaries; the Huron River and Conneaut Creek (U.S.) and in Silver Creek (Canada).

Larval Assessment

- Larval assessments are planned on 60 streams (40 U.S., 20 Canada).

- At least 2.4 ha of gB assessment is planned for the St. Clair River to estimate reach specific larval Sea Lamprey densities in preparation for potential future treatment.

Juvenile Assessment

- Assessment for out-migrating juvenile Sea Lampreys in the St. Clair River is planned for the fourth consecutive year by Walpole Island First Nation, in cooperation with the Commission and other partners.

Adult Assessment

- Adult assessment traps will be operated on five tributaries identified for inclusion in the adult Sea Lamprey index.

Barriers

- Conduct routine maintenance and operation of all Commission purpose built barriers in Lake Erie waters of the U.S. and Canada.

- Continue barrier design review and preparation for permitting and bid solicitation at the Harpersfield Dam on the Grand River (OH). Construction is targeted to begin in 2019.

- Big Creek – Upgrade the existing Obermeyer system to improve reliability in summer 2018.

- Forestville Creek – Rehabilitation of the access road is planned for 2018.

- Little Otter Creek – Replacement of the existing sea lamprey trap to improve function and safety is expected to be completed during in-water work period in 2018.

Risk Management

- The Risk Management Team will participate with partner agencies and local community volunteers to conduct non-target surveys in Ohio waters of Conneaut Creek during the spring lampricide treatment.

    - Tests will be conducted to determine the toxicity of niclosamide to the Eastern pondmussel and the round hickorynut (*Obovaria subrotunda*) following gB exposure. The work will take place streamside in flow-through aquaria with St. Clair River water and sediment and *in situ* in the St. Clair River (Michigan).

Research

- Ongoing pilot study by Chris Holbrook, USGS (*Feasibility of acoustic telemetry to describe the spatial distribution of adult Sea Lampreys in the Huron-Erie Corridor*) is designed to provide information needed to design future studies aimed at understanding the spatial and temporal dynamics of adult Sea Lamprey migration in the Huron-Erie Corridor.

- Ongoing project by Nick Johnson titled: Survival and Metamorphosis of Larval Sea Lampreys in Lake Erie Tributaries seeks to determine if survival and metamorphosis rates of larval Sea Lampreys in the St. Clair River differ from other major Sea Lamprey producing tributaries in Lake Erie, and those in lakes Michigan and Huron.

Charge 5: Maintain an annual interagency electronic database of Lake Erie salmonid stocking and current projections for the STC, GLFC and Lake Erie agency data depositories.

Chuck Murray (PFBC) and James Markham (NYSDEC)

Lake Trout Stocking

A total of 127,438 yearling lake trout were stocked in Lake Erie in 2017 (Figure 5.1). The USFWS stocked 76,456 yearling lake trout in the eastern basin waters of New York. In addition, the Ontario Ministry of Natural Resources and Forestry (OMNRF) stocked 50,982 yearlings at Nanticoke Shoal. All lake trout stocked in New York waters came from the USFWS Allegheny National Fish Hatchery located in Warren, PA, and were Lake Champlain strains. The yearlings stocked in Ontario waters were Slate Island strain lake trout. In addition to the yearlings, a total of 17,043 surplus fall fingerling lake trout (Seneca strain) were stocked at Nanticoke Shoal by the OMNRF. The combined yearling and fall fingerling yearling equivalents totaled 134,426 yearlings, which fell below the current Lake Trout stocking goal of 200,000 yearlings for first time in four years.

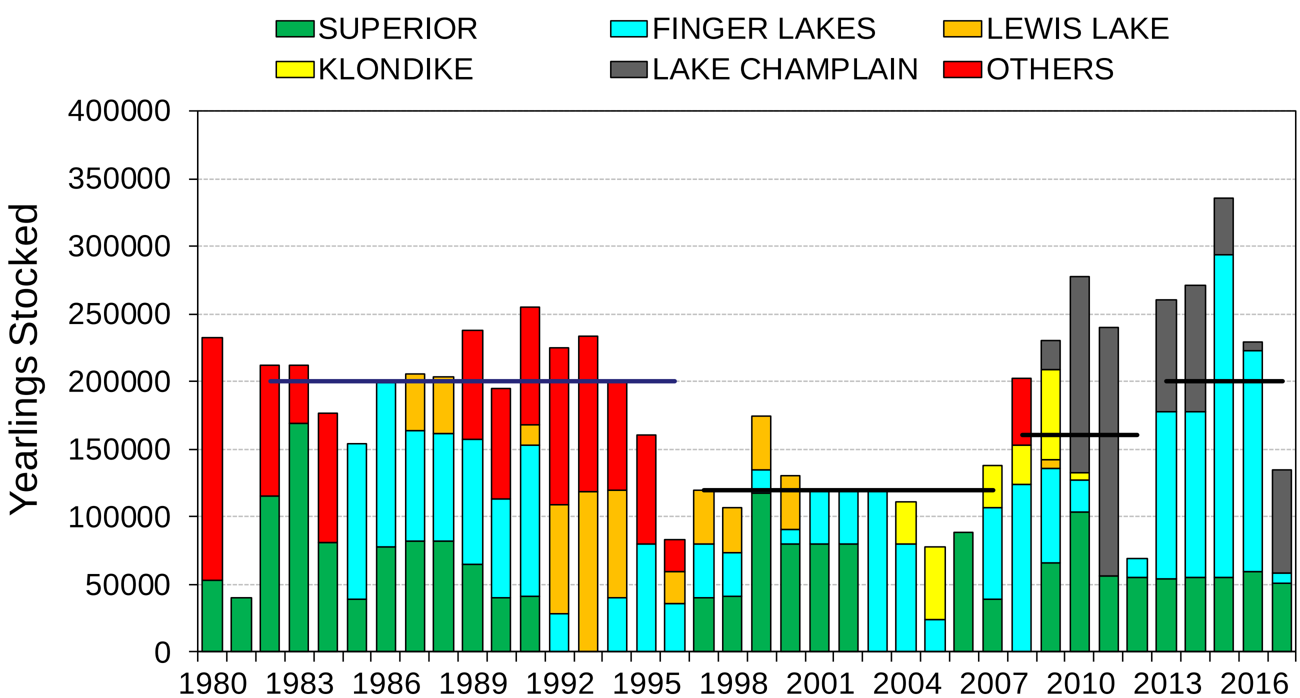

FIGURE 5.1. Lake Trout (in yearling equivalents) stocked by all jurisdictions in Lake Erie, 1980-2017, by strain. Stocking goals through time are shown by black lines dark lines; the current stocking goal is 200,000 yearlings per year. Superior includes Superior, Apostle Island, Traverse Island, Slate Island, and Michipicoten strains; Others include Clearwater Lake, Lake Ontario, Lake Erie, and Lake Manitou strains. 1 fall fingerling = 0.41 yearling equivalents.

Stocking of Other Salmonids

In 2017, over 2.1 million yearling trout were stocked in Lake Erie, including Rainbow/Steelhead Trout, Brown Trout and Lake Trout (Figure 5.2). Total 2017 salmonid stocking declined about 7% from 2016, and about 4% below the long-term average (1990-2016). Annual summaries for each species stocked within individual state and provincial areas are summarized in Table 5.1, and are standardized to yearling equivalents.

All of the US fisheries resource agencies and a few non-governmental organizations (NGO's) in Ontario and Pennsylvania currently stock Rainbow/Steelhead Trout in the Lake Erie watershed. A total of 1,862,271 yearling Rainbow/Steelhead Trout were stocked in 2017, accounting for 87% of all salmonids stocked. This was a 5%

decrease in Steelhead stocking from 2016 and less than 1% below the long-term (1990-2016) average of 1,853,558 yearling Steelhead. About 55% of all Steelhead stocking occurred in Pennsylvania waters, followed by 24% in Ohio waters, 14% in New York waters, 3% in Michigan waters and 3% in Ontario waters. Steelhead/Rainbow Trout stocking increased over 1,200% in Ontario waters, increasing from 4,324 yearling Rainbow Trout in 2016 to 59,750 in 2017. The Ontario fish are stocked by a volunteer NGO. The large increase was primarily due to the switch from stocking 80,000 fall fingerlings (2,824 yearling equivalents) in 2016 to stocking all yearlings in 2017. New York stockings decreased 34% from 2016. This was due to no stocking of surplus fish by the NYSDEC in 2017. The NYSDEC stocked 267,166 yearling steelhead which was about 5% above target stocking levels of 255,000 yearlings. Steelhead stocking increased 6% in Ohio and was 11% above a target objective of 400,000 yearling steelhead. Pennsylvania steelhead stocking declined 4% from 2016 but was 3% above a stocking objective of 1 million yearlings. Michigan steelhead stocking declined 8% from 2016 but was 1% above their stocking objective of 60,000 yearling steelhead. A full account of Rainbow/Steelhead Trout stocked in Lake Erie by jurisdiction for 2017 can be found under Charge 6 of this report, which also provides details about the locations and strains of Steelhead/Rainbow Trout stocked across Lake Erie.

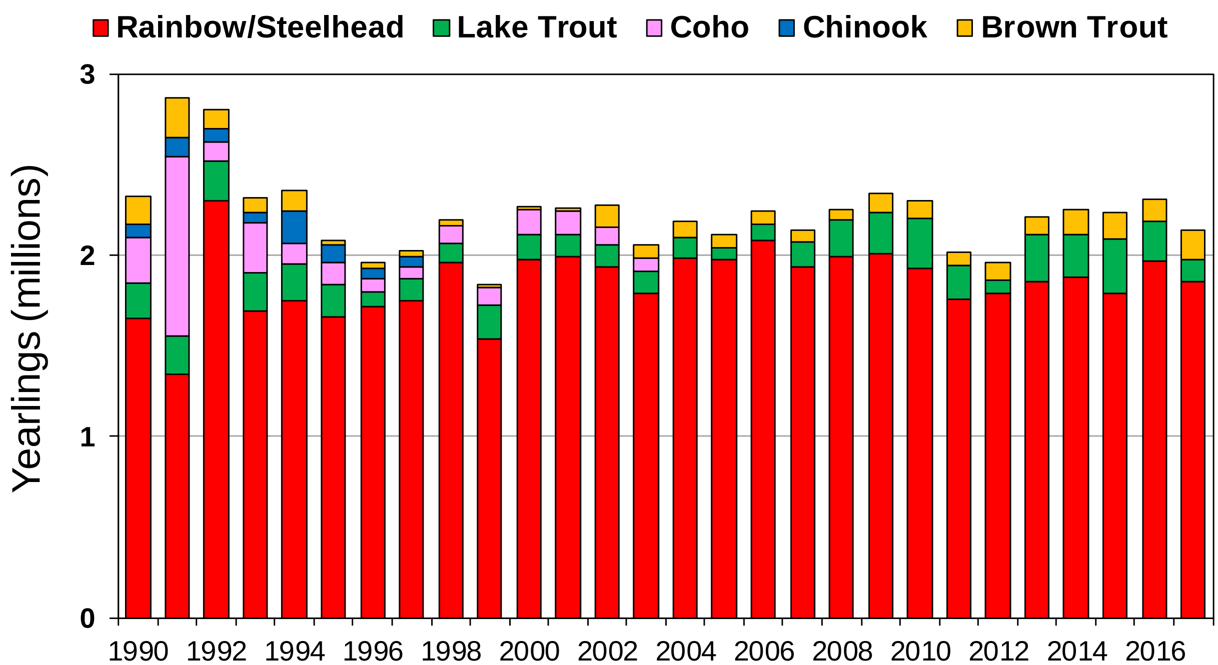

FIGURE 5.2. Annual stocking of all salmonid species (in yearling equivalents) in Lake Erie by all agencies, 1990-2017.

Brown Trout stocking in Lake Erie totaled 157,780 yearlings in 2017. This was a 30% increase from 2016 and 86% above the long-term (1990-2016) average annual stocking of 84,910 Brown Trout. The NYSDEC stocked 36,480 yearling Brown Trout in Dunkirk Harbor, Cattaraugus Creek, Barcelona Harbor and Eighteen Mile Creek. This will be the last stocking of Brown Trout in Lake Erie by the NYSDEC, which will be replacing these fish with a fall fingerling domestic strain rainbow trout.

Between 4 April and 17 May, about 31,700 adult brown trout were stocked by the PFBC and a few NGO hatcheries to provide catchable trout for the opening of the 2017 Pennsylvania trout season and an additional 600 adult Brown Trout were stocked in December in support of late season trout fishing. In a continued effort to provide a trophy brown trout program Pennsylvania NGO's hatcheries stocked about 70,000 yearling brown trout and the PFBC stocked about 19,000 yearling brown trout. These fish are in support of a put-grow-take Brown Trout program that was initiated in 2009. This program was implemented through the annual donation of 100,000 certified IPN-free eggs from the NYDEC. The PFBC has now developed a captive brood egg source for this program to decrease the reliance on New York brown trout eggs. Brown Trout stocking levels for catchable trout as well as the trophy program are expected to continue at the current rates in Pennsylvania.

TABLE 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1990-2017.

Year	Jurisdiction	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
1990	ONT.	--	--	--	--	31,530	31,530
	NYS DEC	113,730	5,730	65,170	48,320	160,500	393,450
	PFBC	82,000	249,810	5,670	55,670	889,470	1,282,620
	ODNR	--	--	--	--	485,310	485,310
	MDNR	--	--	--	51,090	85,290	136,380
	1990 Total	**195,730**	**255,540**	**70,840**	**155,080**	**1,652,100**	**2,329,290**
1991	ONT.	--	--	--	--	98,200	98,200
	NYS DEC	125,930	5,690	59,590	43,500	181,800	416,510
	PFBC	84,000	984,000	40,970	124,500	641,390	1,874,860
	ODNR	--	--	--	--	367,910	367,910
	MDNR	--	--	--	52,500	58,980	111,480
	1991 Total	**209,930**	**989,690**	**100,560**	**220,500**	**1,348,280**	**2,868,960**
1992	ONT.	--	--	--	--	89,160	89,160
	NYS DEC	108,900	4,670	56,750	46,600	149,050	365,970
	PFBC	115,700	98,950	15,890	61,560	1,485,760	1,777,860
	ODNR	--	--	--	--	561,600	561,600
	MDNR	--	--	--	--	14,500	14,500
	1992 Total	**224,600**	**103,620**	**72,640**	**108,160**	**2,300,070**	**2,809,090**
1993	ONT.	--	--	--	650	16,680	17,330
	NYS DEC	142,700	--	56,390	47,000	256,440	502,530
	PFBC	74,200	271,700	--	36,010	973,300	1,355,210
	ODNR	--	--	--	--	421,570	421,570
	MDNR	--	--	--	--	22,200	22,200
	1993 Total	**216,900**	**271,700**	**56,390**	**83,660**	**1,690,190**	**2,318,840**
1994	ONT.	--	--	--	--	69,200	69,200
	NYS DEC	120,000	--	56,750	--	251,660	428,410
	PFBC	80,000	112,900	128,000	112,460	1,240,200	1,673,560
	ODNR	--	--	--	--	165,520	165,520
	MDNR	--	--	--	--	25,300	25,300
	1994 Total	**200,000**	**112,900**	**184,750**	**112,460**	**1,751,880**	**2,361,990**
1995	ONT.	--	--	--	--	56,000	56,000
	NYS DEC	96,290	--	56,750	--	220,940	373,980
	PFBC	80,000	119,000	40,000	30,350	1,223,450	1,492,800
	ODNR	--	--	--	--	112,950	112,950
	MDNR	--	--	--	--	50,460	50,460
	1995 Total	**176,290**	**119,000**	**96,750**	**30,350**	**1,663,800**	**2,086,190**
1996	ONT.	--	--	--	--	38,900	38,900
	NYS DEC	46,900	--	56,750	--	318,900	422,550
	PFBC	37,000	72,000	--	38,850	1,091,750	1,239,600
	ODNR	--	--	--	--	205,350	205,350
	MDNR	--	--	--	--	59,200	59,200
	1996 Total	**83,900**	**72,000**	**56,750**	**38,850**	**1,714,100**	**1,965,600**
1997	ONT.	--	--	--	1,763	51,000	52,763
	NYS DEC	80,000	--	56,750	--	277,042	413,792
	PFBC	40,000	68,061	--	31,845	1,153,606	1,293,512
	ODNR	--	--	--	--	197,897	197,897
	MDNR	--	--	--	--	71,317	71,317
	1997 Total	**120,000**	**68,061**	**56,750**	**33,608**	**1,750,862**	**2,029,281**
1998	ONT.	--	--	--	--	61,000	61,000
	NYS DEC	106,900	--	--	--	299,610	406,510
	PFBC	--	100,000	--	28,030	1,271,651	1,399,681
	ODNR	--	--	--	--	266,383	266,383
	MDNR	--	--	--	--	60,030	60,030
	1998 Total	**106,900**	**100,000**	**0**	**28,030**	**1,958,674**	**2,193,604**
1999	ONT.			--		85,235	85,235
	NYS DEC	143,320		--		310,300	453,620
	PFBC	40,000	100,000	--	20,780	835,931	996,711
	ODNR			--		238,467	238,467
	MDNR			--		69,234	69,234
	1999 Total	**183,320**	**100,000**	**0**	**20,780**	**1,539,167**	**1,843,267**
2000	ONT.	--	--	--	--	10,787	10,787
	NYS DEC	92,200	--	--	--	298,330	390,530
	PFBC	40,000	137,204	--	17,163	1,237,870	1,432,237
	ODNR	--	--	--	--	375,022	375,022
	MDNR	--	--	--	--	60,000	60,000
	2000 Total	**132,200**	**137,204**	**0**	**17,163**	**1,982,009**	**2,268,576**
2001	ONT.	--	--	--	100	40,860	40,960
	NYS DEC	80,000	--	--	--	276,300	356,300
	PFBC	40,000	127,641	--	17,000	1,185,239	1,369,880
	ODNR	--	--	--	--	424,530	424,530
	MDNR	--	--	--	--	67,789	67,789
	2001 Total	**120,000**	**127,641**	**0**	**17,100**	**1,994,718**	**2,259,459**
2002	ONT.	--	--	--	4,000	66,275	70,275
	NYS DEC	80,000	--	--	72,300	257,200	409,500
	PFBC	40,000	100,289	--	40,675	1,145,131	1,326,095
	ODNR	--	--	--	--	411,601	411,601
	MDNR	--	--	--	--	60,000	60,000
	2002 Total	**120,000**	**100,289**	**0**	**116,975**	**1,940,207**	**2,277,471**

TABLE 5.1. (Continued) Summary of salmonid stockings in number of yearling equivalents, 1990-2017.

Year	Jurisdiction	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
2003	ONT.	--	--	--	7,000	48,672	55,672
	NYS DEC	120,000	--	--	44,813	253,750	418,563
	PFBC	--	69,912	--	22,921	866,789	959,622
	ODNR	--	--	--	--	544,280	544,280
	MDNR	--	--	--	--	79,592	79,592
	2003 Total	**120,000**	**69,912**	**0**	**74,734**	**1,793,083**	**2,057,729**
2004	ONT.	--	--	--	--	34,600	34,600
	NYS DEC	111,600	--	--	36,000	257,400	405,000
	PFBC	--	--	--	50,350	1,211,551	1,261,901
	ODNR	--	--	--	--	422,291	422,291
	MDNR	--	--	--	--	64,200	64,200
	2004 Total	**111,600**	**0**	**0**	**86,350**	**1,990,042**	**2,187,992**
2005	ONT.	--	--	--	--	55,000	55,000
	NYS DEC	62,545	--		37,440	275,000	374,985
	PFBC	--	--	--	35,483	1,183,246	1,218,729
	ODNR	--	--	--	--	402,827	402,827
	MDNR	--	--	--	--	60,900	60,900
	2005 Total	**62,545**	**0**	**0**	**72,923**	**1,976,973**	**2,112,441**
2006	ONT.	88,000	--	--	175	44,350	132,525
	NYS DEC		--	--	37,540	275,000	312,540
	PFBC	--	--	--	35,170	1,205,203	1,240,373
	ODNR	--	--	--	--	491,943	491,943
	MDNR	--	--	--	--	66,514	66,514
	2006 Total	**88,000**	**0**	**0**	**72,885**	**2,083,010**	**2,243,895**
2007	ONT.	--	--	--		27,700	27,700
	NYS DEC	137,637	--	--	37,900	272,630	448,167
	PFBC	--	--	--	27,715	1,122,996	1,150,711
	ODNR	--	--	--	--	453,413	453,413
	MDNR	--	--	--	--	60,500	60,500
	2007 Total	**137,637**	**0**	**0**	**65,615**	**1,937,239**	**2,140,491**
2008	ONT.	50,000	--	--	--	36,500	86,500
	NYS DEC	152,751	--	--	36,000	269,800	458,551
	PFBC		--	--	17,930	1,157,968	1,175,898
	ODNR		--	--		465,347	465,347
	MDNR		--	--		65,959	65,959
	2008 Total	**202,751**	**0**	**0**	**53,930**	**1,995,574**	**2,252,255**
2009	ONT.	50,000	--	--	--	18,610	68,610
	NYS DEC	173,342	--	--	38,452	276,720	488,514
	PFBC	6,500	--	--	64,249	1,186,825	1,257,574
	ODNR	--	--	--	--	458,823	458,823
	MDNR	--	--	--	--	70,376	70,376
	2009 Total	**229,842**	**0**	**0**	**102,701**	**2,011,354**	**2,343,897**
2010	ONT.	126,864	--	--		33,447	160,311
	NYS DEC	144,772	--	--	38,898	310,194	493,864
	PFBC	1,303	--	--	63,229	1,085,406	1,149,938
	ODNR	--	--	--		433,446	433,446
	MDNR	--	--	--		66,536	66,536
	2010 Total	**272,939**	**0**	**0**	**102,127**	**1,929,029**	**2,304,095**
2011	ONT.	--	--	--	--	36,730	36,730
	NYS DEC	184,259	--	--	38,363	305,780	528,401
	PFBC	--	--	--	36,045	1,091,793	1,127,838
	ODNR	--	--	--	--	265,469	265,469
	MDNR	--	--	--	--	61,445	61,445
	2011 Total	**184,259**	**0**	**0**	**74,408**	**1,761,217**	**2,019,883**
2012	ONT.	55,330	--	--	--	21,050	76,380
	NYS DEC	--	--	--	35,480	260,000	295,480
	PFBC	--	--	--	65,724	1,018,101	1,083,825
	ODNR	17,143	--	--	--	425,188	442,331
	MDNR	--	--	--	--	64,500	64,500
	2012 Total	**72,473**	**0**	**0**	**101,204**	**1,788,839**	**1,962,516**
2013	ONT.	54,240	--	--	--	2,000	56,240
	NYS DEC	41,200	--	--	32,630	260,000	333,830
	PFBC	82,400	--	--	71,486	1,072,410	1,226,296
	ODNR	82,200	--	--	--	455,678	537,878
	MDNR	--	--	--	--	62,400	62,400
	2013 Total	**260,040**	**0**	**0**	**104,116**	**1,852,488**	**2,216,644**
2014	ONT.	55,632	--	--		56,700	112,332
	NYS DEC	40,691	--	--	38,707	258,950	338,348
	PFBC	53,370	--	--	97,772	1,070,554	1,221,696
	ODNR	83,885	--	--		428,610	512,495
	MDNR	--	--	--		67,800	67,800
	2014 Total	**233,578**	**0**	**0**	**136,479**	**1,882,614**	**2,252,671**
2015	ONT.	55,370	--	--	--	70,250	125,620
	NYS DEC	81,867	--	--	37,840	153,923	273,630
	PFBC	82,149	--	--	103,173	1,079,019	1,264,341
	ODNR	85,433	--	--	--	421,740	507,173
	MDNR	--	--	--	--	64,735	64,735
	2015 Total	**304,819**	**0**	**0**	**141,013**	**1,789,667**	**2,235,499**
2016	ONT.	60,005	--	--	--	4,324	64,329
	NYS DEC	51,461	--	--	38,110	407,111	496,682
	PFBC	32,500	--	--	83,249	1,074,849	1,190,598
	ODNR	75,650	--	--	--	416,593	492,243
	MDNR	--	--	--	--	66,000	66,000
	2016 Total	**219,616**	**0**	**0**	**121,359**	**1,968,877**	**2,309,852**
2017	ONT.	57,970				59,750	117,720
	NYS DEC	76,456			36,480	267,166	380,102
	PFBC				121,300	1,032,421	1,153,721
	ODNR					442,228	442,228
	MDNR					60,706	60,706
	2017 Total	**134,426**	**0**	**0**	**157,780**	**1,862,271**	**2,154,477**

Charge 6. Report on the status of steelhead in Lake Erie, including stocking numbers, strains being stocked, academic and resource agency research interests, and related population parameters; Develop a proposal for mass marking, including lake wide and agency goals and objectives, a study plan, and logistics

Chuck Murray (PFBC) and James Markham (NYSDEC)

Stocking

All Lake Erie jurisdictions stocked steelhead or lake-run rainbow trout (hereafter steelhead) in 2017 (Table 6.1). Based on these efforts, a total of 1,857,271 yearling steelhead and 5,000 domestic strain rainbow trout were stocked in 2017, representing a 5% decrease from 2016 and near the long-term (1990-2016) average. Nearly all (99%) of the steelhead stocked in Lake Erie originated from West Coast strains naturalized to the Great Lakes. A Lake Erie strain accounted for 55% of the strain composition, followed by a Washington strain (14%), Manistee River strain (11%), Ganaraska River strain (7%), Chamber's Creek strain (7%) and less than 1% domestic strain.

TABLE 6.1. Steelhead stocking by jurisdiction and location for 2017.

Jurisdiction	Location	Strain	Number	Life Stage	Yearling Equivalents	
Michigan	Huron River	Manistee River, L. Michigan	60,706	Yearling	60,706	
					60,706	**Sub-Total**
Ontario	Mill Creek	Ganaraska River, L. Ontario / Wild	58,500	Yearlings	58,500	
	Wheatley Harbour	Ganaraska River, L. Ontario / Wild	1,250	Yearlings	1,250	
					59,750	**Sub-Total**
Pennsylvania	Bear Creek	Trout Run, L. Erie	12,000	Yearling	12,000	
	Conneaut Creek	Trout Run, L. Erie	75,000	Yearling	75,000	
	Crooked Creek	Trout Run, L. Erie	62,379	Yearling	62,379	
	Elk Creek	Trout Run, L. Erie	240,377	Yearling	240,377	
	Fourmile Creek	Trout Run, L. Erie	31,710	Yearling	31,710	
	Godfrey Run	Trout Run, L. Erie	18,514	Yearling	18,514	
	Lake Erie	Trout Run, L. Erie	70,000	Yearling	70,000	
	Presque Isle Bay	Trout Run, L. Erie	75,000	Yearling	75,000	
	Raccoon Creek	Trout Run, L. Erie	31,000	Yearling	31,000	
	Sevenmile Creek	Trout Run, L. Erie	29,340	Yearling	29,340	
	Sixteenmile Creek	Trout Run, L. Erie	17,820	Yearling	17,820	
	Trout Run	Trout Run, L. Erie	46,260	Yearling	46,260	
	Twelvemile Creek	Trout Run, L. Erie	31,410	Yearling	31,410	
	Twentymile Creek	Trout Run, L. Erie	106,895	Yearling	106,895	
	Walnut Creek	Trout Run, L. Erie	184,648	Yearling	184,648	
	West Basin Pond	Trout Run, L. Erie	68	Yearling	68	
					1,032,421	**Sub-Total**
Ohio	Ashtabula River	Manistee River/Chamber's Creek/Ganaraska River	41,940	Yearling	41,940	
	Chagrin River	Manistee River/Chamber's Creek/Ganaraska River	90,036	Yearling	90,036	
	Conneaut Creek	Manistee River/Chamber's Creek/Ganaraska River	75,092	Yearling	75,092	
	Grand River	Manistee River/Chamber's Creek/Ganaraska River	90,035	Yearling	90,035	
	Rocky River	Manistee River/Chamber's Creek/Ganaraska River	90,038	Yearling	90,038	
	Vermillion River	Manistee River/Chamber's Creek/Ganaraska River	55,087	Yearling	55,087	
					442,228	**Sub-Total**
New York	Buffalo River - Bison City Rod and Gun Club	Domestic	5,000	Yearling	5,000	
	Buffalo River - Bison City Rod and Gun Club	Washington	35,000	Yearling	35,000	
	Buffalo River - Net Pens	Washington	10,000	Yearling	10,000	
	Canadaway Creek	Washington	20,000	Yearling	20,000	
	Cattaraugus Creek	Washington	203,000	Fall Fingerling	7,166	
	Cattaraugus Creek	Washington	90,000	Yearling	90,000	
	Chautauqua Creek	Washington	40,000	Yearling	40,000	
	Eighteenmile Creek	Washington	40,000	Yearling	40,000	
	Silver Creek	Washington	10,000	Yearling	10,000	
	Walnut Creek	Washington	10,000	Yearling	10,000	
					267,166	**Sub-Total**
					1,862,271	**Grand Total**

State fisheries management agencies are responsible for 96% of all steelhead trout stocking effort in Lake Erie. Approximately 4% of the steelhead stocking is through sportsmen's organizations in Pennsylvania (72,086

yearlings) and Ontario (58,500 yearlings and 1,250 fingerlings). Fisheries agency stocking of spring yearlings took place between 21 February and 16 May, with smolts averaging about 180 mm in length (Table 6.2).

TABLE 6.2. Stocking summaries of yearling steelhead by fisheries agency for 2017.

Agency	Range of Dates Stocked	mean length (mm)	N of yearlings stocked
Michigan Dept. of Natural Resources	13 April - 14 April	194	60,706
New York Dept. of Environmental Conservation	12 April - 16 May	113	255,000
Ohio Division of Wildlife	24 April - 5 May	194	442,228
Pennsylvania Fish and Boat Commission	21 February - 3 April	190	950,353
		180	1,708,287

The NYSDEC staff tagged and marked several lots of juvenile steelhead using a combination of fin clips and coded-wire tags in 2015 and 2016 to evaluate size and location of stocking (Table 6.3). Fin clips included an adipose clip, a left ventral fin clip, coded-wire tag (CWT) only and a combination adipose / CWT marked fish. No steelhead were marked or tagged in 2017.

TABLE 6.3. Rainbow trout (steelhead) fin-clip summary for Lake Erie, 2000-2017.

Year Stocked	Year Class	Michigan	New York	Ontario	Ohio	Pennsylvania
2000	1999	RP	RV	LP	-	-
2001	2000	RP	AD	-	-	-
2002	2001	RP	AD-LV	-	-	-
2003	2002	RP	RV	LP	-	-
2004	2003	RP	-	LP	-	-
2005	2004	RP	AD-LP	RP	-	-
2006	2005	-	-	LP	-	-
2007	2006	-	AD-LP	-	-	-
2008	2007	-	AD-LP	-	-	-
2009	2008	RP	-	-	-	-
2010	2009	-	-	-	-	-
2011	2010	-	AD-LP	-	-	-
2012	2011	-	-	-	-	-
2013	2012	-	-	-	-	-
2014	2013	-	-	-	-	-
2015	2014	-	AD; LV; CWT; AD+CWT	-	-	-
2016	2015	-	AD; LV; CWT; AD+CWT	-	-	-
2017	2016	-	-	-	-	-

Clip abbreviations: AD=adipose; RP= right pectoral; RV=right ventral; LP=left pectoral; LV=left ventral; CWT=Coded Wire Tag.

NYSDEC Stocked Steelhead Emigration Study

Preliminary results of a research study to evaluate stocking size and stocking location on adult returns indicate that the majority (275 of 317; 87%) of the returning fish sampled in this stream were not stocked in Chautauqua Creek. However, it is not known if they originated from stocking by other Lake Erie jurisdictions, such as PA or OH, or another New York stocked tributary. Of the tagged adults sampled, initial results indicate that the best returns (28 of 42 fish; 67%) originated from the larger size group of fish stocked upstream. These results do not necessarily demonstrate that large fish stocked upstream experience improved survival relative to the groups stocked downstream. Other streams were not sampled to assess whether these study groups perhaps

strayed into non-study streams. These results may only indicate that upstream stocked fish exhibit improved homing to the stocked stream relative to fish stocked at downstream locations.

Mass Marking

Steelhead represent the major trout fishery on Lake Erie, accounting for 87% of all stocked salmonids. Additionally, more steelhead are stocked in Lake Erie than in any of the other Great Lakes. Recognizing the prominence of this fishery and the potential impact of stocking so many fish, the Lake Erie Committee has expressed an interest in knowing more about the influence of this species in the fish community and specifically their impact on the forage base. Managers are also interested in how their stocking efforts are performing and what can be done to improve tributary sport fisheries. During this reporting period, the CWTG was charged with developing a proposal for mass marking, including lake wide and agency goals and objectives, a study plan, and logistics.

Lake wide goals

A common goal among all jurisdictions is a better understanding of steelhead population dynamics, including total abundance, wild recruitment, survival, natural and fishing mortality, growth, maturation and life history. Several attempts have been made over the years to quantify steelhead abundance, but without key information such as survival and mortality estimates and some age-based population structure, a population model was difficult to develop.

Agency goals

Agencies share the same lake wide goals, but also want an opportunity to evaluate their respective steelhead programs to see if improvements can be made to maximize juvenile survival, reduce straying, increase adult returns, maximize the time span of the spawning runs, and generally improve their angling fisheries. Otolith microchemistry work on Lake Erie steelhead also suggests that there is also the potential to fine tune returns to specific areas of the streams in which they are stocked using sequential imprinting (Bohler et al., 2012). NYSDEC (Markham 2017)) and PFBC (CWTG 2016) have been evaluating stocking practices, including smolt size and release location in hope of increasing adult returns. All agencies are interested in determining optimal size to stock smolts. The range of currently stocked steelhead smolts will provide an excellent spectrum of relative survival based on size at stocking. This could be coupled by smaller size-at-stocking studies within a local watershed which may provide an opportunity for a finer scale evaluation of size related stocking success. There is also interest in describing behavior of the strains being stocked to see if they are performing as expected, based on seasonal contributions to the fishery, growth and longevity.

Study plan

A detailed mass marking plan will be developed by the CWTG to address the common objectives as well as the individual agency goals of the study. Crucial to success of the analysis is the collection of tags from adult steelhead. Availability, source and abundance of tags will vary by jurisdiction. Samples should be available through the summer boat and tributary fisheries, but fisheries independent sources of information will be needed as well. These samples can be collected through hatchery brood collections, fish used in disease screening, electrofishing or experimental netting. Tags will be taken from all sources, but some collections will need to be directed at specific lots of tagged fish or study locations dictated by the study design. Agency specific research related to tag recoveries could be coordinated internally to minimize costs.

Logistics

Mass marking using CWT technology has been widely used to mark pacific salmon on the great lakes since 2006 (Bronte et al., 2012). Current stocking objectives are about 1.875 million yearling steelhead smolts annually. Based on these combined target stocking levels, it would cost about $218,700 ($0.117/fish) to clip and tag all steelhead stocked in Lake Erie (C. Bronte, 2017).

Mass marking involves bringing the tagging trailers to each individual hatchery during a period when the fish are in the optimal size range for tagging and clipping in the machines. This would involve the Salmon River State Fish Hatchery in NY, the Castalia State Fish Hatchery in OH, the Wolf Lake State Fish Hatchery in MI, the Tionesta and Fairview Fish Culture Stations in PA, as well as several cooperative sportsman's hatcheries in

Pennsylvania and Ontario. Logistically, it should be a priority to clip and tag at the larger hatcheries, and transfer clipped/tagged fish to the smaller cooperative NGO hatcheries. Due to the size variability in hatchery steelhead fry, optimal tagging size would be when juvenile steelhead range in size from 62mm-142mm with a mean size of about 80mm in total length (James Webster, USFWS, personal communication). Tagging also assumes that each hatchery facility is equipped to handle the tagging trailer in terms of electrical and water needs, which may not be the case for every hatchery. Time spent at each hatchery will vary depending upon the number of fish that need to be tagged and clipped. If we assume that 50,000 fish can be tagged per day, then NY would require a maximum of 5 working days, PA 20 days, OH 8 days, and two days each for MI and ON.

Exploitation

While steelhead trout harvest by boat anglers represents only a fraction of the total estimated harvest, it remains the only annual estimate of steelhead harvest tabulated by most Lake Erie agencies. All agencies provide annual measurements of open lake summer harvest by boat anglers, whether by creel surveys or angler diary reports. These can provide some measure of the relative abundance of adult steelhead in Lake Erie.
The 2017 estimated steelhead harvest from the summer open-water boat angler fishery totaled 9,047 fish across all US agencies, about an 87% increase from 2016 (Table 6.4). The Ontario Ministry of Natural Resources and Forestry (OMNRF) has intermittently conducted open lake boat angler creel surveys, but no data was collected in 2017. Harvest increased in all US jurisdictions from 2016; Pennsylvania harvest increased 114%, Ohio harvest increased 90%, and New York harvest increased 14%. No steelhead harvest has been reported from Michigan waters since 2013. Among the US jurisdictions, about 47% of the reported harvest was concentrated in central basin waters of Ohio (34%) and Pennsylvania (13%). The west-central basin waters of Ohio accounted for 39% the harvest. The east basin accounted for 12% of the harvest, equally distributed between New York and Pennsylvania. Some harvest by open lake boat anglers was recorded in the western basin and accounted for about 2% of the total lake wide harvest.

TABLE 6.4. Estimated harvest by open lake boat anglers in Lake Erie, 1999-2017.

Year	Ohio	Pennsylvania	New York	Ontario	Michigan	Total
1999	20,396	7,401	1,000	13,000	100	41,897
2000	33,524	11,011	1,000	28,200	100	73,835
2001	29,243	7,053	940	15,900	3	53,139
2002	41,357	5,229	1,600	75,000	70	123,256
2003	21,571	1,717	400	N/A*	15	23,703
2004	10,092	2,657	896	18,148	0	31,793
2005	10,364	2,183	594	N/A*	19	13,160
2006	5,343	2,044	354	N/A*	0	7,741
2007	19,216	4,936	1,465	N/A*	68	25,685
2008	3,656	1,089	647	N/A*	39	5,431
2009	7,662	857	96	N/A*	150	8,765
2010	3,911	5,155	109	N/A*	3	9,178
2011	2,996	1,389	92	N/A*	3	4,480
2012	6,865	2,917	374	N/A*	9	10,165
2013	3,337	1,375	482	N/A*	53	5,247
2014	3,516	2,552	419	4,165	0	10,652
2015	4,622	1,165	673	N/A*	0	6,460
2016	3,577	806	452	N/A*	0	4,835
2017	6,804	1,727	516	N/A*	0	9,047
mean	12,847	3,419	644	25,736	35	25,523

* no creel data collected by OMNRF in 2003, 2005-2013, 2015, 2016, 2017

A small amount of targeted effort for steelhead occurs in the open lake. While the catch rate statistics are based on a small numbers of interviews that limit the application of these results, the catch rates do provide some measure of the overall performance of the steelhead fishery. Compared to 2016, the 2017 steelhead catch rates increased considerably in Ohio and moderately in Pennsylvania, and both were above the combined agency long-term average of 0.13 steelhead/angler hr. Steelhead boat angler catch rates in 2017 were 0.28 steelhead caught per angler hour in Ohio waters, a 133% increase from 2016, and 0.16 steelhead caught per angler hour in Pennsylvania waters, a 33% increase from 2016. The combined catch rate for 2017 (0.22 steelhead/angler hr.) was about 70% above the long-term average of 0.13 steelhead caught/angler hr. (Figure 6.1)

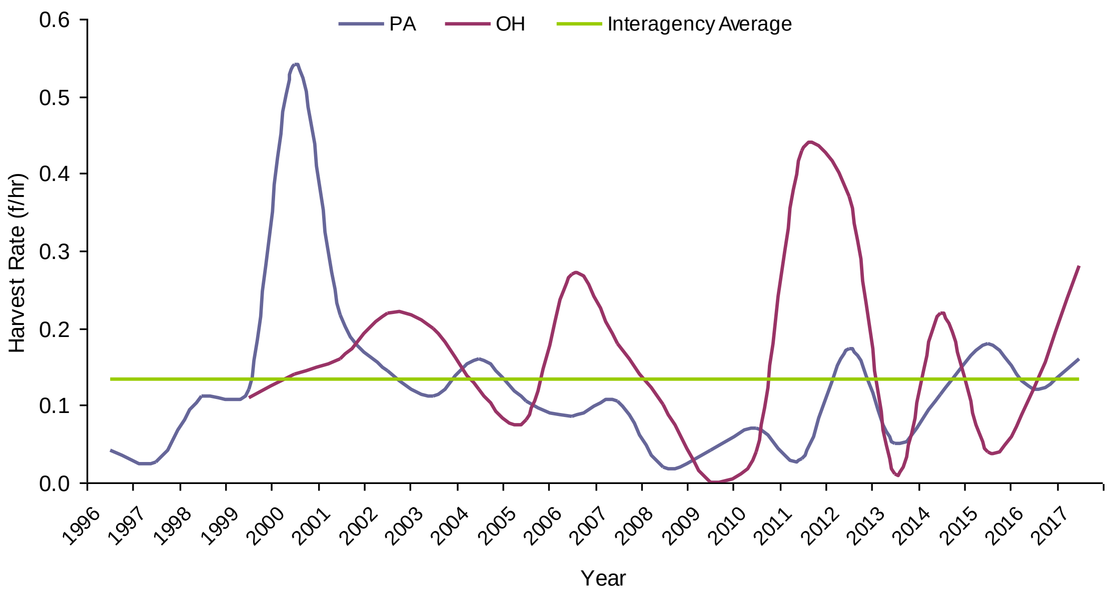

FIGURE 6.1. Targeted steelhead catch rates (fish caught/angler hr.) in Lake Erie by open lake boat anglers in Ohio and Pennsylvania 1996-2017.

The OMNRF collected open water angler diary reports that can detail trends over time by area of the lake. In 2017, diarists reported 65 targeted steelhead (rainbow trout) angler trips in west-central basin and 65 targeted trips in the east-central basin waters of Lake Erie. Fourteen trips targeting steelhead was recorded through the diary program in the east basin for 2016. West-central basin waters angler diary reports show that rod-hours for steelhead in 2017 declined 27% from 2016 and were 27% below the 27-year (1990-2016) mean of 2,634 hours (Figure 6.2). The 2017 steelhead catch rates in the west central basin (0.167 fish per rod-hour) represented a 24% decline from 2016, but were 14% higher than the long-term average of 0.146 steelhead/rod-hr. The 1,291 rod-hours of effort recorded by anglers fishing the east-central basin for steelhead in 2017 was a 130% increase from 2016 but 5% below the 27-year average of 1,353 rod-hours (Figure 6.3). The 2017 catch rate of 0.074 f/rod-hr dropped nearly 13% from 2016 but remained near the long-term average of 0.072 steelhead/rod-hr.

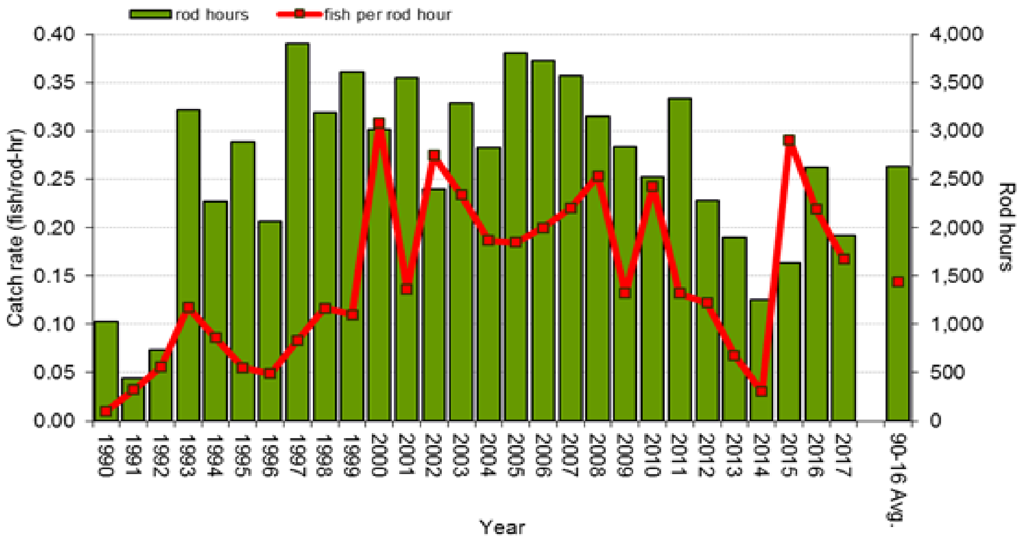

FIGURE 6.2. Targeted steelhead effort and catch rates in Lake Erie's west-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2017.

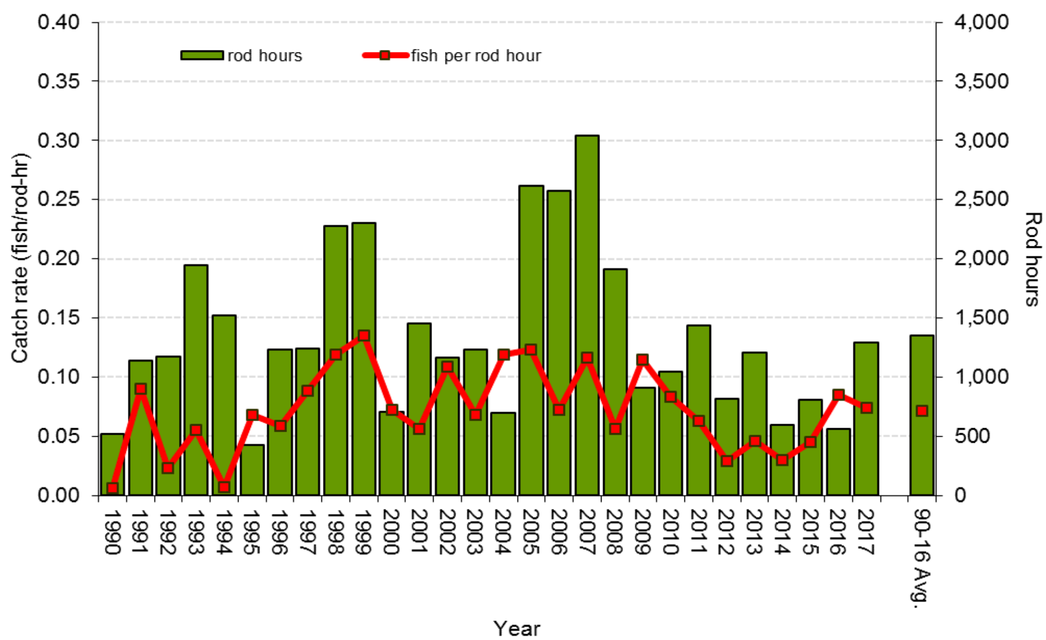

FIGURE 6.3. Targeted steelhead effort and catch rates in Lake Erie's east-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2017.

Tributary Angler Surveys

The Lake Erie tributaries are the focal point of the Steelhead fishery. Unfortunately, data on this segment of the sport fishery is fragmented, preventing a comprehensive review of annual trends in targeted effort and catch rate by stream anglers across all areas of Lake Erie.

The best measures of the Lake Erie Steelhead fishery are provided through comprehensive tributary angler surveys. Initial measures of the fishery were conducted in the 1980's and showed average steelhead catch rates

of 0.10 fish per angler hour (Figure 6.4). Beginning in 2003-04, the NYSDEC began conducting tributary angler surveys to monitor catch, effort, and harvest of the New York steelhead fishery. These surveys were initially conducted in consecutive years, and at 3-year intervals since then. Coincidentally, the PFBC conducted a similar survey on their steelhead fishery in 2003-04, and ODNR on theirs in 2008-09 and 2009-10. Results of these surveys showed high tributary catch rates that averaged 0.60 fish/angler hour in the mid-2000's, but then declined in more recent years to 0.35 fish/hour. The most recent NYSDEC angler survey conducted in 2014-15 found tributary steelhead catch rates of 0.32 fish/angler hour, which are still among the best catch rates for steelhead in the country.

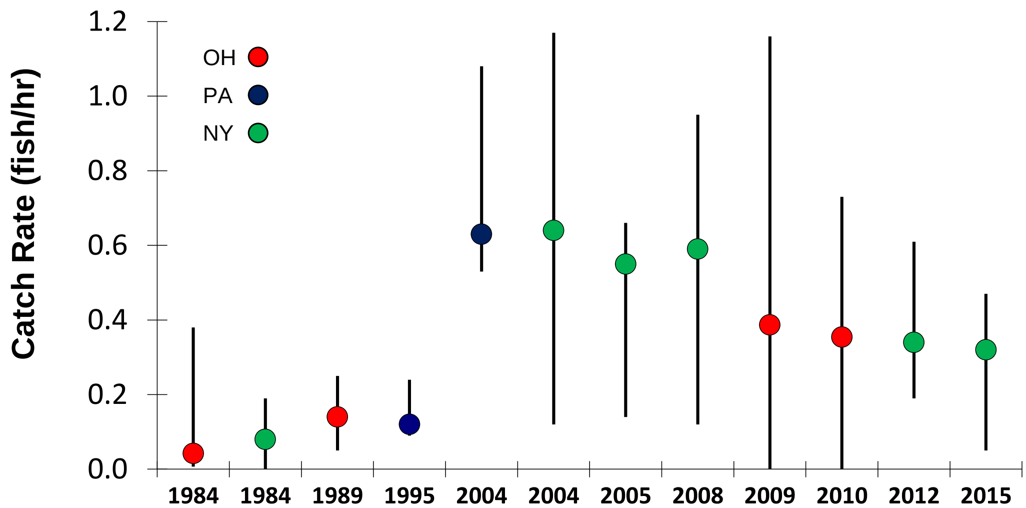

FIGURE 6.4. Targeted Steelhead catch rates (fish/angler hour) in Lake Erie tributary angler surveys by year and jurisdiction, 1984-2015.

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Charge 7: Report on the status of Cisco in Lake Erie. Finalize a Lake Erie Cisco Impediments document.

Tom MacDougall (OMNRF), ChrisVanDerGoot (USGS), Jim Markham (NYSDEC)

Status of Cisco.

Cisco (formerly Lake Herring; *Coregonus artedi*) is indigenous to the Great Lakes and historically supported one of the most productive fisheries in Lake Erie (Scott and Crossman 1973, Trautman 1981). The Coldwater Task Group has struggled with the charge of reporting on the status of Cisco in Lake Erie for over a decade. Although their status in the lake had generally been described as “extirpated”, the regular occurrence of small numbers of individuals, surrendered by the Ontario commercial fishing industry, precluded the task group from unreservedly accepting this description. The presence of a variety of size classes and ages (rough estimates using scales) suggested that reproduction was occurring somewhere. Early genetic analysis of a small number of samples from the 1990s reached a preliminary conclusion that these fish were most similar, to historic Lake Erie *C. artedi* from the turn of the previous century (and next most similar to contemporary Lake Huron samples).

It was recognized that relative abundance could not be assessed from fishery reports as they represent the passive submission of bycatch by the small number of fishers who recognize their importance. Efforts to target the species were hit and miss. In the early 1990s, an OMNRF-OCFA partnership with the Ontario Commercial Fishers Association (OCFA) to test an experimental selective trawl gear focused to reduce bycatch resulted in nine Cisco specimens near Long Point. In this successful example, effort occurred at the location where most subsequent Cisco samples were collected and fishing was conducted by commercial fishermen specifically attuned to bycatch. Targeting historical Cisco spawning locations was conducted with gillnets in the western basin during the falls of 2011, 2012, and 2014 by the USGS-Lake Erie Biological Station near Kelley’s Island, western basin reefs, and Vermilion, OH. No Ciscoes were caught even though expected habitat conditions and fish assemblages, from historical descriptions of Cisco spawning areas, were observed (CWTG 2013; Charge 7, page 5). In recent years, work by USGS continues to explore the suitability western basin islands and shoals for coregonine spawning.

It was eventually concluded that, seasonal fishery-independent community assessment and monitoring surveys, though extensive in the lake, lacked the intensity required for capturing rare species. Despite variable species identification skills and lack of incentive, the sheer magnitude of commercial small-mesh gillnet and bottom trawl fisheries seems to have favored commercial fisheries as the most frequent sources of Lake Erie Cisco.

Recognizing that the status could only be described as “rare”, previous reporting by the CWTG has focussed primarily on describing the demographics and spatial distribution of a small but growing archive of contemporary samples (CWTG 2016) surrendered by the fishery. Beginning in 2010, research and monitoring by USGS and USFWS identified larval and juvenile coregonines in the Saint Clair and Detroit Rivers, providing another source of samples for comparison and suggesting that the Huron-Erie-Corridor could be serving as a possible source for Cisco in Lake Erie. By 2016, OMNRF had archived enough adult samples from Lake Erie (47) to begin to ask questions about the origin contemporary Lake Erie Cisco. The archive was accessed for both morphological and genetic assessments.

Morphology and Meristics of Contemporary Lake Erie Cisco

As part of a larger effort to document Cisco populations throughout the Great Lakes Basin (Eshenroder et al., 2016), the Lake Erie archive of samples was examined and measured (N. Mandrak, U of T and E. Holm, ROM). Based on a detailed analysis of metrics, in particular gill raker lengths and counts, most of these 31 fish were found to be not of the expected Artedia or Albus morphotype, varieties historically described in Lake Erie. Instead, the majority (n=25) resembled “swarm” Cisco (a hybridized form of deep water Cisco prevalent in Lake Huron). Other morphotypes were assigned as: Artedia-like (n=2); Albus-like (n=2). Additional data made available by the OMNRF and Royal Ontario Museum, from nine samples collected in the 1990s, also revealed Artedi-like individuals (n=3), though most (n=6) were dissimilar. Regardless, based on morphometrics and meristics, Eshenroder et al. (2016) describe the historic Lake Erie Cisco forms of Artedi and Albus as being “so scarce in Lake Erie [as to be classified] as extirpated.”

Genetic Characterization of Contemporary Lake Erie Cisco

Tissue samples from the Lake Erie Cisco archive were used to assign individual fish to contemporary Great Lakes populations or historic Lake Erie Cisco populations. Preliminary work on a subset of samples in 2016 indicated that none of the fish assigned with confidence to any of the reference Cisco populations that had been identified to date (the other Great Lakes or to the historic Lake Erie samples from the 1920s). These findings, along with results from the morphometric examination, were used to inform the task group's Cisco Impediment Document (*see below*). Subsequent work was done to run additional samples, to enlarge the reference library of populations and to include other coregonine species including Cisco from Lake Erie in the 1950s. In 2017, it was determined that most of Lake Erie samples were actually bloater (*C. hoyi*); 20 of 27 samples originally field-identified as cisco were identified as bloater, two as cisco, one as lake whitefish (Stott et all, 2018). The bloater samples assigned to the Lake Huron reference population. The two Cisco samples assigned to a Lake Huron reference population (Drummond Island) rather than the Lake Erie 1950s reference. Additionally all nine juvenile coregonines collected from the Detroit and St. Clair rivers were identified as bloater; four samples from Lake Erie and one from the Livingston Channel could not be conclusively assigned to a species.

Impediments Document

In fulfillment of a charge to explore Cisco rehabilitation in Lake Erie, the CWTG submitted a document entitled "Impediments to the Rehabilitation of Cisco (Coregonus artedi) in Lake Erie" to the LEC in April of 2017. In addition to describing the history and ecology of Cisco in the lake, the document outlines potential benefits and detriments resulting from successful rehabilitation. The largest section outlines Impediments and Knowledge Gaps that create uncertainty for decision makers. The expectation is that this document will become available on the GLFC website in 2018.

Ongoing and Future work:

As many of the same samples were used in both the morphometric and genetic characterizations of contemporary fish, effort will be expended in 2018 to reconcile the assignments that resulted from the two techniques. It is anticipated that future research will address many of the knowledge gaps identified in the Impediments Document. Currently, a project being led by the USGS seeks to addresses questions about the spatial distribution of summer refugia for coldwater species in Lake Erie. This project aims to determine how well existing water quality data (e.g., LTLA data from the Forage Task Group and EPA's Central Basin Hypoxia Survey data) delineates habitat for cold water species including: Lake Trout, Lake Whitefish, Burbot, Rainbow Smelt, and the extirpated Cisco. Models primarily developed by P. Jacobson for Minnesota Lakes will be applied to limnological depth profiles to predict coldwater species habitats within Lake Erie.

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Charge 8: Prepare a report addressing the current state of knowledge of Lake Whitefish populations in Lake Erie, including knowledge gaps, impediments, uncertainties and recommendations for strategies to advise future management

Andy Cook, Megan Belore (OMNRF), Chris Vandergoot (USGS), John Deller (ODW)

Declines in Lake Whitefish abundance coupled with the growing need for Marine Stewardship Certification (MSC) for the commercial fishery, prompted the Lake Erie Committee to add Charge 8 to the list of CWTG charges in 2014-2015. In addition to general stock status metrics described in Charge 2, more quantitative metrics, biological reference points and broader indications of stock health have been incorporated in a draft version of the Charge 8 Report. The Coldwater Task Group has collaborated with members of other task groups to fulfill this charge in support of Lake Whitefish management. Collaboration continued with the Data Deficient Work Group (DDWG) on the development of Lake Whitefish management reference points and with research scientist Yingming Zhao predicting recruitment.

The statistical catch-at-age (SCAA) model for Lake Whitefish was updated with 2017 fishery and survey data to estimate abundance at age from 1994 to 2017 for ages 3 to 9 and older. The abundance estimate of 7 million Lake Whitefish in 2017 represented a dramatic increase from 2016 (466 thousand fish) (Figure 8.1). The primary cause of this increase was the recruitment of age 3 Whitefish in 2017 (2014 year class). The age 3 abundance estimate for 2017 was 6.7 million Whitefish. This was the second strongest recruitment estimated by the SCAA model over the 1994-2017 time series (Figure 8.2). The strongest recruitment estimated by the SCAA model was the 2003 cohort at 15.3 million fish in 2006. While the recruitment of the 2014 cohort represents a reversal in the decline of Lake Erie Whitefish, the recruitment estimate in the most recent year has the greatest amount of uncertainty. As more years of fishery and survey data accumulate, the strength of this cohort will be better defined. The ability to forecast abundance in future years is invaluable to fisheries management.

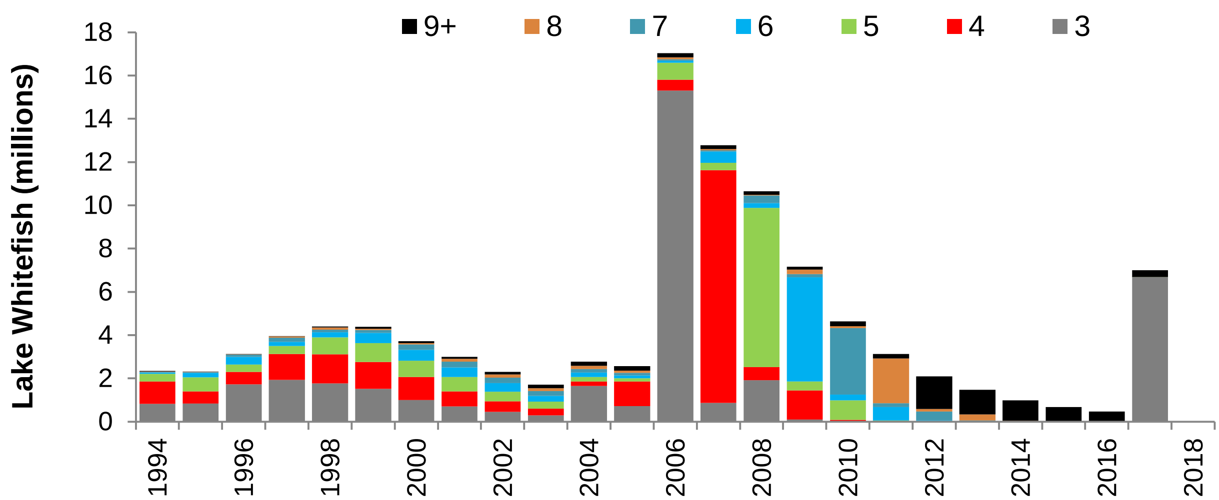

FIGURE 8.1**.** Statistical catch-at-age analysis (SCAA) population estimates for Lake Erie Lake Whitefish ages 3 to 9 and older,1994 - 2017.

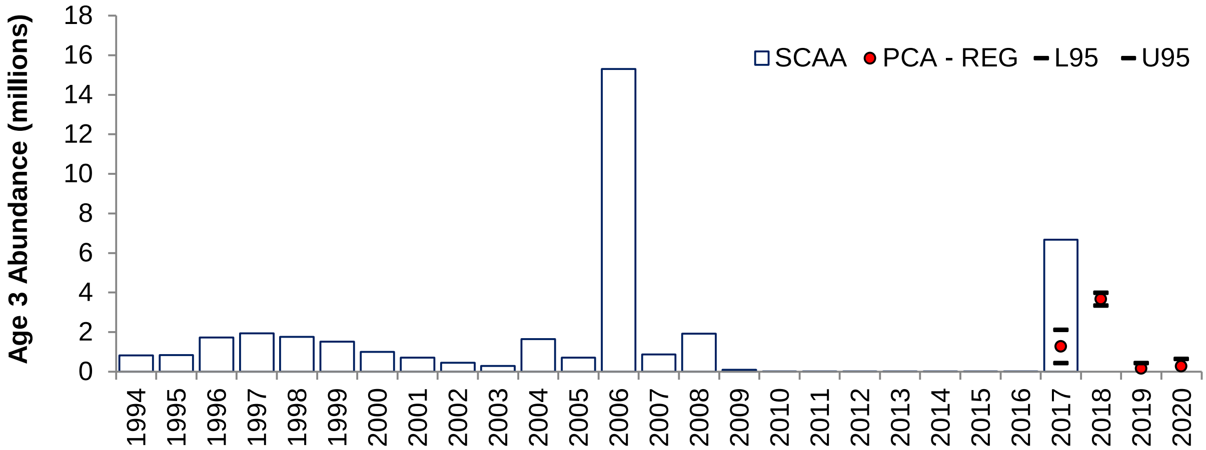

FIGURE 8.2. SCAA abundance estimates of age 3 Lake Whitefish (bars - 1994 – 2017) and recruitment predictions (dots with 95% confidence limits) from linear regression of SCAA age 3 abundance and PCA components P1 and P2 for the 2014, 2015, 2016, 2017 cohorts.

TABLE 8.1. SCAA age 3 abundance estimates for the 2014 cohort, PCA – regression predictions of age 3 abundance for 2014-2017 cohorts. Number of surveys used in each PCA, age groups present in Whitefish indices used for each PCA, cumulative variance explained by PCA components P1, P2 and regression coefficient of determination R^2 by cohort.

	Age 3 Abundance Estimates				Cumulative Variance		Regression
COHORT	SCAA	PCA	# SURVEYS	AGES	P1	P1, P2	R^2
2014	6,670,920	1,265,173	7	0,1,2	61%	89%	0.86
2015	N/A	3,658,455	9	0,1,2	65%	87%	0.99
2016	N/A	145,083	9	0,1	64%	86%	0.99
2017	N/A	272,302	5	0	64%	90%	0.97

Assessment of juvenile Lake Whitefish conducted by multiple Lake Erie jurisdictions provide insight about future recruitment to fisheries. These juvenile Lake Whitefish surveys provide measures of cohort strength with varying levels of agreement. Principal component analysis, or PCA, can be useful for consolidating recruitment surveys based on their correlations (Zhao unpublished).

Principle component analyses of 10 Lake Whitefish indices at ages 0, 1 and 2 described the strength of four cohorts in advance of recruitment to fisheries at age 3. Surveys included bottom trawl indices of ages 0 and 1 Lake Whitefish from Ohio's central basin waters (O-2+O-3) during June and October, Pennsylvania from May to November and New York during October. Gill net surveys in Ontario waters of central and eastern Lake Erie from August to November generated data for ages 0, 1 and 2 Lake Whitefish indices. Due to differences in time series length and missing years of data, PCA (SAS 9.4) was run four times to describe the magnitudes of the 2014, 2015, 2016 and 2017 cohorts using the maximum number of surveys possible for each year class.

Principle component analyses used from 5 to 9 surveys for analyses of cohorts 2014 to 2017 (Table 8.1). Variance explained by the first principle component P1 ranged from 61% to 65% for these four analyses. Addition of the second component P2 resulted in 86% to 90% of the variance explained. Linear regression of SCAA age 3 estimates and P1, P2 had good fits for all four analyses with coefficients of determination (R^2) ranging from 0.86 to 0.99.

The PCA – regression abundance estimate for the 2014 year class was 1.265 million age 3 Whitefish, considerably lower than the SCAA estimate of 6.670 million Whitefish (Table 8.1, Figure 8.2). PCA recruitment analyses predict the 2015 cohort (3.658 million) to be stronger than the 2014 year class (1.265 million). The 2016 and 2017 year classes were assessed as relatively weak, with age 3 abundance forecasts of 0.145 million and 0.272 million three-year-old Whitefish respectively. The status of Lake Whitefish is expected to improve in 2018, strengthened by the 2015 cohort.

Lake Whitefish have been implanted with acoustic transmitters and tagged with external Floy tags since 2015. This collaboration of USGS, ODNR, USFWS, OMNRF, GLFC, GLATOS and local partners seeks to describe Lake Whitefish movements during spawning and other seasons. From 2015 to 2017, Lake Whitefish were tagged near the Maumee River Ohio (10), on west basin spawning reefs in Ohio (50) and in Ontario waters (92) (Table 8.2). Since the project began, 10 tagged Lake Whitefish were caught by Ontario's commercial fishery. Lake Whitefish Movement is described from detections by acoustic receivers deployed throughout the Great Lakes. Preliminary results are presented in Figure 8.3 in which Lake Whitefish tagged at Maumee Bay and Little Chicken Island during 2015-2016 were later detected from April – June 2017. Most detections during spring, 2017 occurred in the central basin, primarily in U.S waters. Seasonal habitat use and population metrics such as mortality are expected to inform Lake Whitefish population models as more data accumulates in this study. Information about this project and other GLATOS projects is online: https://glatos.glos.us/.

TABLE 8.2. Number of Lake Whitefish tagged and recaptured from 2015 to 2017.

		Recaptured			
Year Tagged	# Tagged	2016	2017	Total	%
2015	10	0	1	1	10%
2016	37	3	0	3	8%
2017	105	0	6	6	6%
All	152	3	7	10	7%

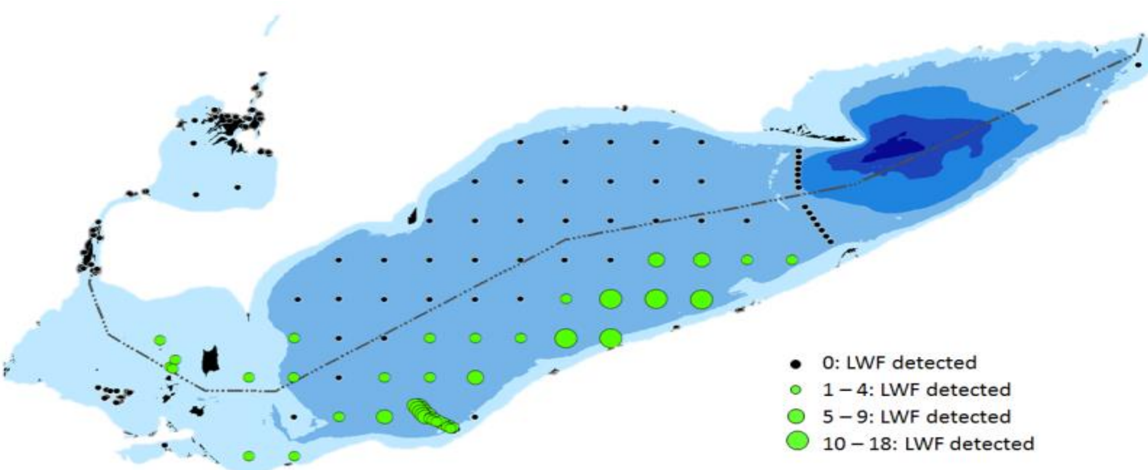

FIGURE 8.3. Acoustic detections of Lake Whitefish during April-June, 2017 (green dots) that were tagged from 2015-2016. Active receivers that did not detect tagged Whitefish are represented by black dots.

In order to meet Marine Stewardship Council (MSC) certification conditions for the large mesh gill net Walleye fishery of Lake Erie certified in 2015, a partial management strategy for Lake Whitefish is required by 2019. Lake Whitefish must remain within biologically based limits, otherwise measures are required to ensure that the large mesh gill net fishery does not hinder Lake Whitefish recovery or pose a risk of serious or irreversible harm.

The MSC Conformity Assessment Body (CAB) recognized progress made with Lake Whitefish assessment models reported by the CWTG and DDWG, low Whitefish quotas which reduced the incentive to target Lake Whitefish and efforts to reduce the harvest of migrating, spawning Lake Whitefish by permitting Walleye quota transfers out of western Lake Erie since 2016. Additional focus on developing biological reference points and management strategies for Lake Whitefish will continue in 2018.

Following completion of the Charge 8 report in 2018, elements of Charge 8 will be incorporated annually in CWTG Charge 2 to support Lake Whitefish management.

References

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