2016 REPORT OF THE LAKE ERIE COLDWATER TASK GROUP

24 March 2017

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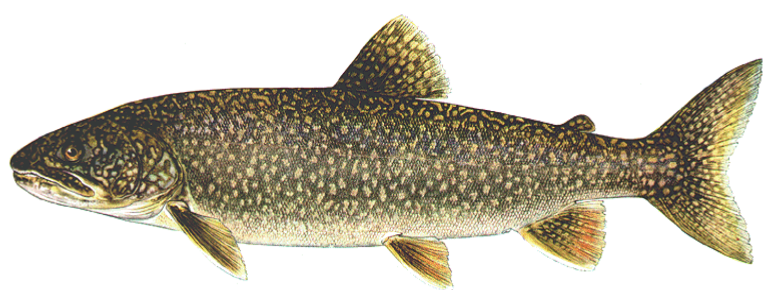
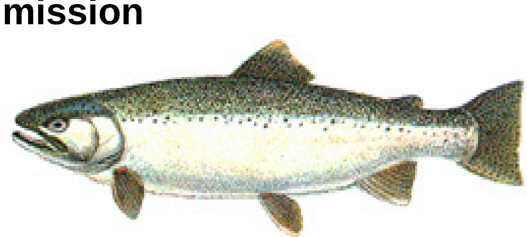


Presented to:

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. 2017. 2016 Report of the Lake Erie Coldwater Task Group, March 2017. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

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Reporting of 2016 – 2017 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 over the past year and evaluate progress towards the fish community goals and objectives for Lake Erie's coldwater fish community. A presentation of this progress occurs annually to the LEC at the annual meeting, held this year on 23-24 March 2017 in Ypsilanti, Michigan. 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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COLDWATER TASK GROUP EXECUTIVE SUMMARY REPORT MARCH 2017

Lake Erie Committee

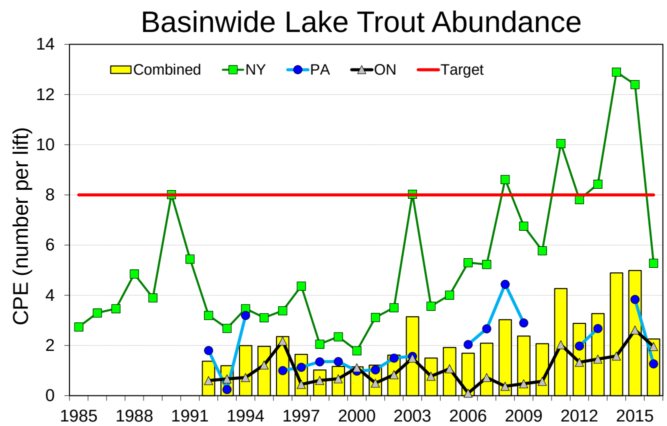
REPRESENTING THE FISHERY MANAGEMENT AGENCIES OF LAKE ERIE AND LAKE ST. CLAIR

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 2016-2017: (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.

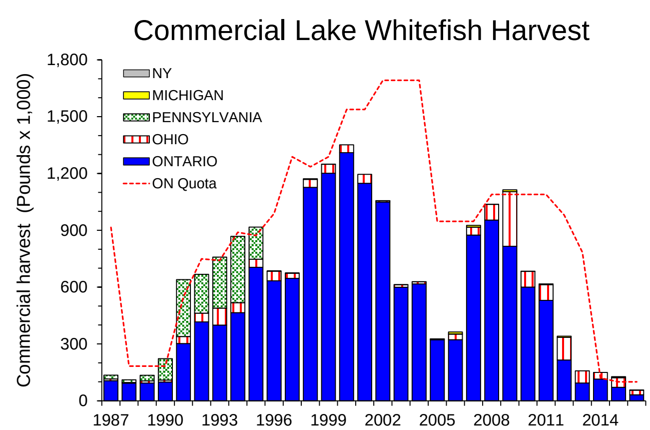
Lake Trout

A total of 385 Lake Trout were collected in 120 unbiased gill net lifts across the eastern basin of Lake Erie in 2016. Lake Trout catches declined sharply compared to the time-series highs in 2014 and 2015. Basin-wide Lake Trout abundance (weighted by area) declined 54% to 2.3 fish per lift and was remained below the rehabilitation target of 8.0 fish/lift. Lake Trout ages 4 and 6-8 were the dominate cohorts with Lake Trout ages 10 and older only sporadically caught. The adult (ages 5+) abundance index decreased in 2016 to 1.4 fish/lift and fell below the target of 2.0 fish per lift for the first time in the past 3 years. Klondike, 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.



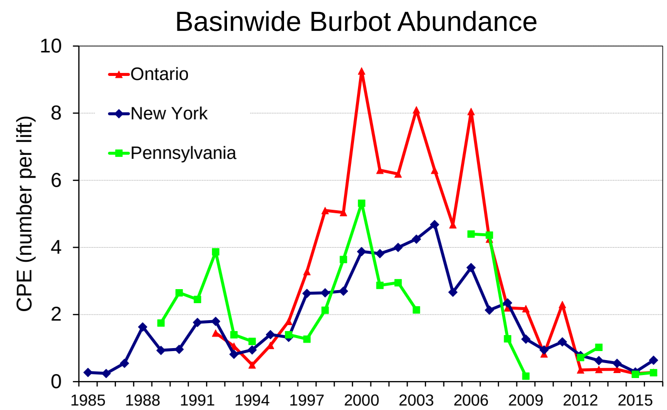
Lake Whitefish

Lake Whitefish harvest in 2016 was 55,951 pounds, distributed among Ontario (57%), Ohio (43%), Pennsylvania (<1%) and New York (<1%). Harvest in 2016 was the lowest observed since 1986. Gill net fishery age composition ranged from 2 to 18. The 2003 year class (age 13) comprised the largest fraction (58%) of the Lake Whitefish gill net fishery. Gill net surveys caught Lake Whitefish from age 1 to 27, with age 13 most abundant. Central and east basin bottom trawl surveys indicated the presence of some reproduction in both 2014 and 2015, but the magnitude of the cohorts and their influence on the declining Lake Whitefish population is uncertain. Conservative harvest is recommended until Lake Whitefish spawner biomass improves.



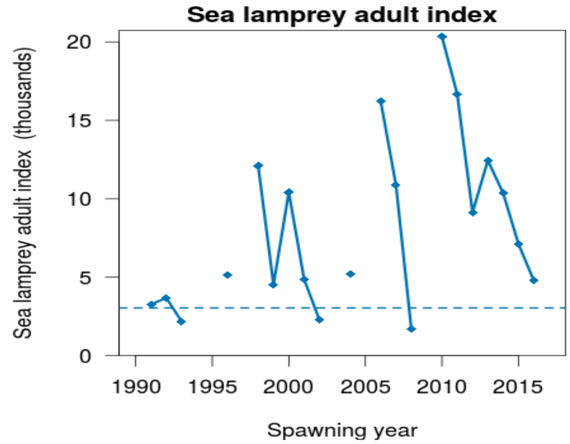
Burbot

Total commercial harvest of Burbot in Lake Erie during 2016 was 1,349 pounds (612 kg) of which 46% came from Ontario waters. Burbot abundance and biomass indices from annual coldwater gillnet assessments remained at low levels in all jurisdictions in 2016, continuing a downward trend since the early-2000s. Agency catch rates during 2016 averaged 0.39 Burbot per lift across all jurisdictions, which represented about a 95% decline in mean catch rates observed during 2000-2004. Burbot ranged in age from 3 to 24 years in 2016. Ongoing low catch rates of Burbot in assessment surveys, the majority (77%) of the population being age-10+, and persistently low recruitment signal continuing troubles for this population. Round Goby and Rainbow Smelt continue to be the dominant prey items in Burbot diets in eastern Lake Erie.



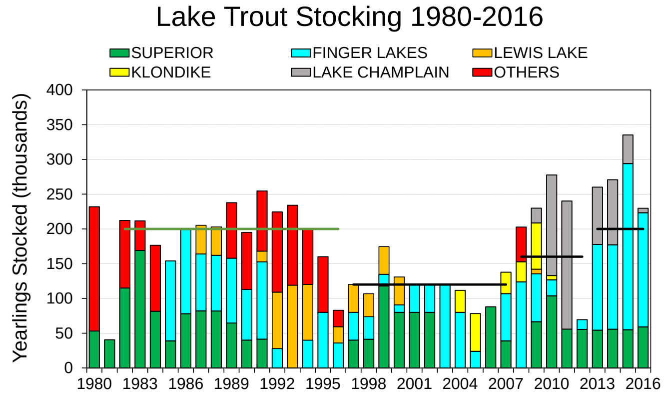
Sea Lamprey

The A1-A3 wounding rate on Lake Trout over 532 mm was 14.8 wounds per 100 fish in 2016. This was higher than the 10-year wounding rate (12.9 wounds/100 fish) and nearly 3 times the target rate of 5.0 wounds per 100 fish. Wounding rates have been above target for 20 of the past 21 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 (4,788) was lower than 2015 estimates and the third consecutive annual decline. However, it is still above the target population of 3,039. Comprehensive stream evaluations continued in 2016, including extensive surveys of Lake St. Clair and the Detroit River, to determine sources contributing to the Lake Erie population.



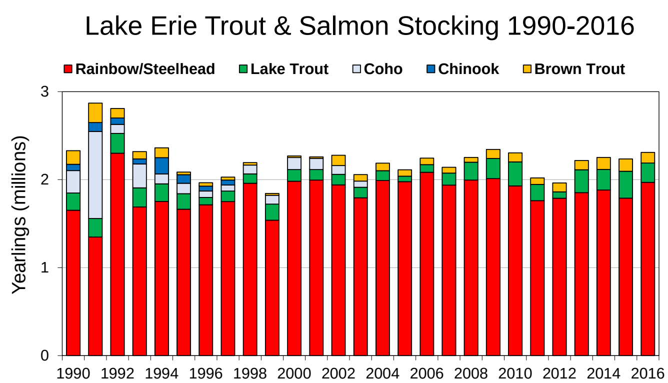
Lake Erie Salmonid Stocking

A total of 2,309,852 salmonids were stocked in Lake Erie in 2016. This was a 3% increase in the number of yearling salmonids stocked compared to 2015, and was 4% above the long-term average since 1990. Increases in stocking numbers were observed for Steelhead while Lake Trout stocking decreased but remained above targets for the fourth consecutive year. Brown Trout make up only 5% of all trout stockings, and the numbers stocked decreased 14% from 2015. By species, there were 219,616 yearling Lake Trout stocked in all three basins of Lake Erie, 121,359 Brown Trout stocked in New York and Pennsylvania waters, and 1,968,877 Steelhead/Rainbow Trout stocked across all five jurisdictional waters.



Steelhead

All agencies stocked yearling Steelhead in 2016. The summary of Steelhead stocking in Lake Erie by jurisdictional waters for 2016 is: Pennsylvania (1,074,849; 55%), Ohio (416,593; 21%), New York (407,111; 21%), Michigan (66,000; 3%) and Ontario (4,324; <1%). Total Steelhead stocking in 2016 (1.969 million) represented a 10% increase from 2015 and 7% above than 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 4,835 Steelhead across all US agencies in 2016, about a 25% decrease compared to 2015 estimates and lower than average harvest from 2008-15. Estimates of harvest were not available for Ontario in 2016. Overall open lake catch rates remain near the long-term average, but reported effort remains minimal. 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 2015.



Cisco

Cisco, considered extirpated in Lake Erie, have been reported in small numbers (1-7) in 19 of the past 22 years. Of the 47 observations since 1995, all but two were surrendered by commercial fishermen operating in Ontario waters. Three more cisco were reported in 2016, but not confirmed. None were captured in 2016 in assessment gear. The question that arises from these recent captures is whether these specimens represent a remnant stock or transients from Lake Huron. A study of the morphometrics and meristics of these contemporary samples was recently completed by Eshenroder et al. (2016) which concluded that 27 of the 31 samples examined were characterized as hybrids of deepwater forms typically found in Lake Huron, supporting the theory of downward migration via the St. Clair – Detroit River system. Further research on the genetic composition of these fish is underway and is expected to be completed in 2017, however preliminary results of these analyses also indicate that a remnant Lake Erie population of Cisco no longer exists. A technical document “Impediments to the Rehabilitation of Cisco (*Coregonus artedi*) in Lake Erie” is expected to be completed in 2017 and will help determine the future of restoration activities in Lake Erie.

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

James Markham (NYSDEC), Tom MacDougall, Andy Cook (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.

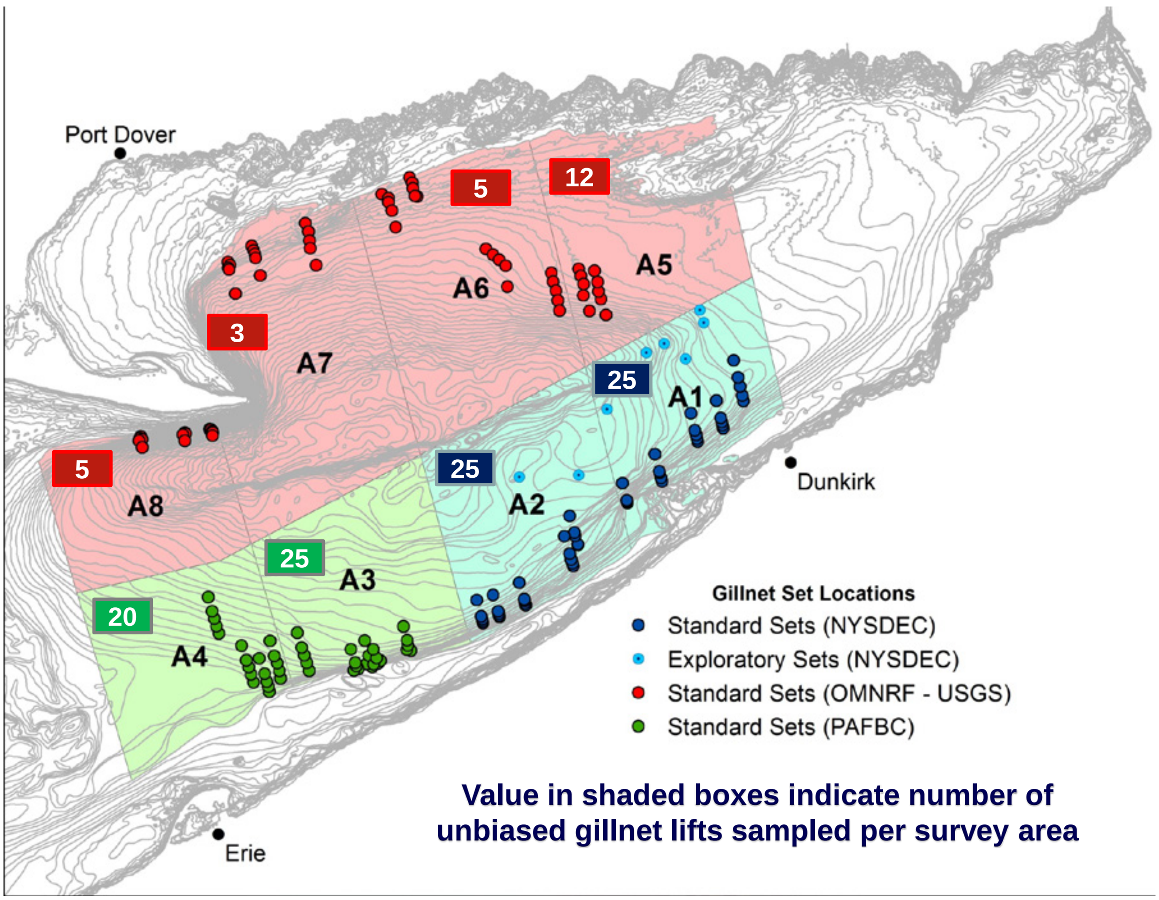


FIGURE 1.1. Standard sampling areas (A1-A8) used for assessment of Lake Trout in the eastern basin of Lake Erie, 2016. Colored circles represent the location of all nets set in each sampling area, and boxes indicate the number of unbiased gill net lifts per area.

Each area contains 13 equidistant north/south-oriented LOPs that serve as transects. Six transects are randomly selected for sampling in each area. A full complement of eastern basin effort should be 60 standard gill net lifts each for New York and Pennsylvania waters (two areas each) and 120 lifts from Ontario waters (four areas total). To date, this amount of effort has never been achieved. A1 and A2 have been the most consistently sampled areas across survey years while effort has varied in all other areas (Figure 1.2). Area A4 is infrequently sampled due to the lack of enough cold water to set gill nets according to the sampling protocol.

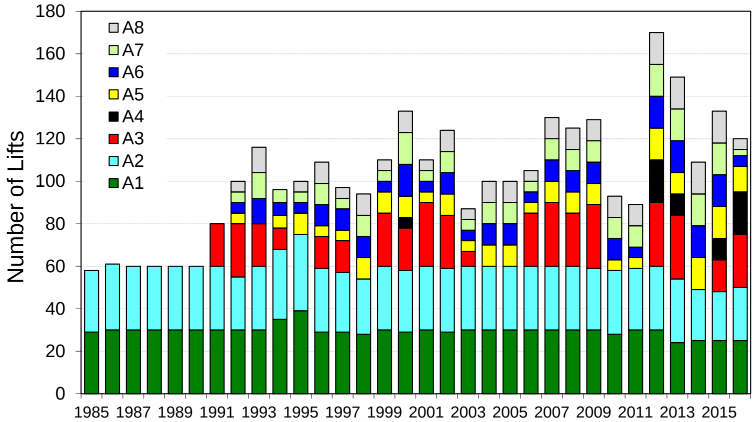


FIGURE 1.2. Number of unbiased coldwater assessment gill net lifts by area in the eastern basin of Lake Erie, 1985-2016.

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 2016 by the combined agencies was 120 unbiased standard Lake Trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 50 lifts by the NYSDEC, 45 by the PFBC, and 25 by USGS/OMNRF. NYSDEC moved 10 of their standard 60 lifts to new locations 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 2017).

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 2016 (Figure 1.1), collecting a total of 385 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 indicates a lack of movement away from the stocking area.

Lake Trout ranging from ages 1 to 32 were captured in 2016 and represented seventeen age-classes (Table 1.1). Adult cohorts ages 4 and 6-8 were the most abundant and represented 84% of the total catch in standard assessment nets (Figure 1.3). Cohort abundance begins to decline after age-5, and relatively low numbers of Lake Trout age-10+ were caught, comprising less than 4% of the overall catch. One fish from each of the 1984 and 1985 cohorts (ages 32 and 31, respectively) and were caught in 2016, representing the oldest Lake Trout sampled in Lake Erie assessment surveys.

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 2016.

A) Lean Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (grams)	PERCENT MATURE
1	Combined	3	260	149	0
2	Male	2	403	763	0
	Female	1	463	1080	0
3	Male	8	567	2344	100
	Female	3	559	2040	0
4	Male	47	640	3148	100
	Female	20	636	3194	27
5	Male	0	---	---	---
	Female	6	660	3376	100
6	Male	55	720	4719	100
	Female	46	709	4656	100
7	Male	55	742	5223	100
	Female	53	734	5211	100
8	Male	22	739	5156	100
	Female	12	761	5658	100
9	Male	18	789	5783	100
	Female	16	771	5627	100
10	Male	5	779	5518	100
	Female	3	797	6948	100
11	Male	0	---	---	---
	Female	1	845	7138	100
13	Male	2	802	6248	100
	Female	0	---	---	---
14	Male	4	835	7283	100
	Female	0	---	---	---
15	Male	3	840	7257	100
	Female	1	815	6276	100
26	Male	0	---	---	---
	Female	1	925	9060	100
31	Male	0	---	---	---
	Female	1	823	6664	---
32	Male	1	882	8444	100
	Female	0	---	---	---

B) Klondike Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (grams)	PERCENT MATURE
6	Male	1	650	3081	100
	Female	0	---	---	---
8	Male	12	688	4278	100
	Female	8	683	4254	100
9	Male	3	666	3953	100
	Female	0	---	---	---

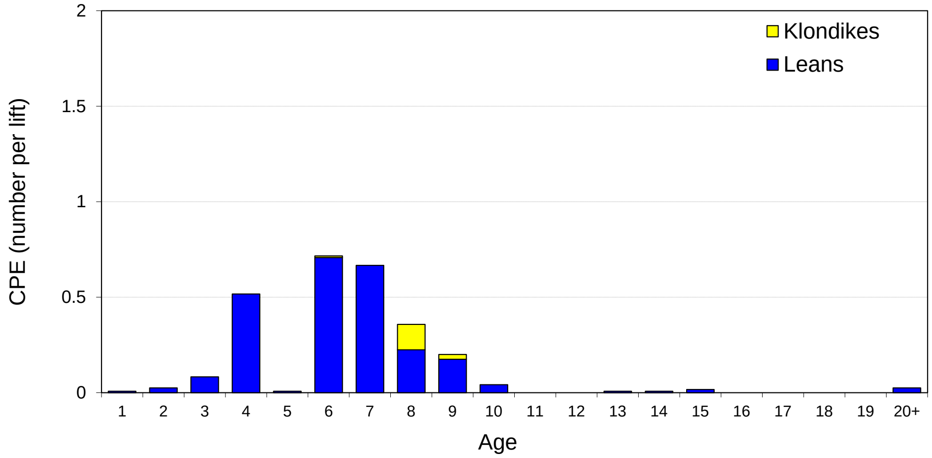


FIGURE 1.3. Relative abundance (number per lift) at age of Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie 2016.

The overall trend in area-weighted mean CPE of Lake Trout caught in standard nets in the eastern basin slightly decreased 54% in 2016 to 2.3 fish per lift (Figure 1.4). This was the lowest abundance in the past six years and ends a general trend of increasing Lake Trout abundance that has occurred 2000. Decreases in relative abundance were observed in all jurisdictions in 2016. Basin-wide abundance remains well below the rehabilitation target of 8.0 fish/lift (Markham et al. 2008).

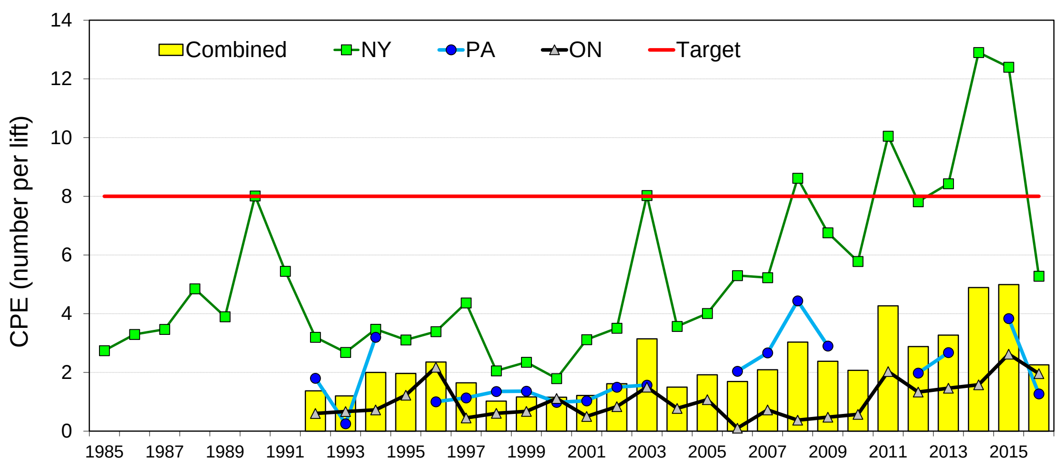


FIGURE 1.4. Mean CPE (number per lift) by jurisdiction and combined (weighted by area) for Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1986-2016.

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 (1) and the east basin (9). Lake Trout indices in the east basin (0.15 fish/lift) and Pennsylvania Ridge area (0.06) were below their time series means 0.40 and 0.20 fish/lift respectively (Figure 1.5). Coded-wire tags were retrieved from 8/10 Lake Trout, revealing the following strains: Slate Island (4), Finger Lakes (2), Lake Champlain (1), and Michipicoten (1). All Lake Trout had fin clips including 9 adipose and 1 left pectoral-right ventral clip. Variability of abundance estimates in this survey is high due to lower sample sizes in hypolimnetic waters, especially in the Pennsylvania Ridge area.

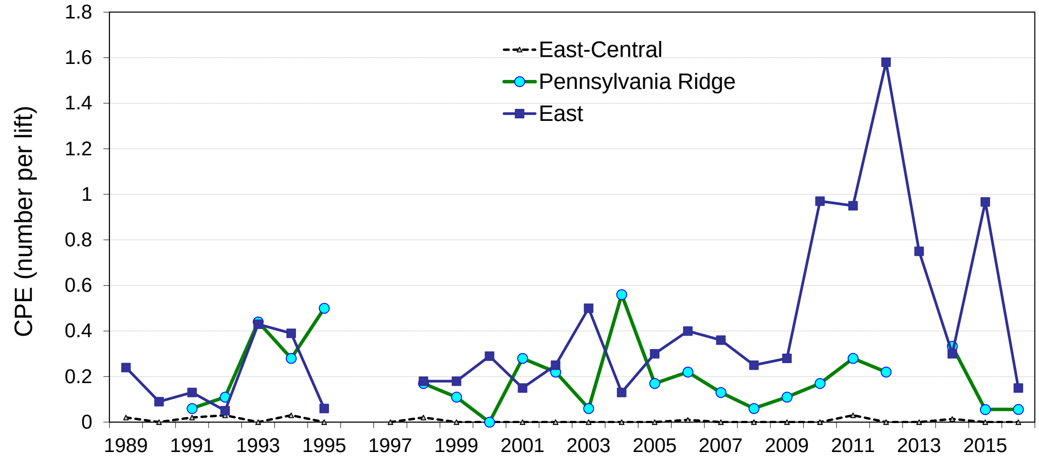


FIGURE 1.5. Lake Trout CPE (number per lift) by basin from the OMNRF Partnership Index Fishing Program, 1989-2016. Includes canned (suspended) and bottom gill net sets, excluding thermocline sets.

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 decreased sharply in 2016 to 1.4 fish per lift, representing a 62% decline compared to 2015 measures (Figure 1.6). Adult abundance also fell below the basin-wide rehabilitation target of 2.0 fish/lift for the first time in the past 3 years. Despite the large decrease, the 2016 measure of adult abundance still ranked as the third highest value in the 25-year time series.

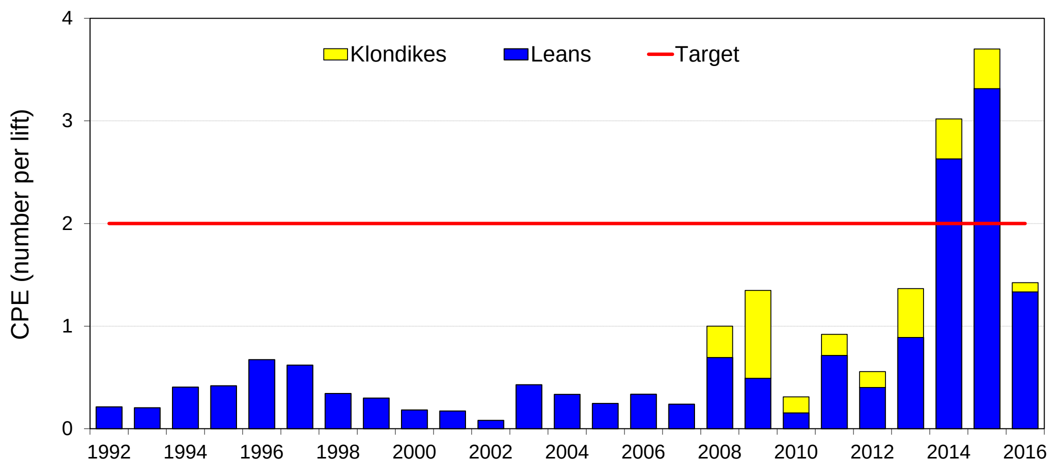


FIGURE 1.6. Relative abundance (number per lift; weighted by area) of age-5-and-older Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2016. The red solid line represents the rehabilitation target.

Strains

Six different Lake Trout strains were found in the 428 fish caught with either hatchery-implanted coded-wire tags (CWTs) or fin-clips in 2016 (Figure 1.7). The majority of the Trout (91%) were comprised of the Lake Champlain (LC; 63%) and Finger Lakes (FL; 28%) 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 5% of the catch. Slate Island (SI; 3%), Apostle Island (AI; <1%), and Lewis Lake (LL; <1%) strains were the only other strains sampled in 2016. 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; 95% (N=21) of Lake Trout age-10 and older were FL strain fish.

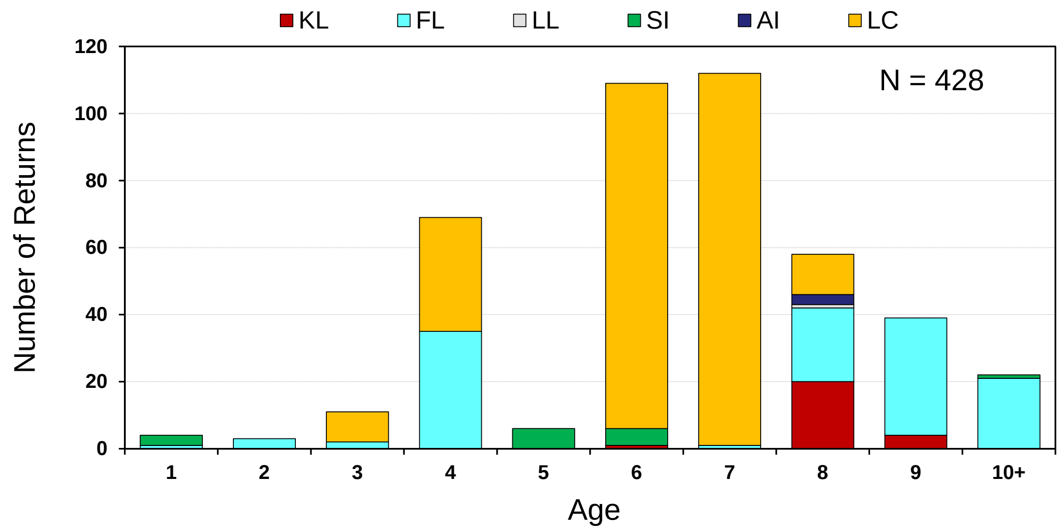


FIGURE 1.7. Number of Lake Trout by stocking strain and age collected in all gill nets from the eastern basin of Lake Erie, August 2016. Stocking strain codes are: KL = Klondike, FL = Finger Lakes, LL = Lewis Lake, SI = Slate Island, AI = Apostle Island, LC = Lake Champlain.

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 CPE with ages 4 through 11. A running average was used due to the high year-to-year variability in catches. Mean overall adult survival estimates varied by strain and year. Survival estimates prior to 1986 are low due to excessive mortality from a large, untreated Sea Lamprey population. Substantial increases in Lake Trout survival occurred following the first successful treatments of Sea Lamprey in Lake Erie in 1986. Survival estimates during this period (1987-91) ranged from 0.71 for the Superior (SUP) strain to 0.93 for the Finger Lakes (FL) strain, and from 0.62 – 0.77 for all strains combined, which was higher than the target survival rate of 60% (Table 1.3; Lake Trout Task Group 1985; Markham et al. 2008).

More recent estimates indicate that survival has declined well below target levels for some strains, presumably due to increased Sea Lamprey predation (see Section G). Survival estimates of the 1997-2001 year classes of SUP strain Lake Trout range from 0.23-0.44 (Table 1.3). Survival estimates from the 1996, 1997, and 1999-2003 FL strain are much higher, but were generated from very low sample sizes. Estimates from the 2005 year class of FL strain indicate lower survival rates, but estimates from 2006 – 2008 year classes are within the ranges previously observed for this strain during the period of successful Sea Lamprey control. Estimates of the 2003 and 2004 year classes of Klondike (KL) strain fish indicate very low survival rates at adult ages that are comparable to survival rates of SUP strain Lake Trout from the 1997-2001 year classes. However, preliminary estimates indicate a higher survival rate for the 2006 and 2007 year classes. Initial estimates from the Lake Champlain (LC) strain indicate higher survival than the KL strain but lower than the FL strain (Table 1.3).

Mean overall survival estimates were above the target of 60% or higher (Lake Trout Task Group 1985; Markham et al. 2008) for the FL strain but below target for the SUP and KL strains. The FL strain, the most consistently stocked Lake Trout strain in Lake Erie, had an overall mean survival estimate of 0.73. Mean overall survival for all strains combined was slightly above target levels (0.60).

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, 1985–2016. Three-year running averages of CPE from ages 4–11 were used due to year-to-year variability in catches. 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*			0.724	0.607	0.788
2007*			0.802	0.614	0.804
2008*	0.611		0.732	0.444	0.748
MEAN	**0.611**	**0.575**	**0.733**	**0.478**	**0.608**

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 1.8 and 1.9). 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 2016, but were below average for age-5 Lake Trout. It is worth noting that small sample sizes at age-5 (N=6) may have influenced these values.

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 declined below the series average for females in 2016 (Figure 1.10); no males were sampled. Again, it is worth noting that small sample sizes for age-5 females (N=6) may have influenced these values. Condition coefficients for both sexes show an increasing trend from 1993-2000, and have remained high and relatively steady since.

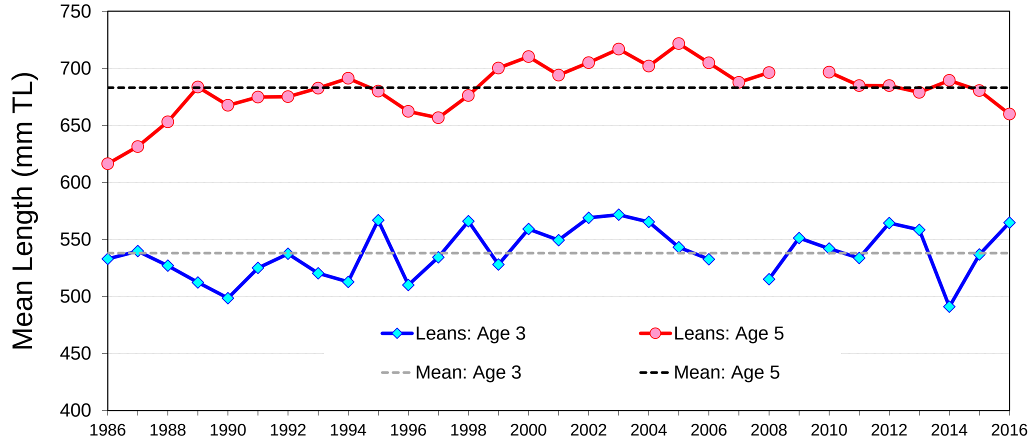


FIGURE 1.8. Mean length (mm TL) of age 3 and age 5 Lean strain Lake Trout sampled in assessment gill nets in the New York waters of Lake Erie, August, 1986-2016.

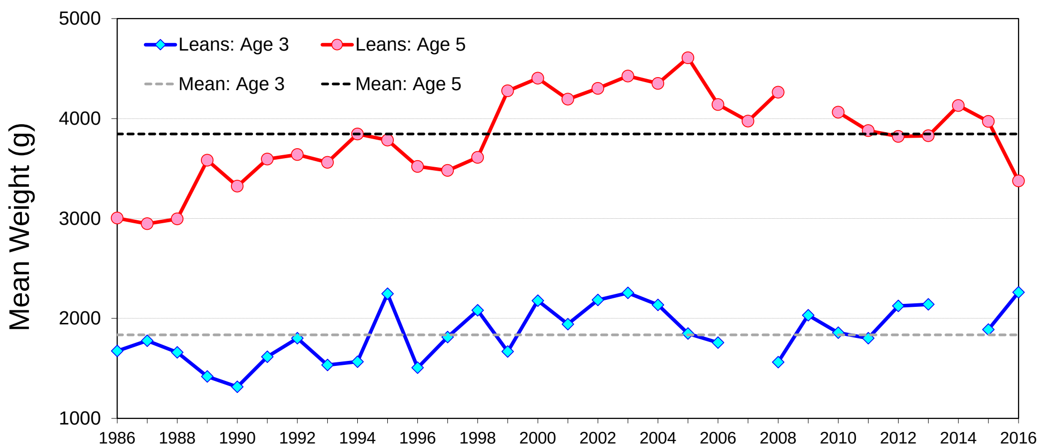


FIGURE 1.9. Mean weight of age-3 and age-5 Lean strain Lake Trout sampled in assessment gill nets in the New York waters of Lake Erie, August, 1986-2016.

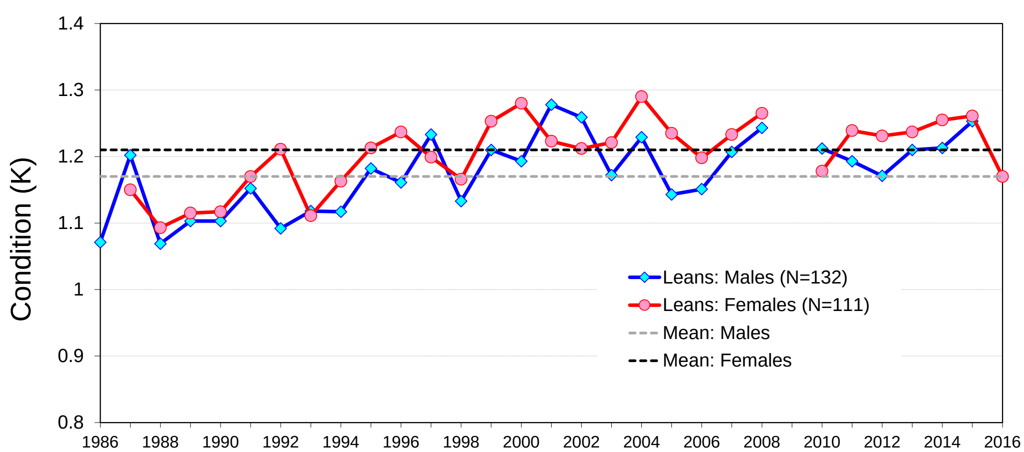


FIGURE 1.10. Mean coefficients of condition for age-5 Lean strain Lake Trout, by sex, collected in eastern basin assessment gill nets in Lake Erie, August 1986-2016.

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 528 Lake Trout were harvested in New York waters out of an estimated catch of 1,072 in 2016 (Figure 1.11). No harvest was detected in Pennsylvania waters in 2016 out of an estimated catch of 433 fish. This was the only the second time in the past six years that harvest was not detected in Pennsylvania waters.

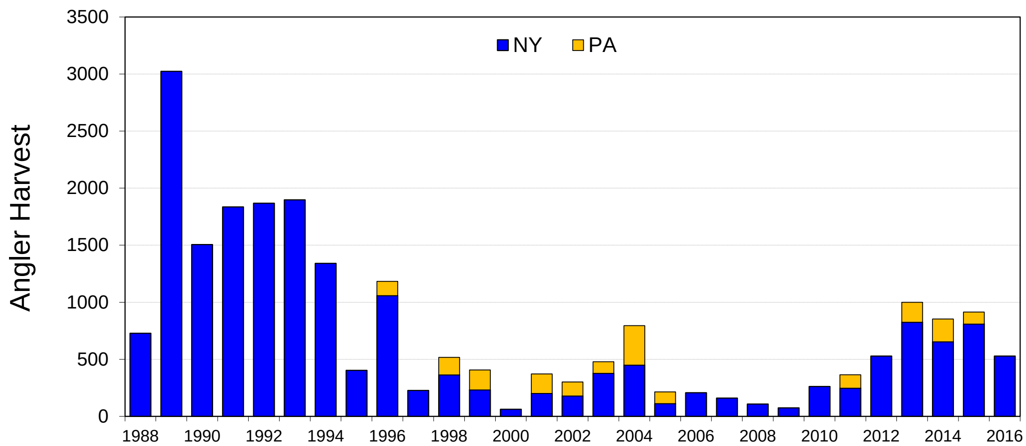


FIGURE 1.11. Estimated Lake Trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2016.

Natural Reproduction

Despite more than 30 years of Lake Trout stocking in Lake Erie, no naturally reproduced Lake Trout have been documented. No potentially wild fish (no fin clips; no CWT's) were caught in eastern basin coldwater gill net surveys in 2016; 67 potentially wild Lake Trout recorded over the past 16 years. 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 2016 Lake Trout model estimated the Lake Erie population at 349,665 fish and the adult (age-5 and older) population at 52,949 fish (Figure 1.12). 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.

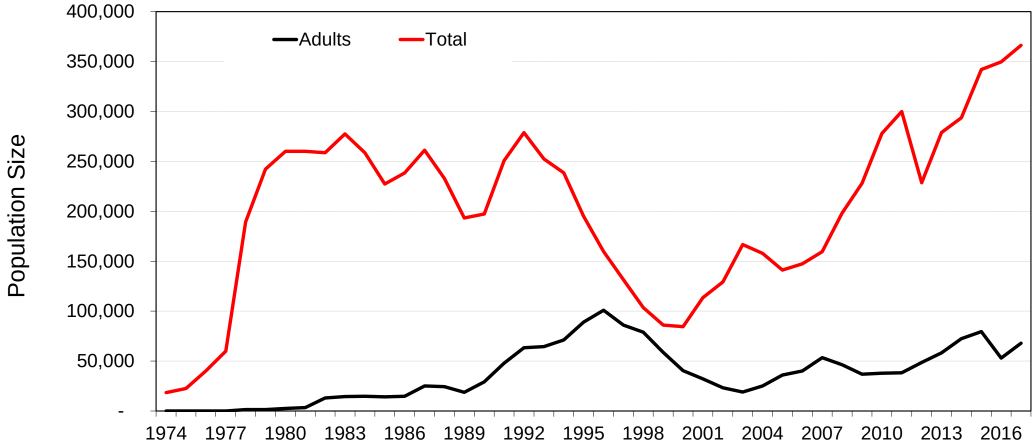


FIGURE 1.12. Projections of the Lake Erie total and adult (ages 5+) Lake Trout population using the CWTG Lake Trout model. Future projections for 2017 were made using low rates of Sea Lamprey mortality with proposed stocking rates. The model estimated the lakewide Lake Trout population in 2016 at 349,665 and the adult population at 52,949.

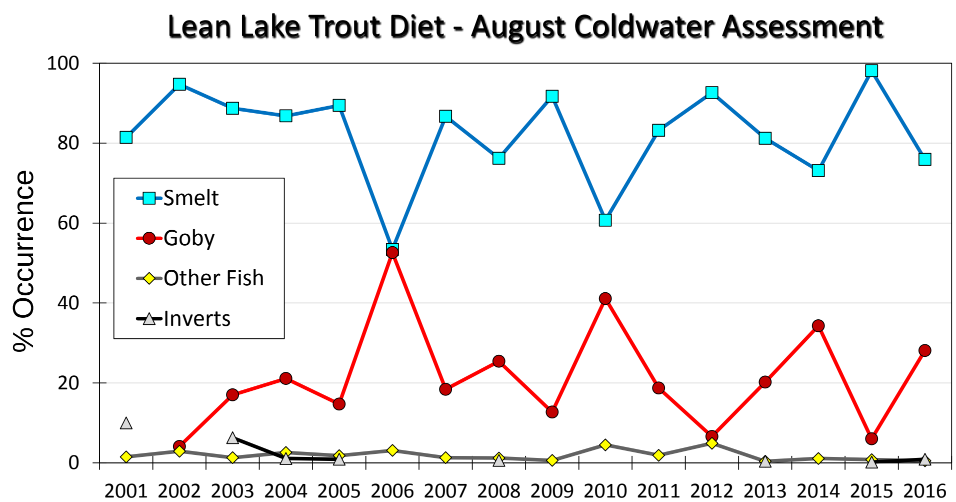
Diet

Seasonal diet information for Lake Trout is not available based on current sampling protocols. Diet information was limited to fish caught during August 2016 in the coldwater gill net assessment surveys in the eastern basin of Lake Erie. Analysis of the stomach contents revealed a similar diet of prey fish species for both Lean and Klondike strain Lake Trout. Rainbow Smelt were the most prevalent diet item for Lean strain Lake Trout in 2016, occurring in 76% of the stomachs (Table 1.4). Round Goby were also common, occurring in 28% of the samples from Lean strain fish. In Klondike strain Lake Trout, Round Goby were more common than Rainbow Smelt, occurred in 75% of the stomachs compared to 50%, respectively. Freshwater Drum were the only other identifiable fish species encountered in Lake Trout diet samples. Two small Lake Trout had also consumed invertebrates.

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 1.13). 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=228) and Klondike (N=8) strain Lake Trout collected in gill nets from eastern basin waters of Lake Erie, August 2016.

PREY SPECIES	Lean Lake Trout (N=228)	Klondike Lake Trout (N=8)
Rainbow Smelt	173 (76%)	4 (50%)
Round Goby	64 (28%)	6 (75%)
Freshwater Drum	1 (<1%)	
Invertebrates	2 (<1%)	
Unknown Fish	6 (3%)	
Number of Empty Stomachs	155	11



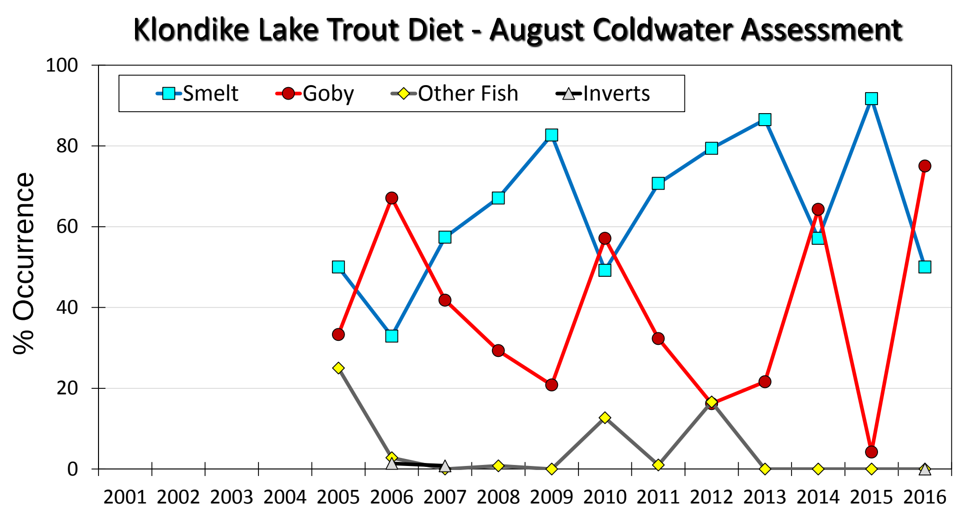


FIGURE 1.13. Percent occurrence in diet of rainbow smelt, round goby, all other fish species, and invertebrates from non-empty stomachs of Lean strain (top) and Klondike (bottom) strain Lake Trout caught in eastern basin assessment gill nets, August, 2001-2016.

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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) and Geoffrey Steinhart (ODW)

Commercial Harvest

The total harvest of Lake Whitefish in Lake Erie during 2016 was 55,951 pounds (Figure 2.1). Ontario accounted for 57% of the lake-wide total, harvesting 31,733 pounds, followed by Ohio (43%; 24,169 pounds), with nominal commercial harvest in Pennsylvania (31 pounds) and New York (18 pounds) and none in Michigan (Figure 2.2). Total harvest in 2016 was 56% lower than the total harvest in 2015. Lake Whitefish harvest decreased in Ontario and Ohio by 55% and 53% respectively.

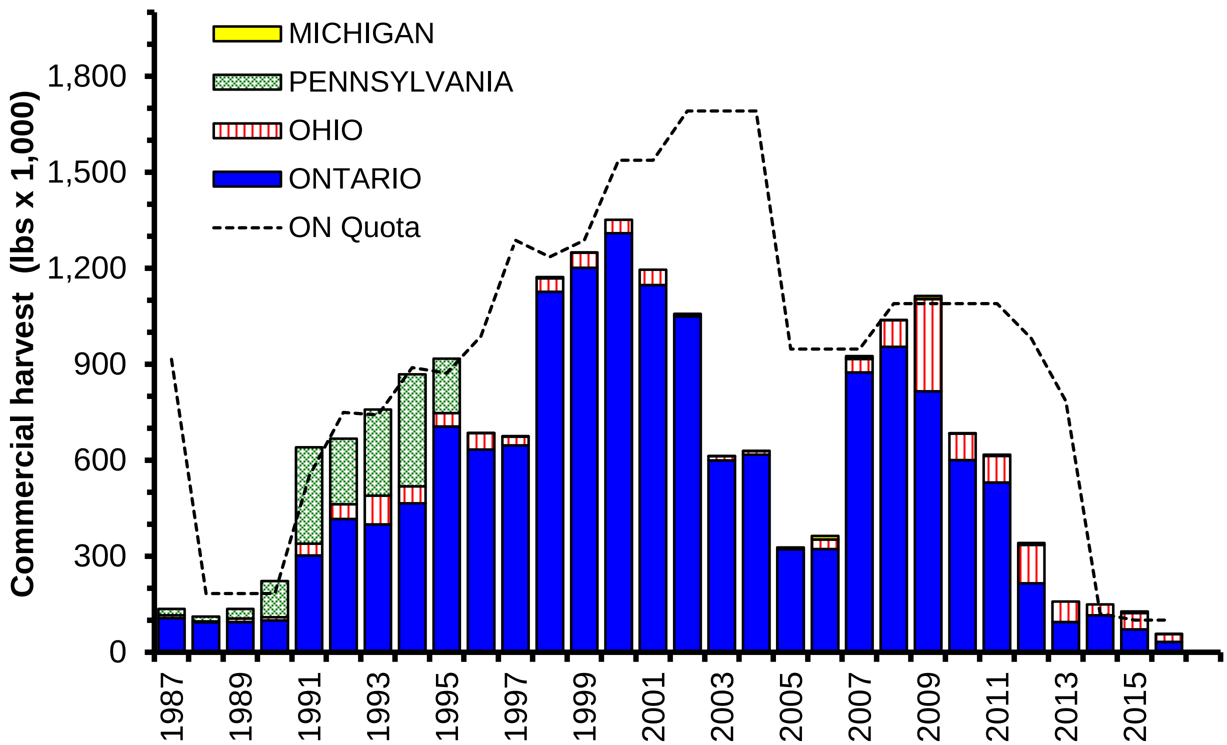

FIGURE 2.1. Total Lake Erie commercial Lake Whitefish harvest from 1987-2016 by jurisdiction. Pennsylvania ceased gill netting in 1996, and Michigan resumed commercial fishing using trap nets in 2006, excluding 2008. Ontario quota is presented as a dashed line

Ontario's 2016 harvest represented 32% of their quota (100,000 pounds). The majority (99%) of Ontario's 2016 Lake Whitefish harvest was taken in gill nets. The remainder (397 pounds) was caught in Rainbow Smelt trawls. The largest fraction of Ontario's Whitefish harvest (76%) 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 (3%), OE-4 (1%) and OE-5 (1%; Figure 2.2). Maximum harvest in 2016 was distributed west and south of Pelee Island (Figure 2.2). Harvest in OE-1 from October to December represented 63% of Ontario's Lake Whitefish harvest. Peak harvests occurred in OE-1 during December (13,916 pounds) and November (4,956 pounds). Fall harvest in OE-2 (Oct-Dec) was 6% while OE-1 and OE-2 harvest from January to May contributed equally (13%) to 2016 Whitefish harvest in Ontario waters. Whitefish harvest in OE-3 was distributed between spring and fall, accounting for 3% of the annual harvest. In eastern Lake Erie (OE-4 and OE-5), Lake Whitefish were landed from spring through fall, accounting for 661 pounds or 2% of 2016 harvest. There was no reported effort targeting Lake Whitefish during 2016 in Ontario waters; the harvest was mainly caught in fisheries seeking

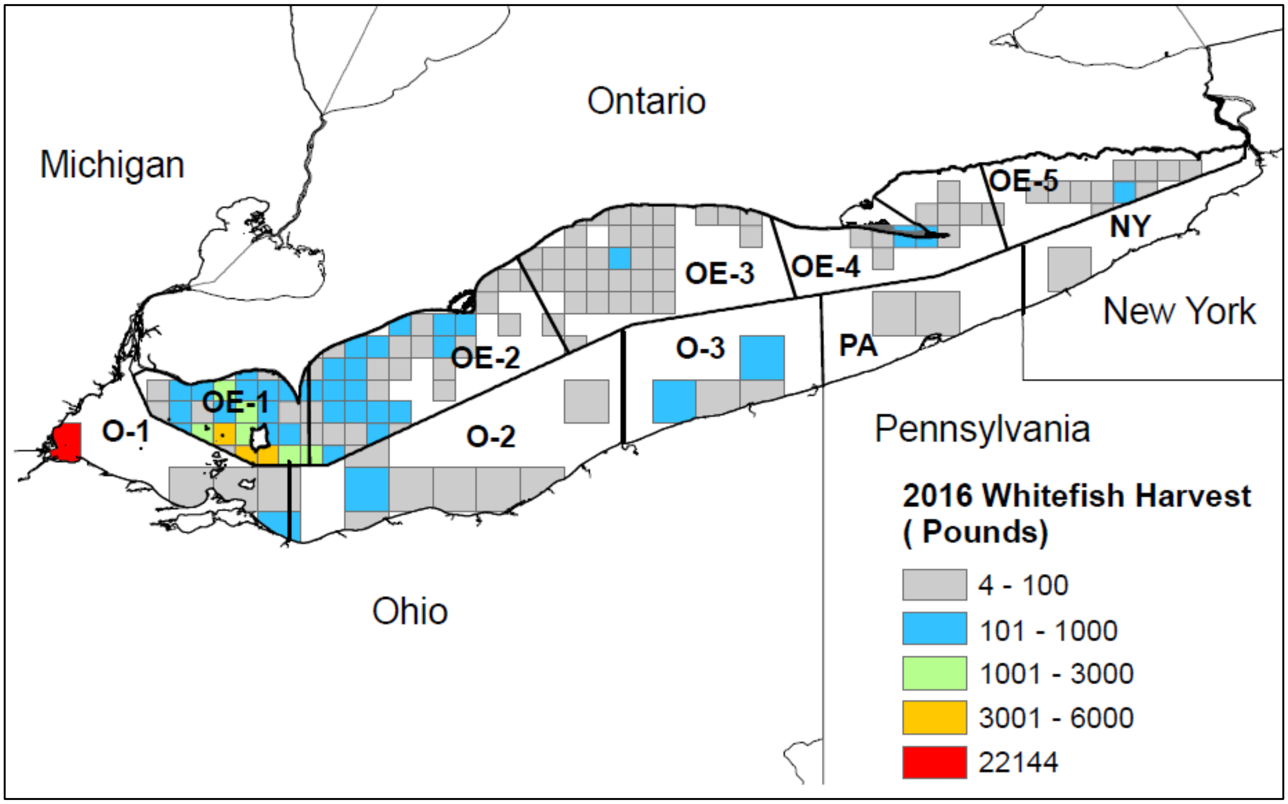

FIGURE 2.2. Lake Erie commercial harvest of Lake Whitefish in 2016 by 5-minute (Ontario) and 10-minute (US) grids with statistical districts. No Lake Whitefish harvest was reported in Michigan in 2016.

Walleye (90%) and White Bass (8%), with the remaining 2% landed by Rainbow Smelt, Yellow Perch and White Perch fisheries.

As there was no reported targeted gill net harvest or effort in 2016, 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 2014-2016 data, catch rates 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 58% from 2015, whereas catch rates based on effort with Lake Whitefish in the catch declined 40%. In both cases, 2016 catch rates were the lowest in their respective 1998-2016 time series.

In Ohio waters during 2016, 93% of the Lake Whitefish trap net harvest occurred in the west basin, with the remaining harvest divided between central basin districts O-2 (4%) and O-3 (3%). Lake Whitefish were harvested from 1,633 Ohio trap net lifts in 2016, with lifts distributed among District 1 (O-1) (26%), District 2 (O-2) (44%) and District 3 (O-3) (30%), respectively. The majority of Ohio's Lake Whitefish harvest occurred during November (84%), followed by December (8%), in the western basin. Ohio's remaining Lake Whitefish harvest occurred in the central basin (7%), from May to August. Lake Whitefish yield in 2016 from Ohio trap nets was greatest near the mouth of the Maumee River (22,144 pounds, Figure 2.2). Ohio trap net catch rates in 2016 (14.8 lbs/lift) decreased 59% from 2015 (36.3 lbs/lift) and was less than half of the 1996-2015 time series average (34.4 lbs/lift; Figure 2.4).

Ohio's Lake Whitefish trap net fishery effectively targets Lake Whitefish during the spawning season, as 92% of the harvest was taken during November-December (Figure 2.5). The catch rate in 2016 (158 lbs/lift) was highest in grid 801, adjacent to Maumee Bay, where Lake Whitefish appear to aggregate (Figure 2.6). The concentration of effort on this potential spawning stock should be monitored continuously to assess its' status and ensure sustainability.

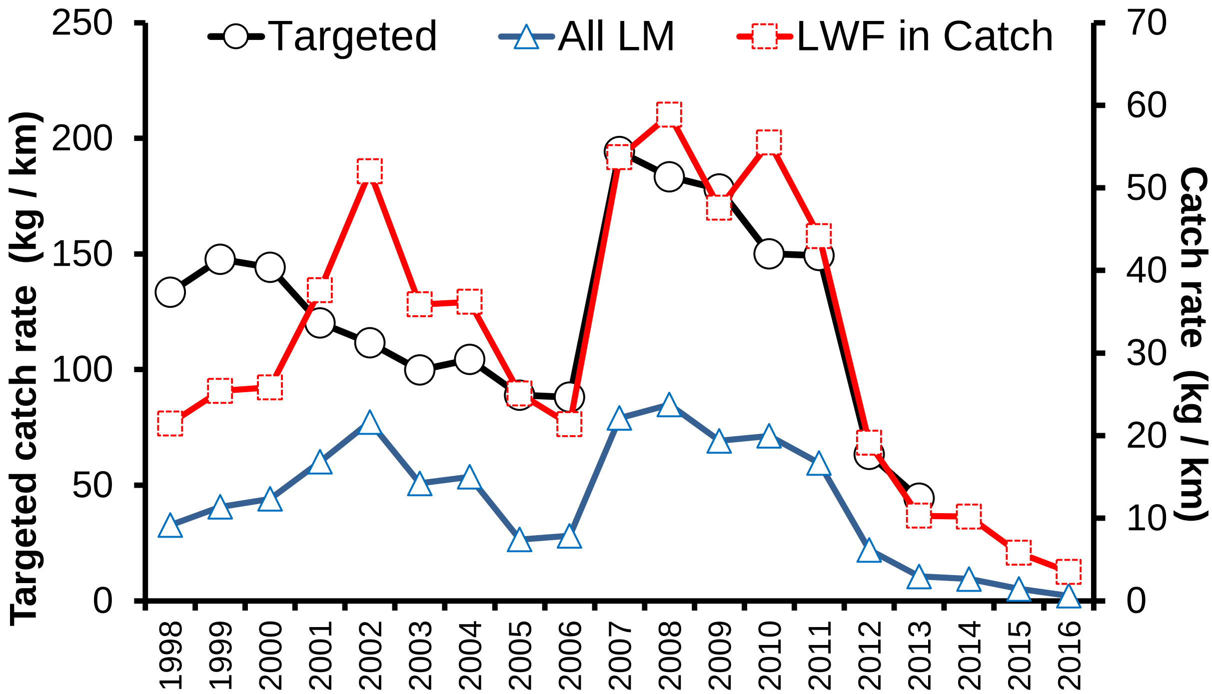

FIGURE 2.3. Lake-wide Ontario annual commercial large mesh gill net catch rates according to three forms of effort 1998-2016. Targeted Lake Whitefish catch rate (kg/km; left axis), catch rate relative to all large mesh gillnet fished (kg/km; right axis), and catch rates from large mesh effort with Lake Whitefish in the catch (kg/km; right axis). No targeted Lake Whitefish effort or harvest in 2014 - 2016.

Ontario's west basin fall Lake Whitefish fishery in 2016 continued to be dominated by older fish, reflecting a trend in poor recruitment (Figure 2.7). The age composition of Lake Whitefish harvest from Ontario is presented for the Walleye and Rainbow Smelt trawl fishery harvest monitoring using otoliths and scales (N=88; Figure 2.8). Based on standard harvest monitoring, Ontario's Whitefish harvest in 2016 consisted of Lake Whitefish from ages 1 to 18. The strong 2003 cohort (age 13) was most abundant, representing 58% of the Lake Whitefish harvest from gill nets (Figure 2.8). Lake Whitefish collected from known source (N=3) and aggregate (N=35) commercial Rainbow Smelt Trawl samples consisted of ages 1 (71%), 2 (26%) and 3 (3%; Figure 2.8). Examination of young Lake Whitefish age structures among programs in 2016 using a variety of methods, revealed the presence of false annuli or checks which lead to uncertainty in age assignments between ages 1 and 2. This age interpretation favored the use of scales when available and the crack and burn otolith method under reflected light.

The age composition of Lake Whitefish harvested in Ohio during 2016 was not assessed.

The landed weight of roe from Ontario's 2016 Lake Whitefish fishery was 72 pounds, most (97%) of which came from OE1 November. The remaining fraction of roe was collected primarily from OE2 during October and November. The approximate landed value of the roe was CDN $ 158.

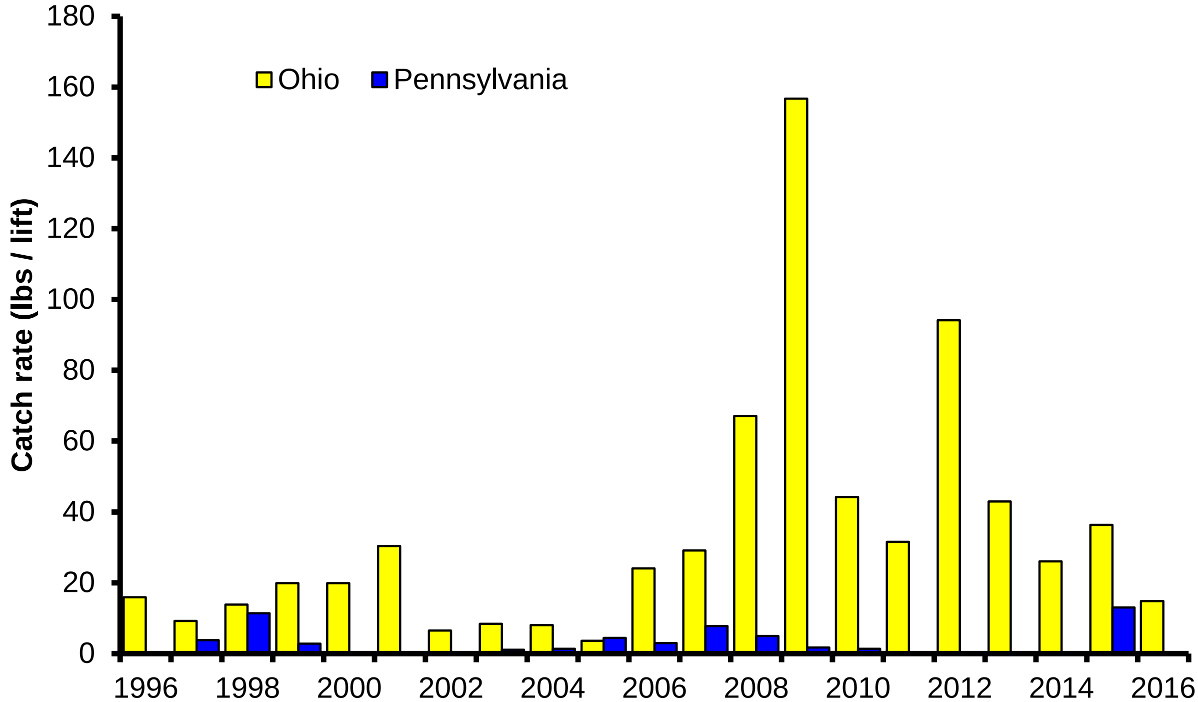

FIGURE 2.4. Lake Whitefish commercial trap net catch rates in Ohio and Pennsylvania (lbs/lift), 1996-2016. Zero harvest for PA in 2011-2014. PA catch rate in 2016=0.05 lbs/lift)

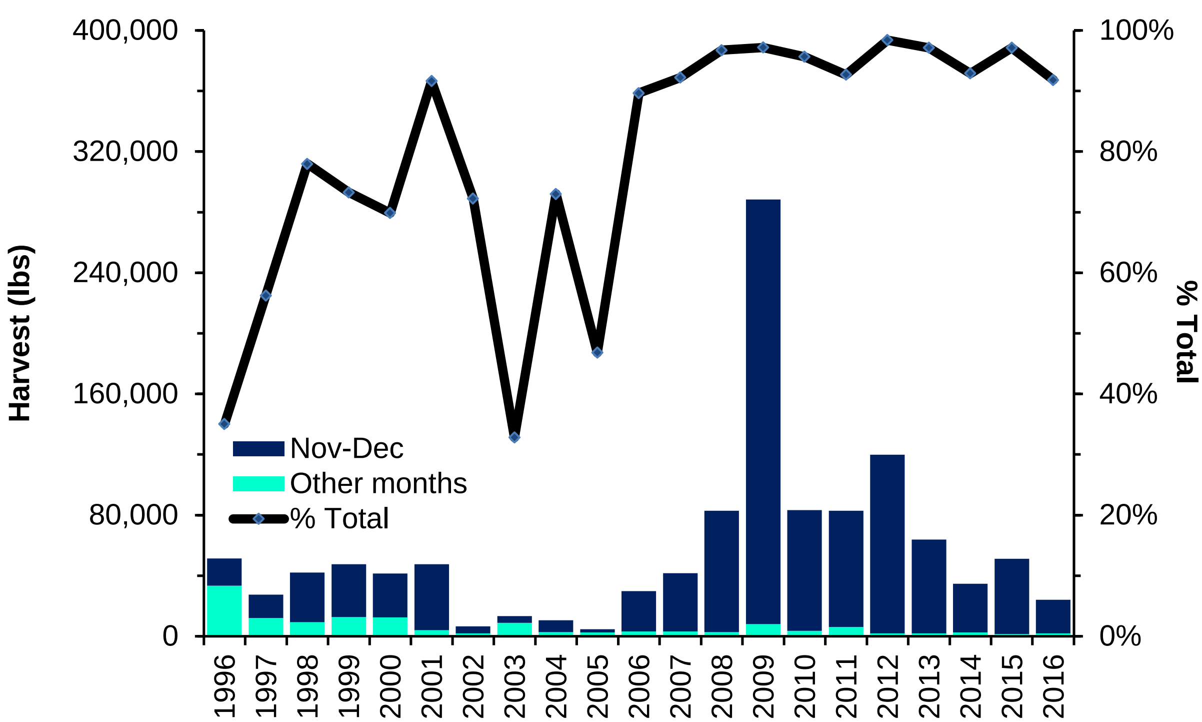

FIGURE 2.5. November and December harvest of Lake Whitefish in Ohio waters of Lake Erie, 1996-2016.

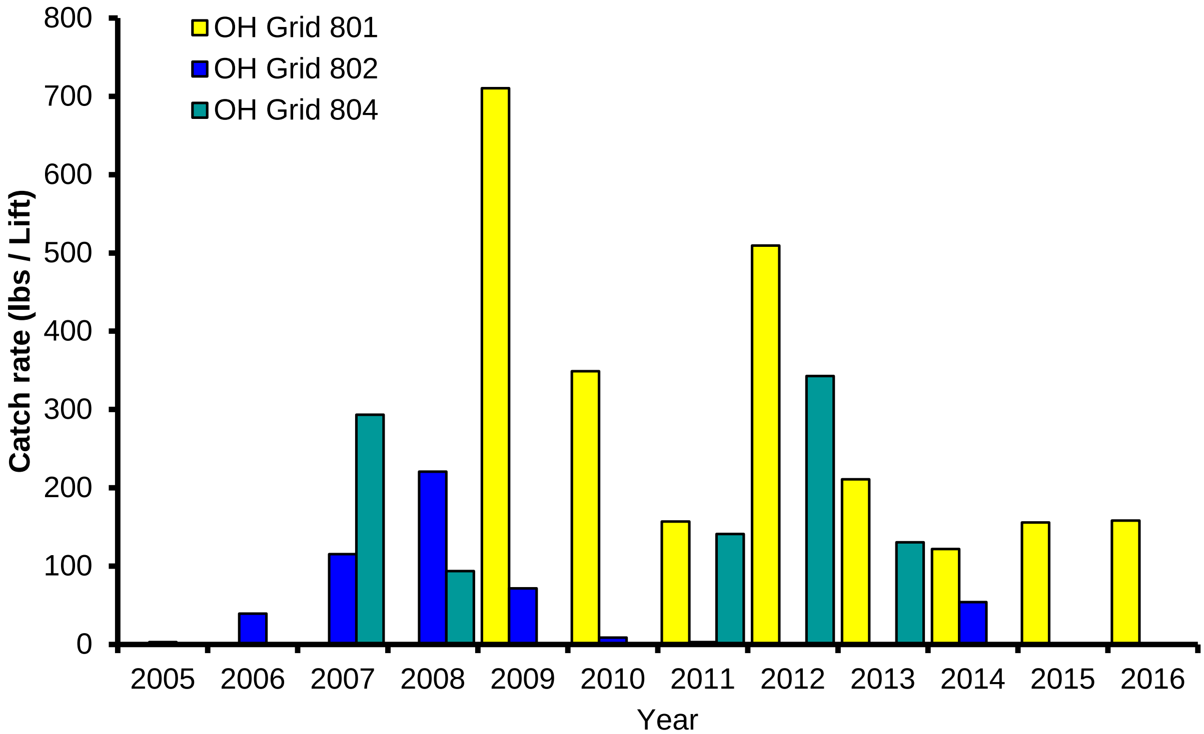

FIGURE 2.6. Ohio Lake Whitefish commercial trap net catch rates (lbs/lift) by grid in western Lake Erie. No harvest from grids 802 and 804 in 2015 - 2016.

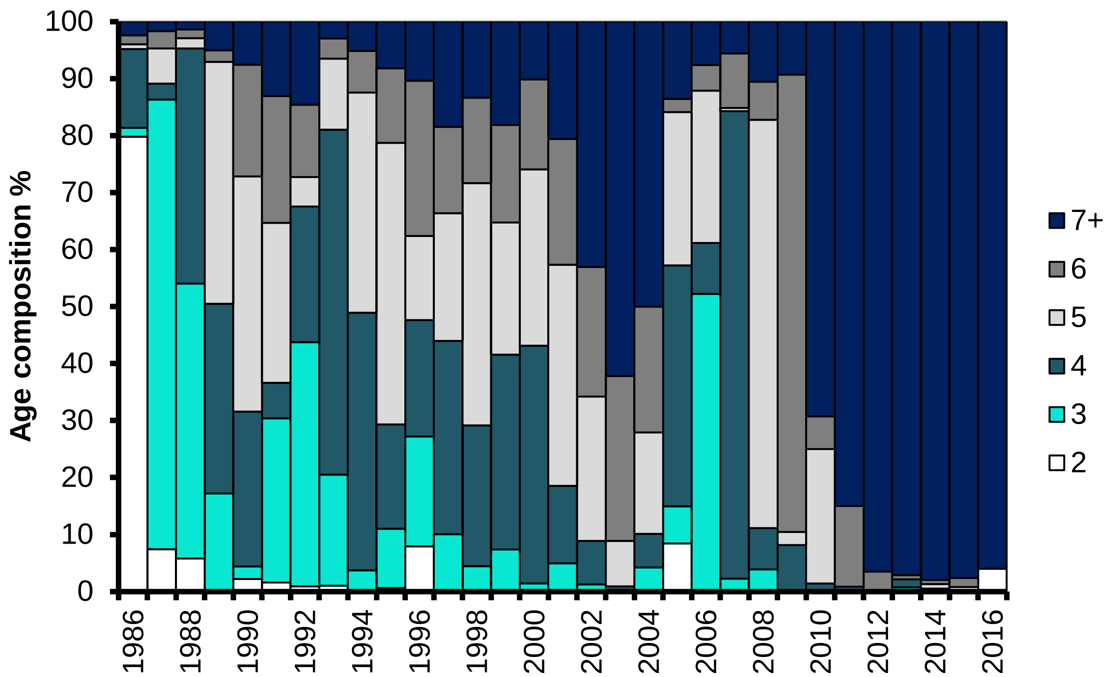

FIGURE 2.7. Ontario fall commercial Lake Whitefish harvest age composition in statistical district 1, 1986-2016, from effort with gill nets ≥3 inches, October to December.

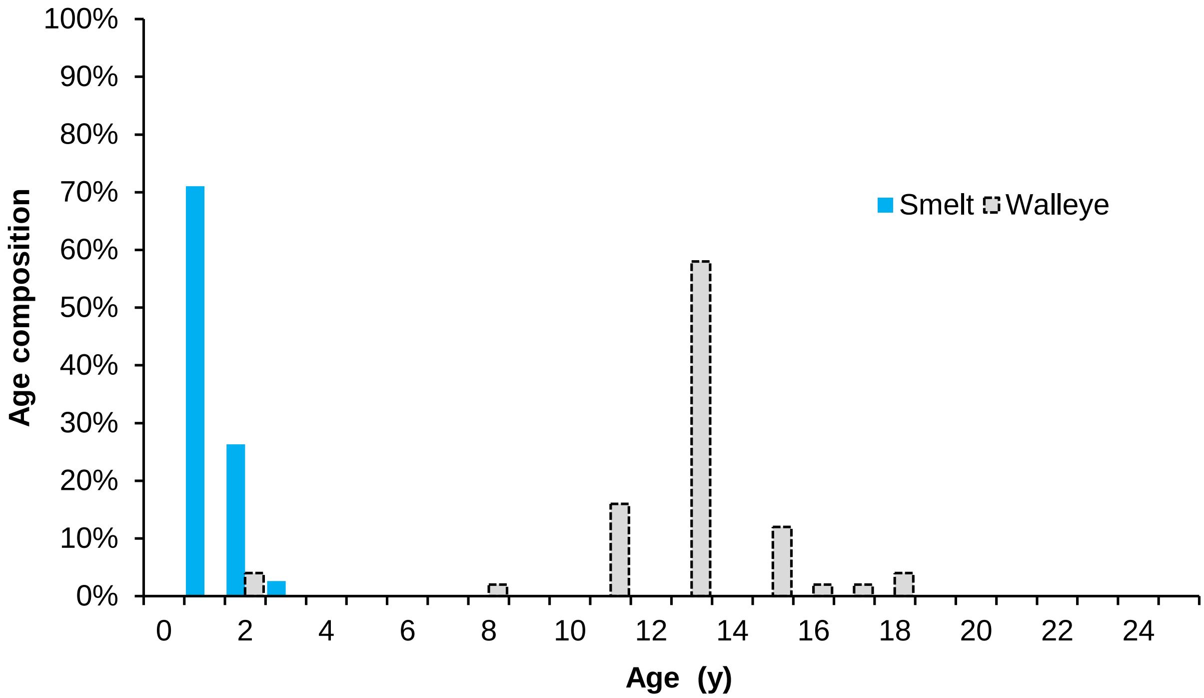

FIGURE 2.8. Age composition (otoliths, scales) of Lake Whitefish caught commercially in Ontario waters of Lake Erie in 2016 by target species fisheries: Smelt Trawl (N=38), and Walleye (N=50). Sex Composition: Male 39%, Female 19%, Unknown 42%; N=88. The supplementary smelt trawl sample (N=35) was obtained from an aggregate of trawl landings.

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 2016 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 (155 lifts) during 2016 (0.78 LWF/lift) increased dramatically from 2015 (0.03 LWF/lift) and was ranked as the 39th percentile over the 32 year time series 1985-2016 (Figure 2.9). Catch rates in ON CWA nets during 2016 (1.13 LWF/lift) were slightly better than in NY waters (0.88 LWF/lift) and more so than in Pennsylvania waters (0.2 LWF/lift). Two percent (2%) had type A1-3 wounds whereas 3% exhibited an A4 wound.

Partnership catch rates of Lake Whitefish ages 0 to 2 was 0.03 LWF/gang in 2016 (Figure 2.9). Catch rates for age-3 and older Lake Whitefish caught in 2016 Partnership surveys increased to 0.05 LWF/gang from 0.03 LWF/gang in 2015. Whitefish were caught in all areas of Lake Erie in 2016 except the west basin survey. In addition to 17 Lake Whitefish caught in Partnership Index gear in 2016, 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 17, with ages 1 (35%; 2015 year class) and 13 (29%; 2003 year class; Figure 2.10) most abundant. Other age groups included 17(12%), and single fish (6%) represented by ages 2, 5, 11 and 15. Lake Whitefish mean age in Partnership gear was 8.1. The Lake Whitefish caught in auxiliary gear was age 15. Of 18 Lake Whitefish examined, none had Sea Lamprey scars or wounds in 2016.

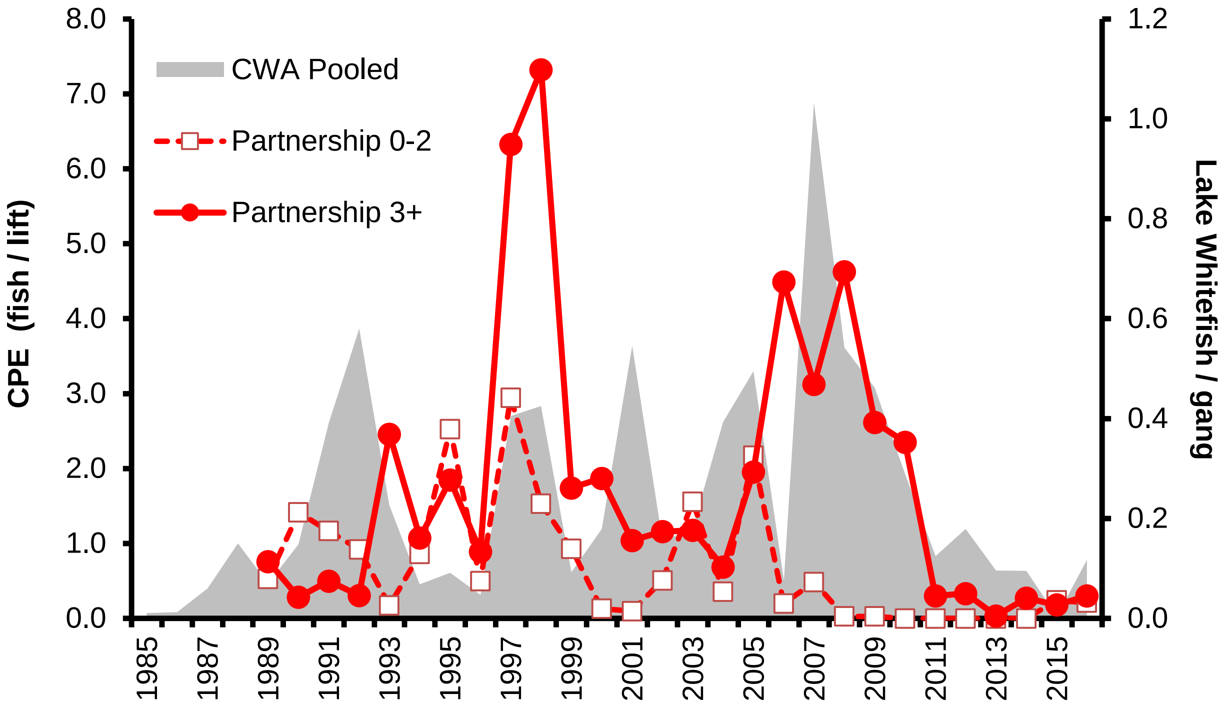

FIGURE 2.9. Catch per effort (number fish/lift) of Lake Whitefish caught in standard coldwater assessment gill nets (CWA) in New York, Ontario and Pennsylvania waters, weighted by number of lifts (grey area). Partnership index catch rates (WF/gang) for ages 0-2 (dots) and ages 3 and older (squares) (second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

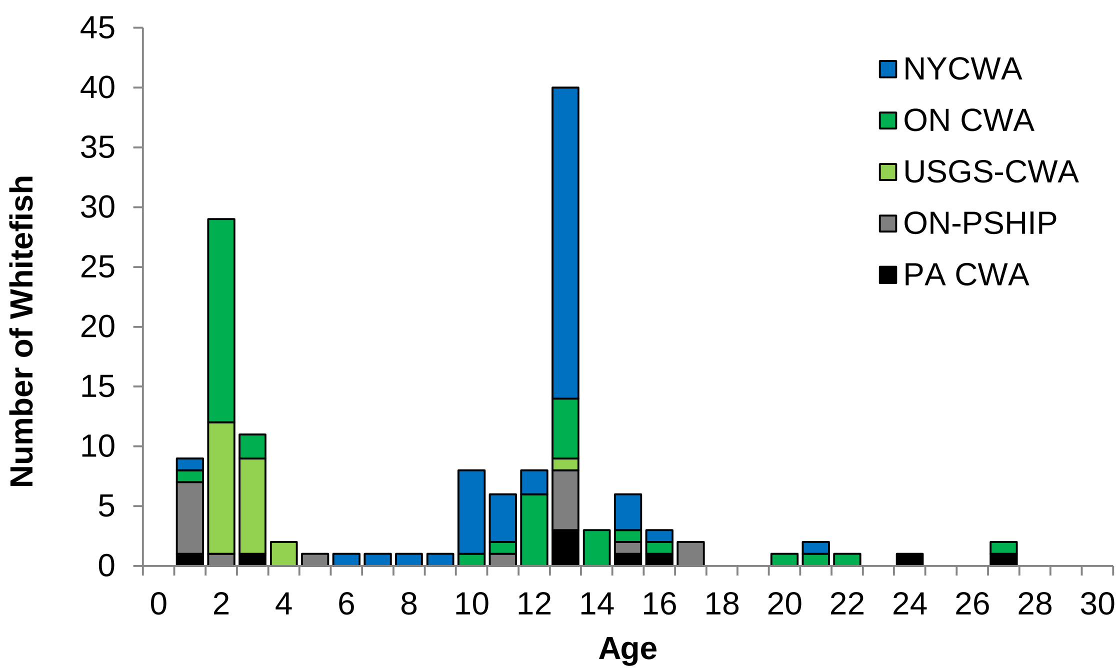

FIGURE 2.10. Age-frequency of Lake Whitefish collected from Cold Water Assessment (CWA) gill net surveys and Ontario Partnership index, 2016 (N=139).

Lake Whitefish captured in CWA surveys by all agencies ranged in age from 1 to 27. Age-13 was most abundant (29%) followed by age 2 (23%; Figure 2.10). Ages 3, 10, 12, 11 and 15 comprised from 9% to 4% of Whitefish caught respectively. All other ages combined made up only 18% of the catch. Mean age of Lake Whitefish caught in CWA nets was 19.3 years.

Ohio trawl surveys in the central basin (Ohio Districts 2 and 3) of Lake Erie encounter juvenile Lake Whitefish in August and October. October catches are presented as an index, describing the presence and magnitude of year classes. In 2016, no young-of-the-year (0 LWF/ha) Lake Whitefish were caught in the Ohio fall survey (Figure 2.11). Age-0 Whitefish were absent from Ohio trawls from 2008 to 2014, after which YOY were caught (0.4 LWF/ha) in the 2015 trawl survey. The 2015 year-class also appeared as yearlings in central basin fall trawls (Figure 2.12). Fall catches of yearling LWF were 0.5 fish/ha in 2016, which was higher than the long-term mean (0.3 yearling LWF/ha).

Pennsylvania bottom trawl surveys from May to November also describe year class strength of juvenile Lake Whitefish. During the last decade, the trawls were not completed in 2006, 2010-2011 and 2014. The assessment in 2016 was completed, indicating with a zero catch of YOY Lake Whitefish (Figure 2.11). Yearling Lake Whitefish were caught in 2016 (0.22 LWF/ha) at a rate higher than observed in 2015 (0.07 LWF/ha). 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 trawl time series indicated the presence of age 0 Lake Whitefish in 2014 (0.1 LWF/ha) and 2015 (0.09 LWF/ha), but no age-0 Lake Whitefish were caught in the 2016 survey (Figure 2.11). As with Ohio and Pennsylvania time series, the age 0 trawl catch rate in 2003 was high in New York waters.

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 juveniles or adults in 2016.

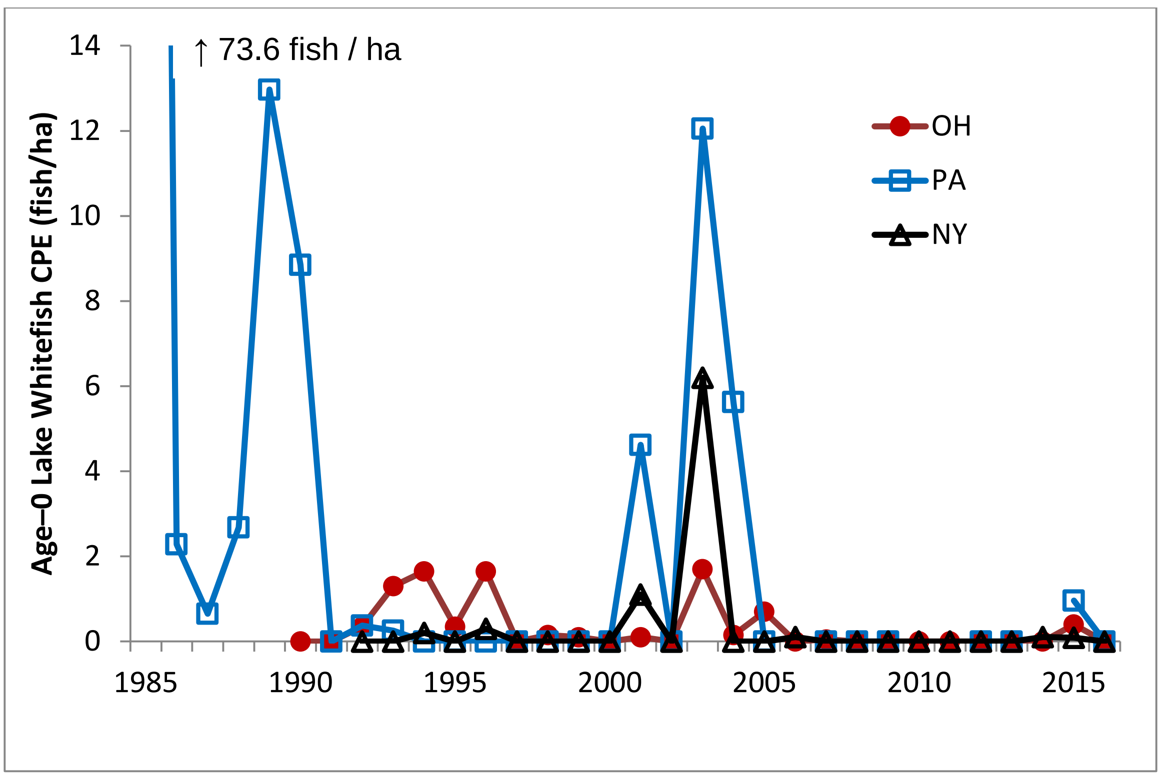

FIGURE 2.11. Mean age-0 Lake Whitefish catch per hectare in Ohio, Pennsylvania and New York fall assessment trawls. Ohio data are means for October trawls in District 2 and 3. Age-0 catch rate for Pennsylvania in 1985 (73.6 fish/ha) exceeds axis range.

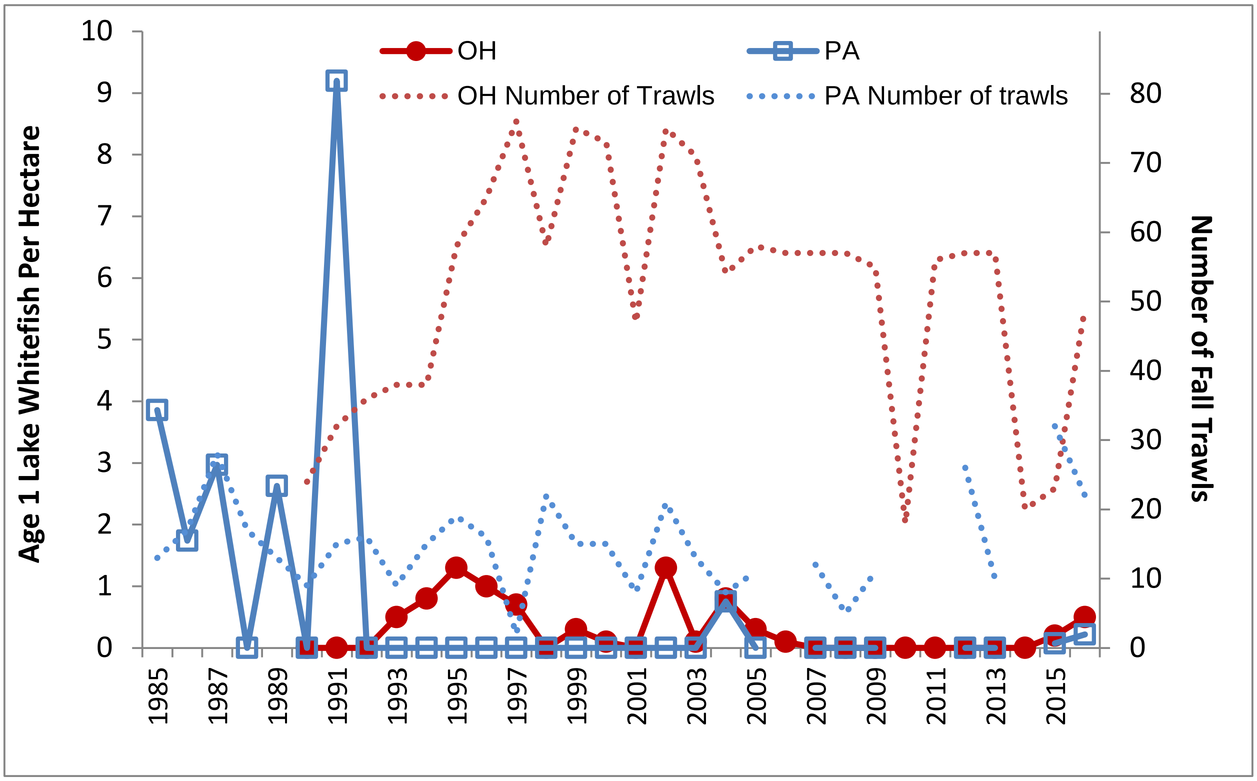

FIGURE 2.12. Age 1 Lake Whitefish trawl catch rates (number per ha) in Pennsylvania (PA) waters (bars) and number of trawls (lines). Dots and line are absent in years when trawl survey did not occur.

Growth and Diet

Trends in condition are presented for Lake Whitefish sampled by ODNR in Ohio waters (Figure 2.13) and Ontario MNRF (Figure 2.14). In 2016, sample sizes for Lake Whitefish condition were very low for Ohio (N=5) and Ontario (N=6). Van Oosten and Hile's (1947) historic condition values are presented for females (1.131) and males (1.015) as a basis for comparison. Mean condition in 2016 was average (Ontario) or above (Ohio) relative to historic levels for the few females examined with opposite trends for males observed based on small sample sizes. Lack of precision prohibits any sound conclusions concerning Lake Whitefish condition in 2016. Lake Whitefish used for Ontario condition analyses included age-4 and older fish that were not spent or running, collected from October to December from commercial samples, Partnership index nets and Partnership auxiliary gear. Most Lake Whitefish in Ontario samples were excluded from condition analyses in 2016 as they were in spawning condition, spent, too young or caught prior to October.

Stomach contents from 54 Lake Whitefish caught in Ohio waters of Lake Erie were examined in 2016. Of these, 49 Lake Whitefish (46 yearlings and three age-2) contained prey. Across the central basin, Lake Whitefish diets were dominated by Chironomids of all life stages (approximately 35% of diet). In District 2 (O-2, west-central basin), Daphnia were the second most abundant prey (28%) and Dreissena spp. were third (11%). In District 3 (O-3, east-central basin), Bythotrephes (23%) and Dreissena (18%) were common prey.

Fishery indicators describe the continued declining abundance of adult Lake Whitefish with some incidental, younger fish present in catches. Total Lake Whitefish harvest in 2016 (approximately 56,000 pounds) was the lowest in recent decades. Ontario's incidental harvest attained 32% of Lake Whitefish quota (100,000 pounds) with no targeted harvest of Lake Whitefish in 2016. Ohio 2016 trapnet harvest (24,000 pounds) ranked 28th percentile since 1987. Lake Whitefish catch rates in 2016 gillnet surveys were low to moderate, showing improvement in 2016 due to the presence of younger fish. Trawl assessments indicate that the 2014 and 2015 cohorts may be significant based on the presence of YOY and yearlings in central and east basin areas. These cohorts may be present in 2017 fisheries but will not likely contribute significantly until 2018 or later. Ontario's

2017 quota was set initially at 30,000 pounds, but is subject to change during the year. Continued conservative harvests are recommended until spawner biomass improves.

Biological reference points and implications of harvest levels are subjects in the draft Charge 8 report. The final version of the Charge 8 report is anticipated in 2017-2018. The Cold Water Task Group continues to work with modelers and the Data Deficient Working Group to support Lake Whitefish management and Marine Stewardship Council sustainable fishery certification.

References

Van Oosten, J. and R. Hile. 1947. Age and growth of the Lake Whitefish, *Coregonus clupeaformis* (Mitchill), in Lake Erie. Transactions of the American Fisheries Society 77: 178-249.

FIGURE 2.13. Mean condition (K) factor values of adult Lake Whitefish obtained from Ohio DNR and USGS fishery and survey data (Aug-Dec) from 1990-2016. Sample sizes in 2016 were very low: Males N=3 and Females N=2. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

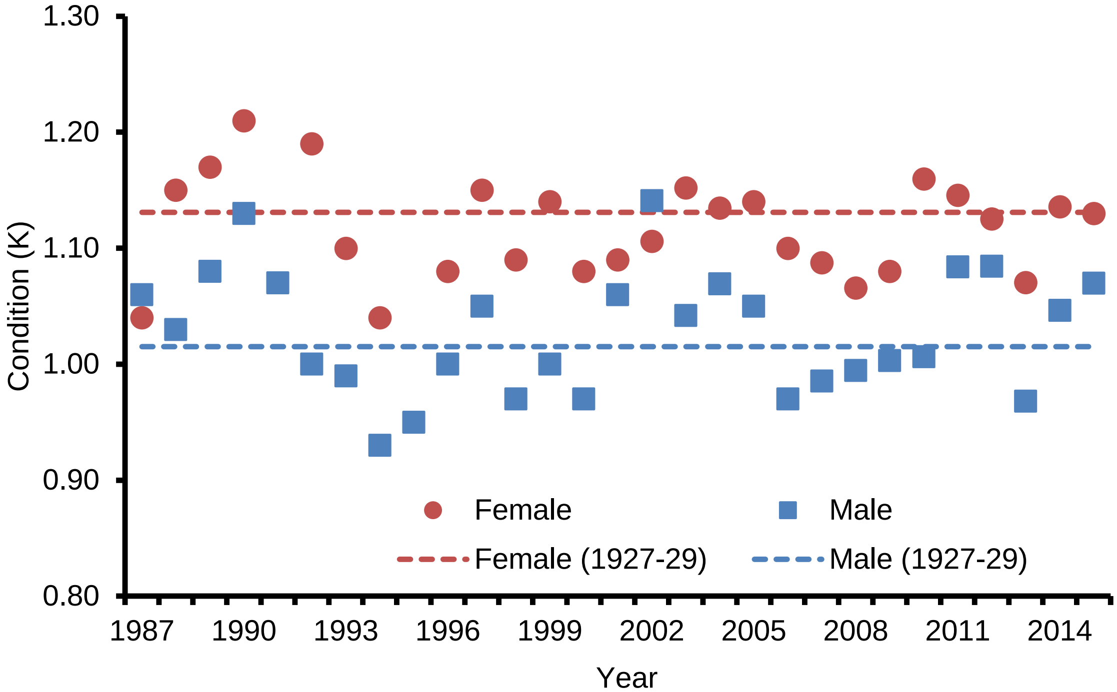

FIGURE 2.14 Mean condition (K) factor values of age 4 and older Lake Whitefish obtained from Ontario commercial and partnership survey data (Oct-Dec) by sex from 1987-2016. Samples sizes in 2016 were very low: Males N=3 and Females N=3. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

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

Chris S. Vandergoot (USGS), Paulette Penton (OMNRF), Andrew Cook (OMNRF), Jim Boase (USFWS), and Zy Biesinger (USFWS)

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 2016 was 1,349 pounds (612 kg) of which 46% came from Ontario waters (Table 3.1). Between 2011 and 2015, harvest was higher in New York waters than all the other jurisdictions combined. The 2016 Burbot harvest represents a shift in harvest trends over the past five years (2011-2015) where Burbot harvest in New York was higher than Ontario. All jurisdictions, recorded less than 1,000 lbs of commercial Burbot harvest in 2016.

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 less than 0.5 Burbot/lift (Figure 3.2). Burbot abundance increased rapidly after 1993 in the Pennsylvania Ridge area and in the eastern basin, reaching a peak of 4.2 Burbot/ lift in 1998. 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 0.5 Burbot/lift in 2005-2006. Catch rates in the eastern basin since 1998 have been variable but exhibited an overall decreasing trend with record low numbers observed in 2015.

In 2016, the abundance and biomass of Burbot in Lake Erie exhibited a slight increase relative to recent years. In the Partnership Survey gear, the abundance of Burbot in the west-central and east-central basins remained low during 2016, which is typical for these regions of the lake (Figure 3.2). In the east basin and along the Pennsylvania Ridge, Burbot catch rates increased in 2016 relative to 2015; however, relative to the time series, these catches remained among the lowest on record (i.e., < 1.0 Burbot/ lift). A slight increase in Burbot biomass (Figure 3.3) in the east basin was observed in 2016 relative to the past few years, but the 2016 value was still among the lowest recorded since 1989. In the Interagency CWA survey, the 2016 Burbot catch rate increased in New York waters relative to 2015, but remained similar in Ontario and Pennsylvania (Figure 3.4). Interagency CWA survey Burbot catch rates in 2016 remained among the lowest in the time series.

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, Burbot were undetected within the two rivers and since 2015, 24 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, 20 of the 24 Burbot were captured either on or near the artificial reefs.

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

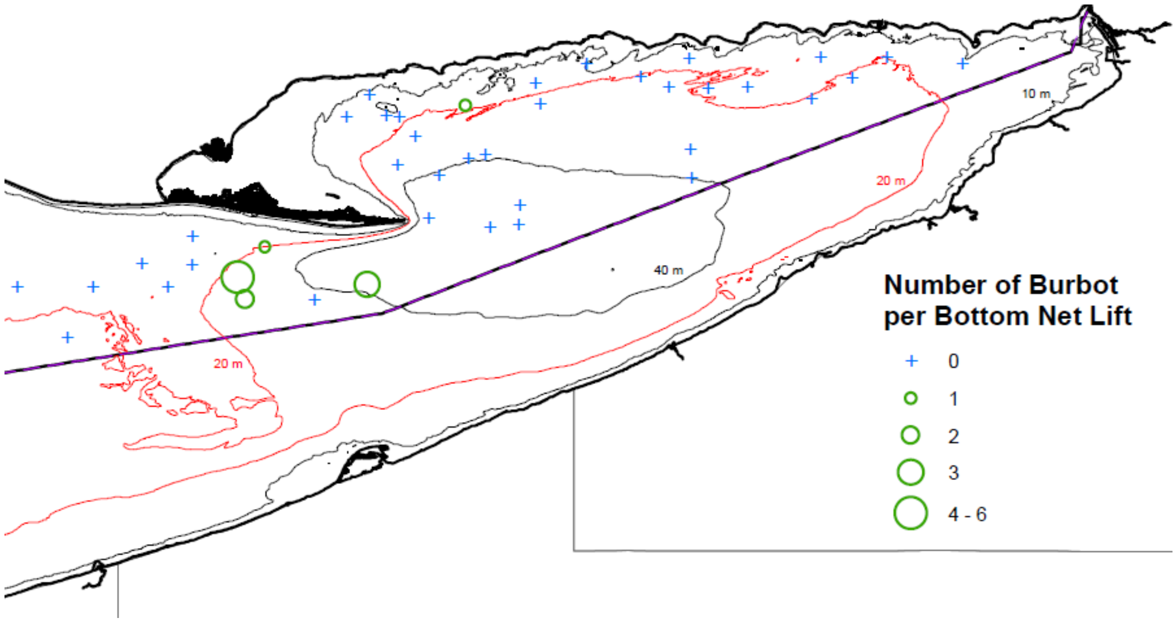

FIGURE 3.1. Distribution of eastern basin Burbot catches (Number per lift) in Ontario Partnership gill nets during August 2016 survey of eastern Lake Erie.

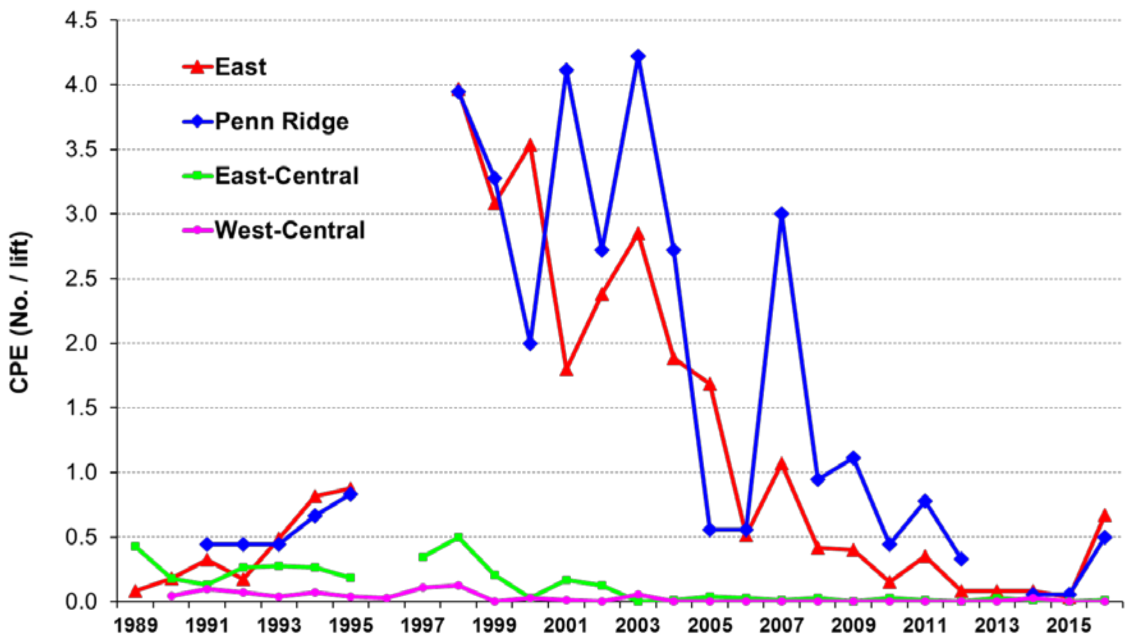

FIGURE 3.2. Burbot CPE (number per lift) by basin from the Ontario Partnership surveys 1989–2016 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets). Pennsylvania Ridge was not sampled in 2013.

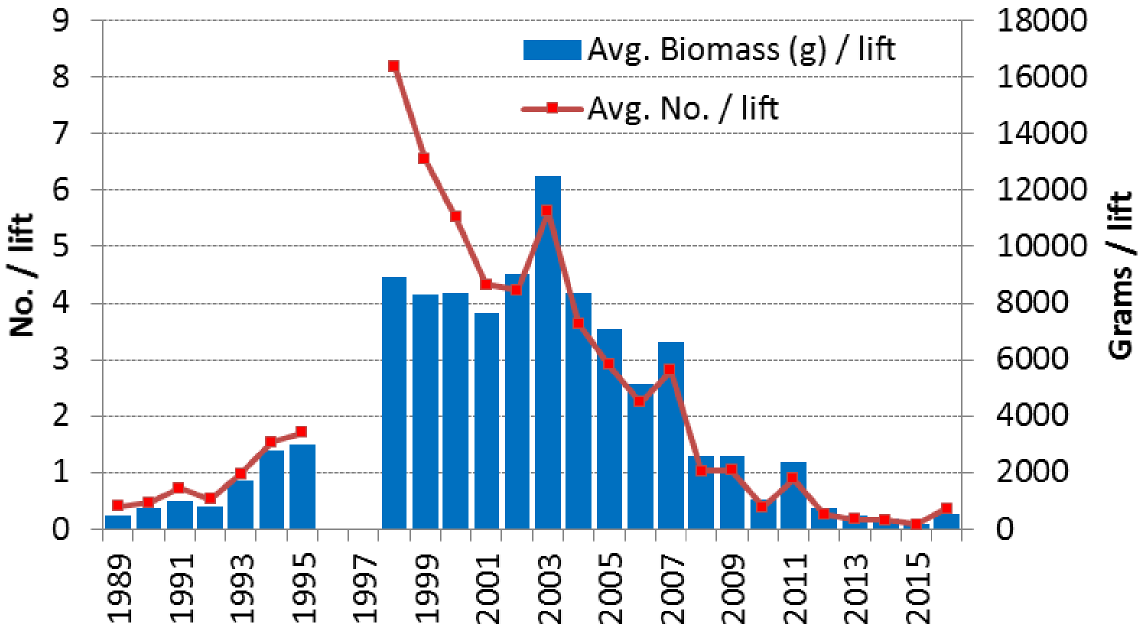

FIGURE 3.3. Average catch rate (CPE as number per lift) and biomass (grams per lift) of Burbot in Ontario waters of eastern Lake Erie, Ontario Partnership gill net survey 1989–2016 (includes only bottom sets, all mesh sizes; PA-ridge and eastern basin sample sites). Pennsylvania Ridge was not sampled in 2013.

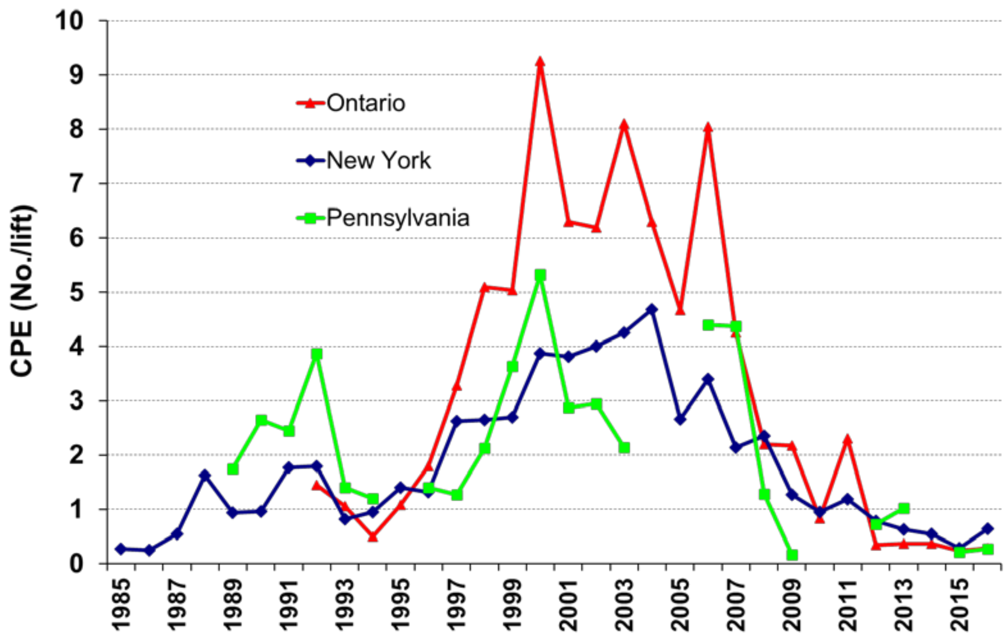

FIGURE 3.4. Average Burbot catch rate (number of fish/lift) from multi-agency summer Coldwater Assessment gill nets by jurisdiction in eastern Lake Erie, 1985-2016.

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 3 and 24 years in 2016 (Figure 3.6). Burbot older than age-10 made up the majority (77%) of the fish collected in the Interagency CWA survey. The mean age of sampled Burbot increased to 14.5 years, up from 9.2 years in the 2015 survey. This trend continues to follow the trend of increasing average age observed prior to 2015 (Figure 3.7). Recruitment of age-4 Burbot increased almost two-fold from 1997 to 2000, but was followed by an abrupt decrease in 2002. Recruitment remained poor through 2015 (Figure 3.7). Evidence of recent recruitment remains scarce, including a single age-0 Burbot captured at a nearshore index trawl station in Long Point Bay during September 2014 (L. D. Witzel, OMNRF-LEMU, pers. comm.). The youngest individuals captured during 2016 Interagency CWA index netting were age 3 individuals (Figure 3.6).

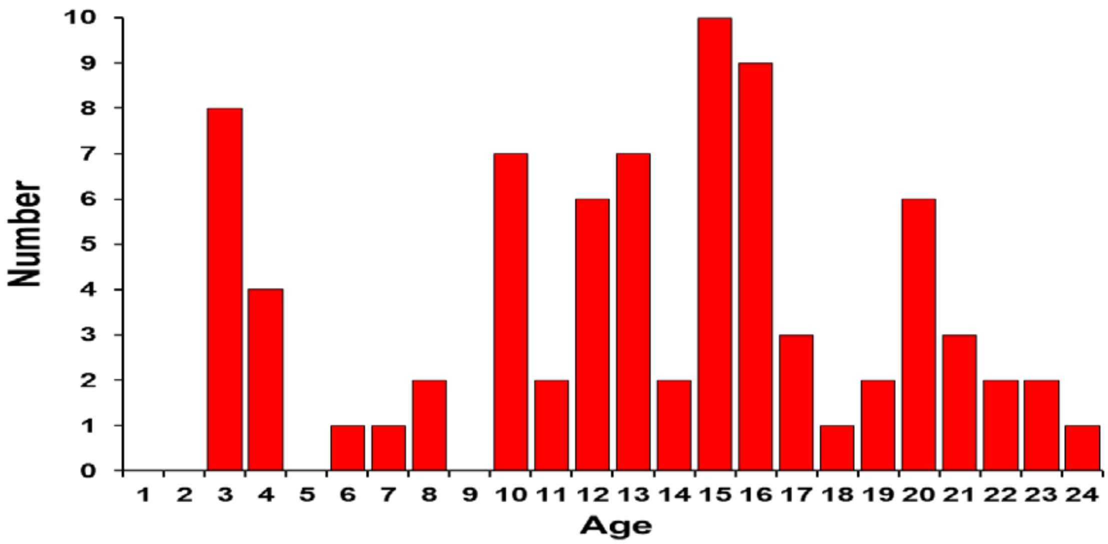

FIGURE 3.6. Age distribution of Burbot caught in multi-agency summer coldwater gill net assessment in eastern Lake Erie, 2016 (N=79).

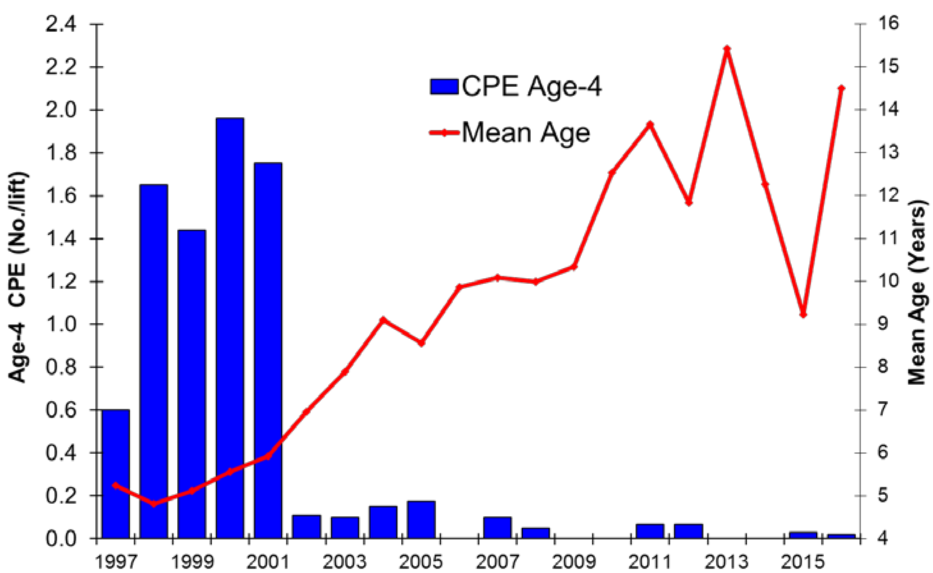

FIGURE 3.7. Mean age and average CPE of age-4 Burbot caught in multi-agency summer coldwater gill net assessment in Ontario waters of eastern Lake Erie during 1997-2016.

Diet

Diet information was limited to fish caught in Ontario and New York waters of Lake Erie during the 2016 Interagency CWA survey; no diet data were collected from fish caught in PA waters nor the Ontario Partnership 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 three different identifiable fish species found in stomach samples. Round Goby were the dominant prey item, occurring in 76% of the Burbot diet samples, followed by Rainbow Smelt (16% occurrence). Yellow perch were found in 5% of the samples, all of which originated from the New York survey sites.

Round Gobies have increased in the diet of Burbot since they first appeared in the eastern basin in 1999, this trend continued in 2016 (Figure 3.9). Prior to 2003, Rainbow Smelt comprised approximately 70% of Burbot diets, after 2003 the percentage decreased to 30%. Similar to the trend observed since 2003, Round Goby were the most common Burbot prey item (i.e., frequency of occurrence) in the 2016 Interagency CWA survey, comprising 80% of the diet samples

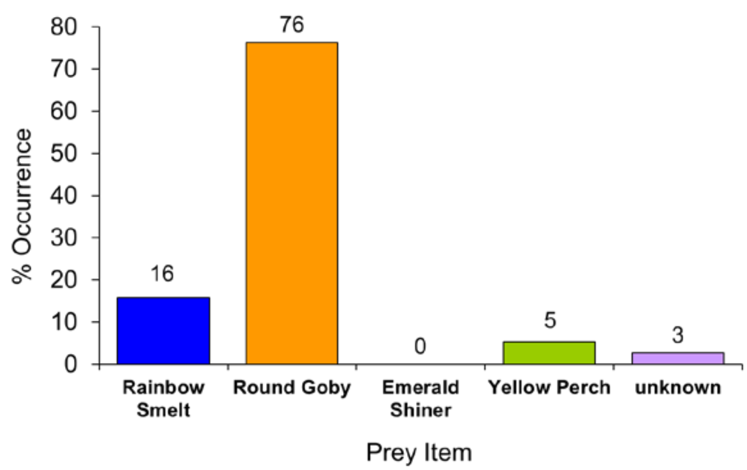

FIGURE 3.8. Frequency of occurrence (%) of diet items from non-empty stomachs of Burbot (N=38) sampled in multi-agency coldwater assessment gill nets from the eastern basin of Lake Erie, August 2016. Unknown includes fish remains that could not be identified to species.

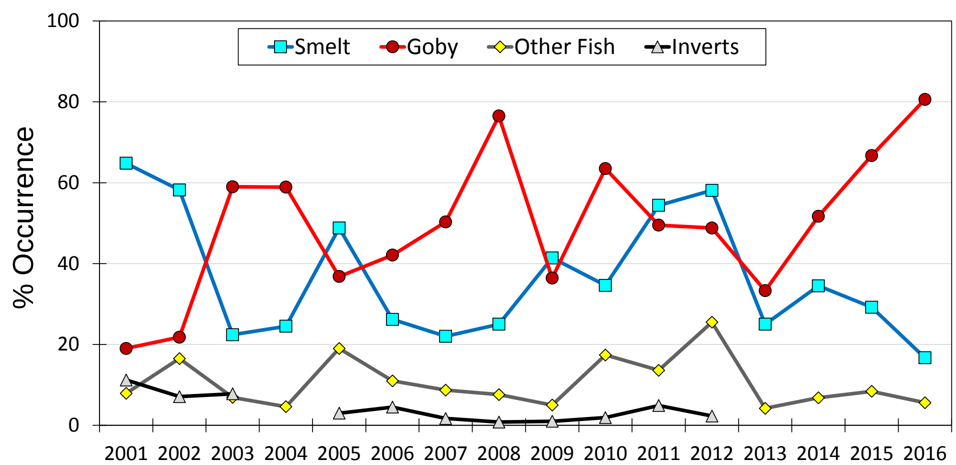

FIGURE 3.9. Frequency of occurrence (%) of Rainbow Smelt, Round Goby, other fish species, and invertebrates in the diet of Burbot caught in summer multi-agency coldwater assessment gill nets in the eastern basin of Lake Erie, 2001-2016.

References

Coldwater Task Group (CWTG). 1997. Report of the Coldwater Task Group to the Standing Technical Committee of the Lake Erie Committee, March 24, 1997.

Edwards, W.H., M.A. Stapanian, A.T. Stoneman. 2011. Precision of Two Methods for Estimating Age from Burbot Otoliths. Journal of Applied Ichthyology 27 (Supplement 1): 43-48.

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 72 A1-A3 wounds were found on 488 Lake Trout greater than 532 mm (21 inches) total length in 2016 during coldwater assessment gill netting, equaling a wounding rate of 14.8 wounds per 100 fish (Table 4.1; Figure 4.1). This was higher than the average wounding rate from the previous 10 years (12.9 wounds/100 fish) and nearly 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 20 of the past 21 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 (17.3 wounds/100 fish) while Lake Trout greater than 736 mm (29 inches) total length (TL) were slightly less (15.2 wounds/100 fish; Table 4.1). Small Lake Trout less than 532 mm (21 inches) are rarely attacked when larger Lake Trout are available.

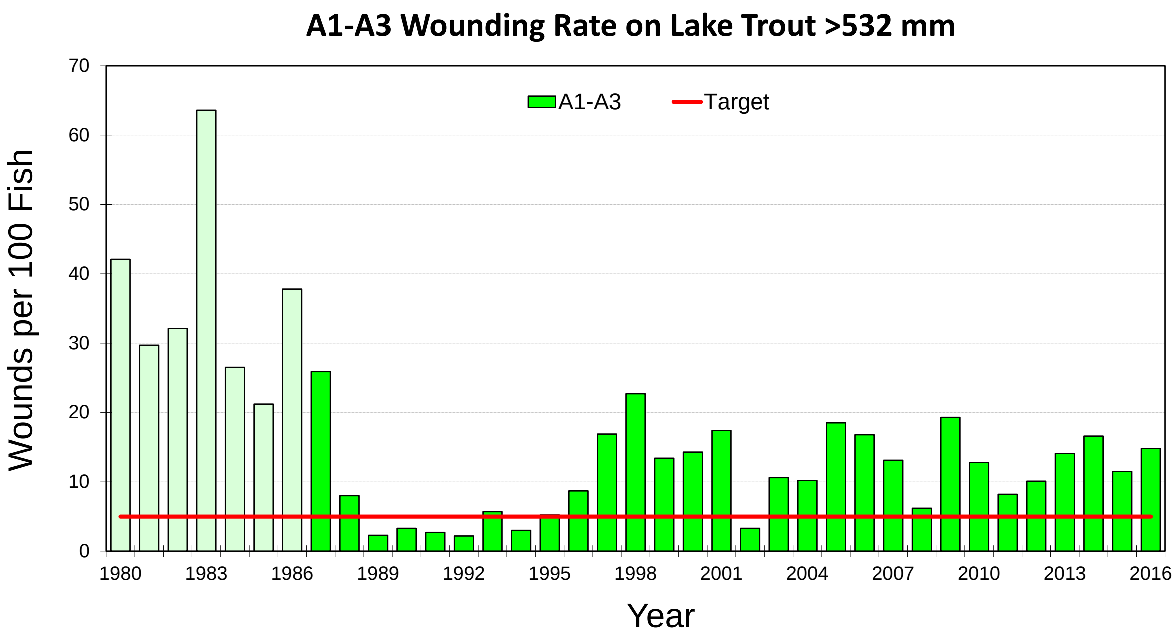

FIGURE 4.1. Number of fresh (A1-A3) Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2016. The target rate is 5.0 wounds per 100 fish. Lighter shading indicates pre-treatment years.

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 2015.

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	5	0	0	0	0	0.0	0.0
533-634	54	0	1	0	4	1.9	7.4
635-736	243	3	5	34	140	17.3	57.6
>736	191	3	5	21	170	15.2	89.0
>532	488	6	11	55	314	14.8	64.3

Finger Lakes (FL), Klondike (KL), and Lake Champlain (LC) strain Lake Trout were the most sampled strains in 2016, 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 the highest on LC strain Lake Trout in 2016 and lowest on FL strain fish. A4 wounds were the highest on KL strain fish. Lake Superior Lake Trout strains (Klondike (KL), Slate Island (SI), Apostle Island (AI)) have higher wounding rates than Finger Lakes (FL) strain Lake Trout, indicative of higher susceptibility of these strains to Sea Lamprey attacks. Wounding statistics from the previous few years indicated the LC strain Lake Trout performed better than Superior strains of Lake Trout and were similar to FL strain Lake Trout in their susceptibility to attacks. However, this trend did not continue in 2016 as LC strain fish registered A1-A3 wounding rates that were over three times the rates found on FL strain Lake Trout.

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 2015. 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	3	0	0	1	5	33.3	166.7
FL	116	3	1	3	70	6.0	60.3
KL	25	0	1	2	31	12.0	124.0
LC	266	2	7	42	171	19.2	64.3
LL	1	0	0	1	2	100.0	200.0
SI	12	1	0	1	1	16.7	8.3

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 2016, there were two A1-A3 wounds on the 68 Burbot sampled greater than 532 mm (21 inches) during coldwater assessment gill netting, equaling a wounding rate of 2.9 wounds/100 fish. A4 wounding rates were 4.4 wounds per 100 fish. Both A1-A3 and A4 wounding rates on Burbot have remained relatively steady since 2007.

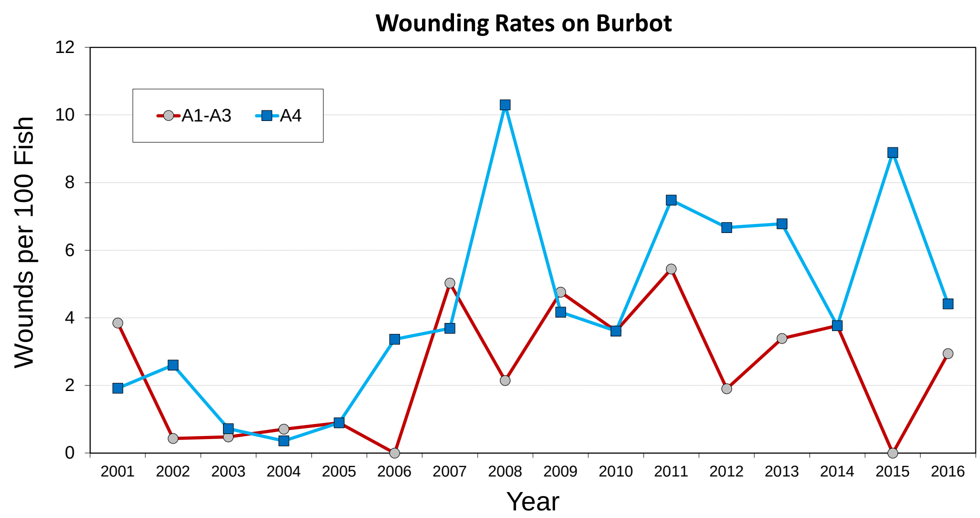

FIGURE 4.2. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Burbot greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2016.

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 77 Lake Whitefish greater than 532 mm (21 inches) were caught in 2016 assessment netting; 2 of these fish had A1-A3 wounds (2.6 wounds/100 fish) and 4 had A4 wounds (5.2 wounds/100 fish) (Figure 4.3). Both A1-A3 and A4 wounding rates on Lake Whitefish remain consistent over the previous five years with the exception of 2015 when only two fish were caught.

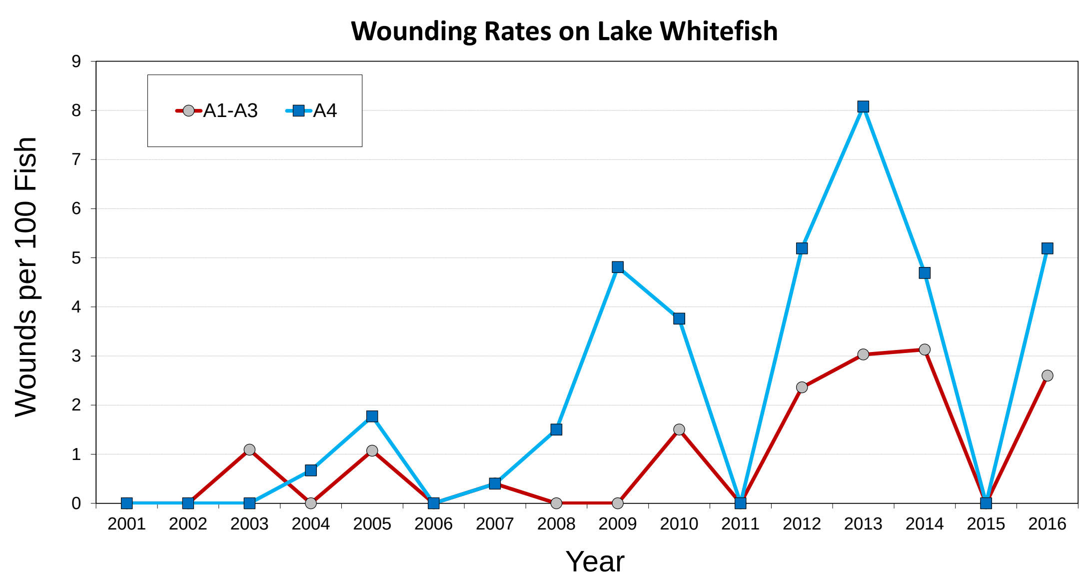

FIGURE 4.3. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Lake Whitefish greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2016.

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 2016 during a research project being conducted on Chautauqua Creek, NY. Total wounding rates (A1-A4 + B wounds) on Steelhead from these surveys were 21.8 wounds/100 fish with the majority of the wounds (24 of 31; 77%) being A4 wounds.

TABLE 4.3. Frequency of Sea Lamprey wounds observed on Steelhead from various Lake Erie tributary surveys, 2003-2016.

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

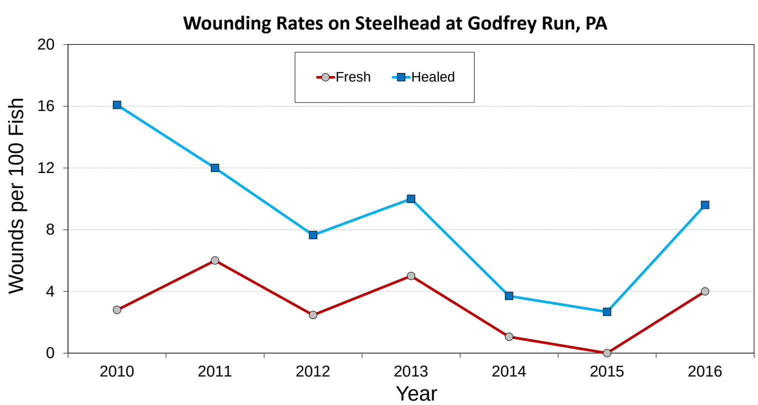

FIGURE 4.4. Number of fresh (A1-A3) and healed (A4+ B Type) Sea Lamprey wounds per 100 Steelhead sampled in Godfrey Run, PA, 2010-2016.

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 2016. 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 10 Lake Trout (all sizes) were collected from index and auxiliary gear in 2016 and examined for wounds. There was one A1 wound observed, yielding a wounding fraction of 0.10. Fresh (A1-A3) Sea Lamprey wounds were also found on Burbot, White Sucker, and Walleye (Figure 4.5). There were no healed A4 wounds found on any fish in 2016, but B-type wounds were observed on a Smallmouth Bass.

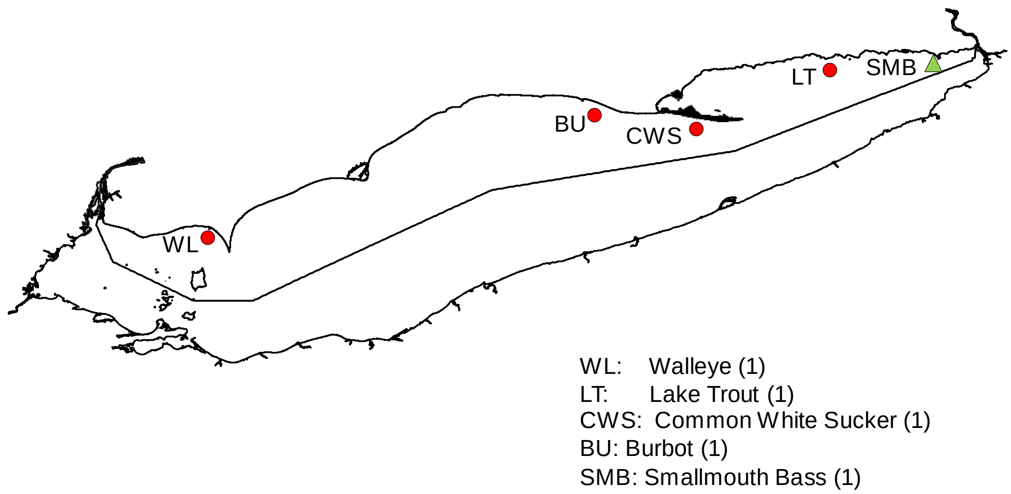

FIGURE 4.5. Number of fish with fresh (A1-A3; red circles) and B-type (green triangle) Sea Lamprey wounds during Lake Erie Partnership Index gill netting 2016. Includes index and auxiliary gear.

Summary of 2016 Actions and 2017 Plans for the Integrated Management of Sea Lampreys in Lake Erie

The Great Lakes Fishery Commission and its control agents (U.S. Fish and Wildlife Service and Department of Fisheries and Oceans, Canada) 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.

2016 Highlights

Lampricide Control

- Lampricide treatments were completed in 3 tributaries (1 Canada, 2 U.S.).
- The main branch of Catfish Creek was treated for the first time in 2016.
- Favorable weather conditions in early May resulted in a highly successful treatment of Cattaraugus Creek and its tributaries.
- The Grand River was deferred due to unfavorable conditions. It will be treated in the spring of 2017.

Larval Assessment

- Larval assessments were conducted on 51 tributaries (20 Canada, 31 U.S.) and offshore of 1 U.S. tributary. The status of larval Sea Lampreys in historically infested Lake Erie tributaries and lentic areas is presented in Appendix I.
- Surveys to detect new larval populations were conducted in 25 tributaries (10 Canada, 15 U.S.). No new populations were discovered.
- Post-treatment assessments were conducted in 4 tributaries (1 Canada, 3 U.S.) to determine the effectiveness of treatments conducted during 2015 and 2016.
- Surveys to evaluate barrier effectiveness were conducted in 7 tributaries (6 Canada, 1 U.S.).
- 2.3 ha of the St. Clair River was surveyed with granular Bayluscide (gB), including the upper river and the three main delta channels. Thirty-five 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 14.8 kg active ingredient of gB (7.0 Canada, 7.8 U.S.).

Juvenile Assessment

- Based on standardized fall assessment data, the marking rate during 2015 was 14 A1-A3 marks per 100 Lake Trout >532 mm, down from 17 in 2014.
- In cooperation with Walpole Island First Nation, the GLFC and partners completed the second year of an annual index for out-migrating juvenile Sea Lampreys in the St. Clair River (SCR). Ten floating fyke nets were initially deployed in November 2016. Due to complications surrounding USCG aids to navigation and winter servicing, only four nets remained during the final three weeks of operation. Two-hundred and two juvenile Sea Lampreys were captured over the collection period.

Adult Assessment

- A total of 1,560 Sea Lampreys were trapped in 5 tributaries during 2016, all of which are index locations. Adult population estimates based on mark-recapture were obtained from 4 of the 5 index locations; the other (Cattaraugus Cr.) was estimated using the relative annual pattern of abundance.

- The index of adult Sea Lamprey abundance was 4,788 (95% CI; 2,716 – 6,860), which was higher than the target of 3,039 (Figure 4.6).

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

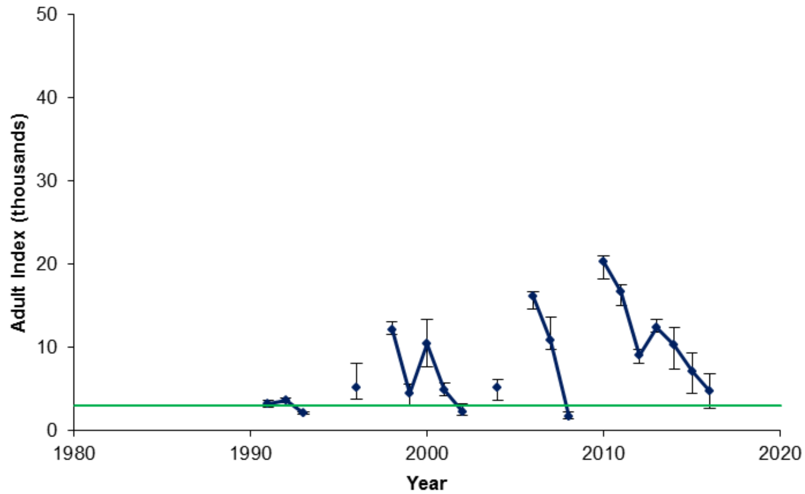

FIGURE 4.6. Index estimates with 95% confidence intervals (vertical bars) of adult Sea Lampreys. The point estimate was above the target of 3,039 (green horizontal line). The index target was estimated as the mean of indices during a period with acceptable marking rates (1991-1995).

Barriers

- Field crews visited 15 structures 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 (4 U.S., 7 Canada).

- Repairs or improvements were conducted on three Canadian barriers:

  - Big Otter Creek – The Black Bridge dam on Big Otter Creek near Tillsonburg, Ontario has been identified as a potential structure to retrofit as a Sea Lamprey barrier. An engineering firm has been contracted and a detailed study is underway, funded through a Government of Canada infrastructure renewal program.

  - Big Creek – The control system of the inflatable barrier failed in 2016. A steel beam was placed across the stream to raise the Obermeyer gates during the Sea Lamprey spawning run during 2016.

  - Forestville Creek - The landowner is being consulted on rehabilitation of the access road, which is planned for 2017.

- Cattaraugus Creek **–** The 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 still needs to be completed, but once completed the study team will move forward with the engineering and design phase of this project. This project will open up approximately 70 miles of Cattaraugus Creek upstream of the Springville Dam. The selected plan will lower a portion of the existing spillway from 28 to 13 feet high to serve as a Sea Lamprey barrier. A rock riffle ramp with seasonal trapping and sorting operations is also included in the design. Construction is targeted for summer of 2018.

- 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 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 (DPR). The Project Partnership Agreement (PPA) is in review by the USACE and the allocation agreement between GLFC and Ashtabula County has been signed. Barrier design is currently under review. The existing structure does not provide a sufficient drop at the 10-year flood event and is a sloped crest. Construction is targeted to begin in 2018.

- East Branch Chagrin River – Larval and habitat surveys were conducted upstream of the Kirtland Country Club Dam during July 2016 to determine the production potential for Sea Lampreys in areas upstream of the dam, which has been proposed for removal.

- Consultation to ensure blockage at barriers were conducted with partner agencies for seven sites in four streams during 2016 (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	Comments
Chagrin R.	East Br. Chagrin R.	ECT[1]	Kirkland Hills Country Club Dam	Conditional	First Blocking
Cuyahoga R.		OSMP[2]	Gorge Plant Dam	Conditional	First blocking
Cuyahoga R.		OEPA[3]	Brecksville Dam	Conditional	Ineffective barrier
River Rouge.		MIDNR[4]	Ford Estate Dam	Concur	Ineffective Barrier
Rocky R.	Baldwin R.	RRWC[5]	Webster Rd. Dam	Concur	Ineffective Barrier
Rocky R.	Baldwin R.	RRWC[5]	Lucerne Dr. Dam	Concur	Ineffective Barrier
Rocky R.	Baldwin R.	RRWC[5]	Dam #4	Concur	Ineffective Barrier

[1]Environmental Consulting & Technology, Inc.
[2]Ohio Summit Metro Parks.
[3]Ohio Environmental Protection Agency.
[4]Michigan Department of Natural Resources.
[5]Rocky River Watershed Council.

Risk Management

- Granular Bayluscide Study in a Lotic System – Three field tests were conducted (May 31 – June 9) on the Middle Channel of the St. Clair River to determine the concentration of niclosamide (2', 5-dichloro-4'-nitrosalicylanilide) in the water column and sediment following the application of Bayluscide 3.2% granular Sea Lamprey larvicide. Analysis of samples will be completed by March 2017 and a report will follow.

2017 Plans

Lampricide Control

- Lampricide treatments are planned for 4 tributaries (2 Canada, 2 U.S.).
- Lampricide applications are planned for the Grand River and Tributary 3 of Crooked Creek (U.S.) and in Big Otter and Big Creeks (Canada).

Larval Assessment

- Larval assessments are planned on 79 streams (54 U.S., 25 Canada) (Appendix I).
- There are plans to conduct detection surveys on 59 (41 U.S., 18 Canada) Lake Erie tributaries.
- At least 2.4 hectares of gB assessment is planned for the St. Clair River to estimate reach specific larval Sea Lamprey densities in preparation for potential future treatment.
- Adult assessments are planned on Big Otter, Big, Youngs, and Cattaraugus creeks and the Grand River (2 U.S., 3 Canada).

Juvenile Assessment

- Assessment for out-migrating juvenile Sea Lampreys in the St. Clair River (SCR) is planned for the third consecutive year by Walpole Island First Nation, in cooperation with GLFC 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 GLFC purpose built barriers in Lake Erie waters of the U.S. and Canada.
- Grand River – Continue barrier design review and preparation for permitting and bid solicitation. Construction is targeted to begin in 2018.

Risk Management

- Grand River Non-target Surveys – The Risk Management Team (RMT) will participate with partner agencies and local community volunteers to conduct non-target surveys from Harpersfield Dam to Vrooman Road during the Grand River lampricide treatment.

- Logperch Tests – Tests to determine the toxicity of TFM to logperch will occur during May 2017. Snuffbox mussel (federal endangered species) glochidia attach to the gills of logperch (*Percina caprodes*) during an important stage of their life cycle. Logperch are sensitive to lampricides. To protect the snuffbox mussel the RMT is seeking to define the timing and toxicity limits required to ensure logperch are not negatively affected while serving as a host to the glochidia. While some data is available from previous laboratory studies, there was a concern about specimen health coupled with a strong desire to collect data from a field environment to more accurately reflect the conditions encountered during a treatment.

- Freshwater Mussel Tests – Tests will be conducted to determine the toxicity and sub-lethal effects of niclosamide following gB applications to the Eastern pondmussel (*Ligumia nasuta*; 2017) and the round hickorynut (*Obovaria subrotunda*; 2018) in flow through aquaria in a portable laboratory containing St. Clair River sediment and water, and in situ in the Middle Channel of 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.

Appendix I. Larval Sea Lamprey assessments of Lake Erie tributaries during 2016 and plans for 2017.

Stream	History	Surveyed in 2016	Survey Type[1]	Results	Plans for 2017
Canada					
St. Clair R.	Positive	Yes	Evaluation	Positive	Evaluation
Talford Cr.	Negative	Yes	Detection	Negative	
Thames R. (Komoka Cr.)	Positive	No	Evaluation		Evaluation
Thames R. (Tribs)	Negative	Yes	Detection	Negative	Detection
Unnamed Cr.	Negative	No	Detection		Detection
Dolsons Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No	Detection	Negative	
Unnamed Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Muddy Cr.	Negative	No			Detection
Hillman Cr.	Negative	Yes	Detection	Negative	
West Two Cr.	Negative	No			Detection
Indian Cr.	Negative	No			Detection
Unnamed Cr.	Negative	Yes	Detection	Negative	
Unnamed Cr.	Negative	No			Detection
East Cr.	Positive	No			Evaluation
Catfish Cr.	Positive	Yes	Evaluation	Negative	
Silver Cr.	Positive	Yes	Evaluation	Positive	Evaluation
Big Otter Cr.	Positive	Yes	Distribution	Positive	Treatment Evaluation
South Otter Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Long Point Cr.	Negative	No			Detection
Big Cr.	Positive	Yes	Distribution	Positive	Treatment Evaluation
Fishers Cr.	Positive	No			Evaluation
Youngs Cr.	Positive	No			Evaluation
Grand R.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Frenchman Cr.	Negative	No			Detection
Miller Cr.	Negative	No			Detection
Black Cr.	Negative	No			Detection
Boyers Cr.	Negative	No			Detection
Usshers Cr.	Negative	No			Detection

Appendix I. ***continued***

Stream	History	Surveyed in 2016	Survey Type[1]	Results	Plans for 2017
United States					
Niagara R.	Positive	No			Evaluation
Buffalo R.	Positive	Yes	Evaluation	Negative	Evaluation
Buffalo R. – lower lotic	Negative	No			Evaluation-GB
Rush Cr.	Negative	Yes	Detection	Negative	
North Athol Springs Cr.	Negative	No			Detection
Locksley Park Cr.	Negative	No			Detection
Clifton-Heights Cr. West	Negative	No			Detection
Pike Cr.	Negative	No			Detection
Little Sister Cr.	Negative	No			Detection
Big Sister Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Delaware Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Cattaraugus Cr.	Positive	Yes	Treat-Evaluation	Positive	Evaluation/Dist
Cattaraugus Cr. (estuary)	Positive	No			Evaluation-GB
Silver Cr.	Negative	No			Detection
Eagle Bay Cr.	Negative	No			Detection
Halfway Br.	Positive	No	Evaluation	Negative	
Merritt Winery Cr.	Negative	No	Detection	Negative	
Beaver Cr.	Negative	No			Detection
Canadaway Cr.	Positive	Yes	Treat-Evaluation	Negative	
Canadaway Cr. (lentic)	Positive	No			Evaluation-GB
North Light Rd. Cr. No. 1	Negative	No			Detection
North Light Rd. Cr. No. 2	Negative	No			Detection
Orchard Beach Cr.	Negative	No			Detection
Shades Beach Cr.	Negative	No			Detection
Walker Cr.	Negative	Yes	Detection	Negative	
Chatauqua Cr.	Positive	Yes	Evaluation	Negative	
Mill Cr.	Negative	No			Detection
Twenty Mile Cr.	Negative	Yes	Detection	Negative	
Wilkins Rd. Cr.	Negative	No			Detection
Trout Run	Negative	No			Detection
Lake Erie Park Cr.	Negative	No			Detection
Elk Cr.	Negative	No			Detection
Townline Cr.	Negative	No			Detection
Seven Mile Creek	Negative	No	Detection	Negative	
Cascade Creek	Negative	No	Detection	Negative	
Nursery Rd. Creek	Negative	No	Detection	Negative	

Appendix I. ***continued***

Stream	History	Surveyed in 2016	Survey Type[1]	Results	Plans for 2017
United States *continued*					
Crooked Cr.	Positive	Yes	Treat-Eval/Barrier	Positive	Treat-Evaluation
Racoon Cr. (PA)	Positive	Yes	Evaluation/Dist	Negative	Evaluation
Turkey Cr.	Negative	No			Detection
Conneaut Cr.	Positive	Yes	Evaluation	Positive	Evaluation/Dist
Conneaut Cr. lentic	Positive	Yes	Evaluation-GB	Positive	
Camp Luther Cr. No. 3	Negative	No			Detection
Wheeler Cr.	Negative	No			Detection
Driftwood Cr.	Negative	No			Detection
Arcola Cr.	Negative	No			Detection
Grand R. (OH)	Positive	Yes	Evaluation/Dist	Positive	Treat-Eval
Grand R. (OH) lentic	Negative	No			Evaluation-GB
Chagrin R.	Positive	Yes	Evaluation/Dist	Negative	Evaluation
Black R. (OH)	Negative	No			Detection
Cranberry Cr.	Negative	Yes	Detection	Negative	
Beaver Cr. (OH)	Negative	No			Detection
Vermilion R.	Negative	No			Detection
Anderson Cr.	Negative	No			Detection
Huron R. (East & West Br.)	Negative	Yes	Detection	Negative	
Huron R. (lentic)	Negative	No			Evaluation-GB
Sandusky R. (lentic)	Negative	No			Evaluation-GB
Muddy Cr. (lentic)	Negative	No			Evaluation-GB
Meadow Brook	Negative	Yes	Detection	Negative	
Portage R.	Negative	Yes	Detection	Negative	Detection
La Carpe Cr.	Unknown	Yes	Detection	Negative	
Toussiant River	Negative	Yes	Detection	Negative	
Toussaint River (lentic)	Negative				Evaluation-GB
Crane Cr.	Negative	No			Detection
Maumee R.	Negative	No			Detection
Ottawa R.	Negative	No			Detection
Flat Cr.	Negative	No			Detection
La Plaisance Cr.	Negative	No			Detection
Stony Cr.	Negative	No			Detection
Swan Cr. (Monroe Co.)	Negative	No			Detection
Little Cr.	Negative	No			Detection

Huron R. (MI)- Barrier	Negative	Yes	Detection	Negative	
Black R. (MI)	Positive	Yes	Evaluation	Negative	Evaluation

Appendix I. ***continued***

Stream	History	Surveyed in 2016	Survey Type[1]	Results	Plans for 2017
<u>United States *continued*</u>					
Mill Cr. (Black R.)	Positive	Yes	Evaluation	Negative	Evaluation
Pine R. (St. Clair Co.)	Positive	Yes	Evaluation	Positive	Evaluation
Belle R.	Positive	Yes	Evaluation	Negative	Evaluation
Swan Cr. (East & West)	Negative	Yes	Detection	Negative	
Clinton R.	Positive	Yes	Evaluation/Dist	Positive	Evaluation/Dist
St. Clair R.	Positive	Yes	Evaluation-GB	Positive	Evaluation-GB
Detroit R.	Negative	No			

[1]*Evaluation survey* – conducted to detect larval recruitment in streams with a history of Sea Lamprey infestation.
Detection survey – conducted to detect larval recruitment in streams with no history of Sea Lamprey infestation.
Distribution survey – conducted to determine in-stream geographic distribution or to determine lampricide treatment application points.
Treatment evaluation survey – conducted to determine the relative abundance of survivors from a lampricide treatment.
Ranking survey – conducted to index the larval population to determine need for lampricide treatment the following year. Projected treatment cost is divided by the estimate of larvae > 100 mm to provide a ranking against other Great Lakes tributaries for lampricide treatment.
Biological collection – conducted to collect lamprey specimens for research purposes.
Barrier survey - conducted to determine larval recruitment upstream of barriers.
GB – surveys conducted using granular Bayluscide.

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 218,666 yearling Lake Trout were stocked in Lake Erie in 2016 (Figure 5.1). For the fourth consecutive year, Lake Trout stocking occurred in each of the Lake Erie basins: yearling Lake Trout were stocked in Ohio at both Catawba (40,200) and Fairport Harbor (35,450), in Pennsylvania at the East Avenue Boat Launch (32,500), and in New York offshore of Dunkirk (51,461). In addition, the Ontario Ministry of Natural Resources and Forestry (OMNRF) stocked 59,055 yearlings at Nanticoke Shoal in eastern Lake Erie. All Lake Trout stocked in NY, OH, and PA waters came from the USFWS Allegheny National Fish Hatchery located in Warren, PA, and were Finger Lakes or Lake Champlain strains. Slate Island strain Lake Trout were stocked in Ontario waters. In addition to the yearlings, a total of 26,916 surplus fall fingerling Lake Trout (Finger Lakes strain) were stocked at Nanticoke Shoal by the OMNRF. The combined yearling and fall fingerling yearling equivalents totaled 229,702 yearlings, which exceeded the current Lake Trout stocking goal of 200,000 yearlings for the four consecutive year.

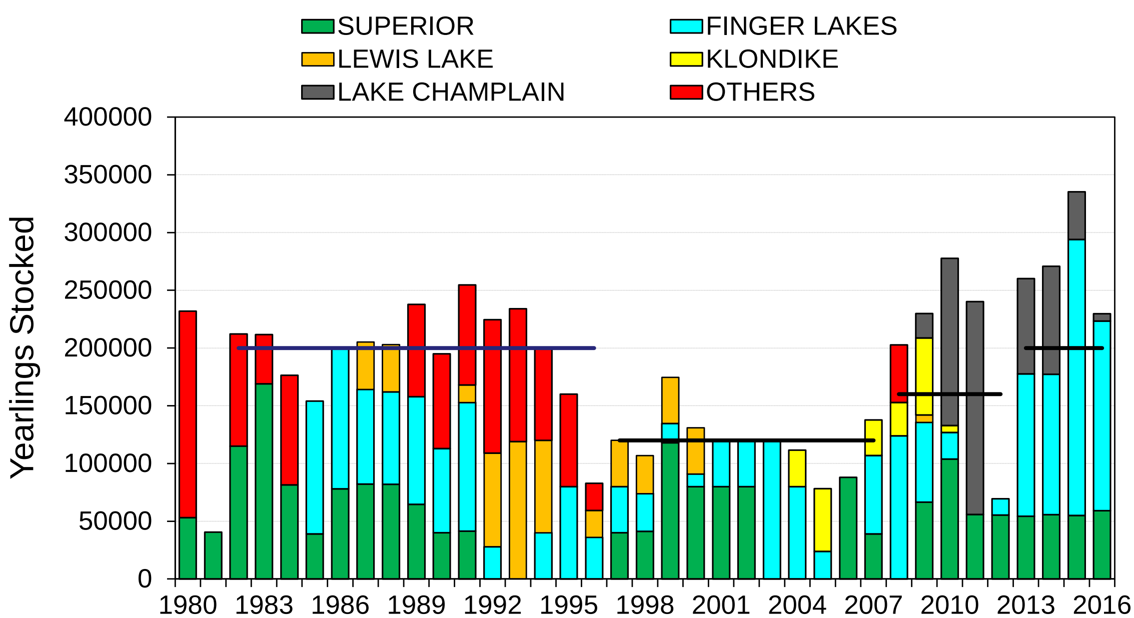

FIGURE 5.1. Lake Trout (in yearling equivalents) stocked by all jurisdictions in Lake Erie, 1980-2016, by strain. Stocking goals through time are shown by black lines dark lines; the current stocking goal is 200,000 yearlings per year. Superior includes Superior, Apostle Island, Traverse Island, Slate Island, and Michipicoten strains; Others include Clearwater Lake, Lake Ontario, Lake Erie, and Lake Manitou strains.

Stocking of Other Salmonids

In 2016, over 2.3 million yearling trout were stocked in Lake Erie, including Rainbow/Steelhead Trout, Brown Trout and Lake Trout (Figure 5.2). Total 2016 salmonid stocking increased about 3% from 2015, and was 4% above the long-term average (1990-2015). 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 1,968,877 yearling

Rainbow/Steelhead Trout were stocked in 2016, accounting for 85% of all salmonids stocked. This was a 10% increase in Steelhead stocking from 2015 and 7% above the long-term (1990-2015) average of 1,825,000 yearling Steelhead. The majority of Steelhead stocking in 2016 occurred in Pennsylvania waters (1,074,849 fish; 55%), followed by Ohio (416,593; 21%), New York (407,111; 21%), Michigan (66,000; 3%) and Ontario (4,324; <1%). Compared to annual stocking targets, Steelhead stocking was above targets in Pennsylvania (7.5%), New York (60.0%), Ohio (4.1%), and Michigan (10.0%), but was below targets in Ontario (92.8%). The substantial increase in Steelhead by New York was due to an isolated stocking of surplus yearlings from the Salmon River State Fish Hatchery, and represented the highest stocking of Steelhead in their Lake Erie stocking program. A full account of Rainbow/Steelhead Trout stocked in Lake Erie by jurisdiction for 2016 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.

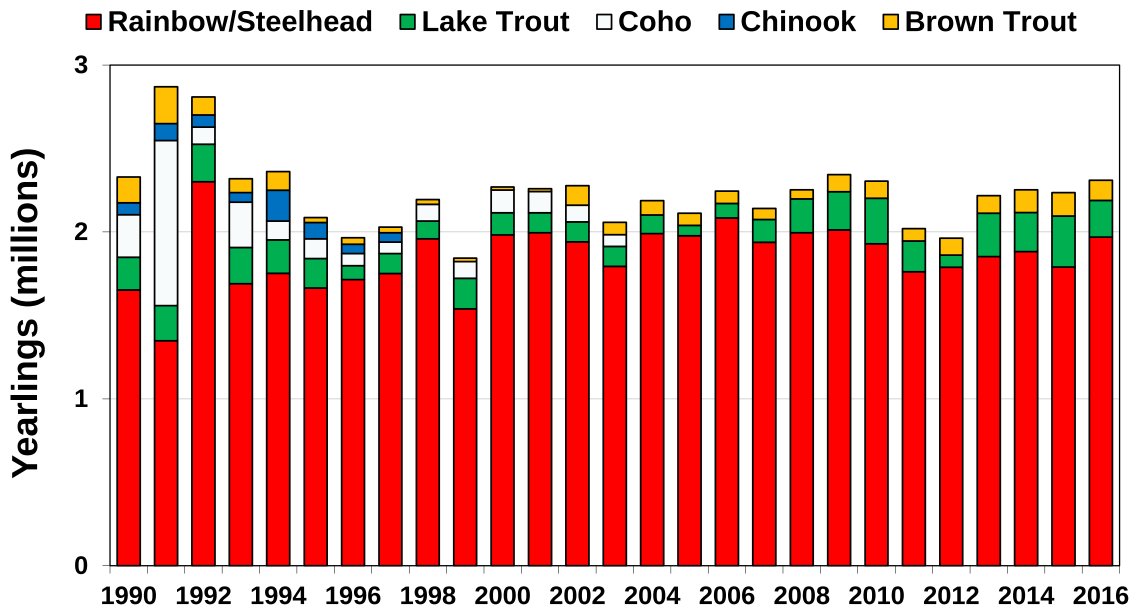

FIGURE 5.2. Annual stocking of all salmonid species (in yearling equivalents) in Lake Erie by all agencies, 1990-2016.

Recent increases in Brown Trout stocking is attributed to the stocking of yearlings and advanced fingerlings in the New York and Pennsylvania waters of Lake Erie. The purpose of these stocking efforts is the development of a trophy Brown Trout fishery to enhance and diversify the stream and offshore trout fisheries. Some Brown Trout (~28% of Pennsylvania total) are also stocked to provide adult trout for the opening day of trout season in Pennsylvania.

Brown Trout stocking in Lake Erie totaled 121,359 yearlings in 2016. This was a 14% decrease from 2015 but still 45% above the long-term (1990-2015) average annual stocking of 83,508 Brown Trout. Between 19 April and 25 April, the NYSDEC stocked 38,110 yearling Brown Trout in Dunkirk Harbor, Cattaraugus Creek, Barcelona Harbor and Eighteen Mile Creek. This was 85% of the target stocking objective of 45,000.

Between 1 March and 24 May, about 28,000 adult Brown Trout were stocked by the PFBC and a few NGO hatcheries to provide catchable trout for the opening of the 2016 Pennsylvania trout season. An additional 700 adult Brown Trout were stocked on November and December in support of late season trout fishing. Pennsylvania NGO's also stocked about 55,000 yearling Brown Trout, primarily in support of a put-grow-take Brown Trout program that was initiated in 2009. This program has been supported through the annual donation of 100,000 certified IPN-free eggs from the NYDEC. The PFBC has been working on developing and maintaining a captive brood source for this program. Brown Trout stocking is expected to continue at the current rates in both Pennsylvania and New York in 2017.

TABLE 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1990-2016.

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, 1990-2016.

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**

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, including growth and exploitation

Chuck Murray (PFBC), James Markham (NYSDEC) and Geoff Steinhart (ODOW)

Stocking

All Lake Erie jurisdictions stocked Steelhead or lake-run Rainbow Trout (hereafter Steelhead) in 2016 (Table 6.1). Based on these efforts, a total of 1,963,877 yearling Steelhead and 5,000 domestic strain Rainbow Trout were stocked in 2016, representing a 10% increase from 2015 and a 7% increase from the long-term (1990-2015) average. Nearly all (99%) of the Steelhead stocked in Lake Erie originated from naturalized Great Lakes strains. A Lake Erie strain accounted for 55% of the strain composition, followed by a Washington strain (20%), Manistee River strain, Ganaraska River strain (7%), Chamber's Creek strain (7%) and less than 1% domestic and Skamania strains.

TABLE 6.1. Steelhead stocked by jurisdiction and location for 2016.

Jurisdiction	Location	Strain	Number	Life Stage	Yearling Equivalents	
Michigan	Huron River	Manistee River, L. Michigan	66,000	Yearling	66,000	
					66,000	**Sub-Total**
Ontario	Mill Creek	Ganaraska River, L. Ontario	40,000	Fingerlings	1,412	
	Erieau Harbor	Ganaraska River, L. Ontario	1,500	Yearlings	1,500	
	Erieau Harbor	Ganaraska River, L. Ontario	40,000	Fingerlings	1,412	
					4,324	**Sub-Total**
Pennsylvania	Bear Creek	Trout Run, L. Erie	12,000	Yearling	12,000	
	Conneaut Creek	Trout Run, L. Erie	73,624	Yearling	73,624	
	Crooked Creek	Trout Run, L. Erie	74,000	Yearling	74,000	
	Elk Creek	Trout Run, L. Erie	240,510	Yearling	240,510	
	Fourmile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Godfrey Run	Trout Run, L. Erie	18,500	Yearling	18,500	
	Presque Isle Bay	Trout Run, L. Erie	87,378	Yearling	87,378	
	Raccoon Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Sevenmile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Sixteenmile Creek	Trout Run, L. Erie	18,500	Yearling	18,500	
	Trout Run	Trout Run, L. Erie	46,250	Yearling	46,250	
	Twelvemile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Twentymile Creek	Trout Run, L. Erie	111,001	Yearling	111,001	
	Walnut Creek	Trout Run, L. Erie	185,000	Yearling	185,000	
	West Basin Pond	Trout Run, L. Erie	86	Yearling	86	
	Lake Erie	Trout Run, L. Erie	60,000	Yearling	60,000	
					1,074,849	**Sub-Total**
Ohio	Chagrin River	Manistee River/Chamber's Creek/Ganaraska River	97,162	Yearling	97,162	
	Conneaut Creek	Manistee River/Chamber's Creek/Ganaraska River	75,019	Yearling	75,019	
	Grand River	Manistee River/Chamber's Creek/Ganaraska River	95,512	Yearling	95,512	
	Rocky River	Manistee River/Chamber's Creek/Ganaraska River	92,855	Yearling	92,855	
	Vermilion River	Manistee River/Chamber's Creek/Ganaraska River	56,045	Yearling	56,045	
					416,593	**Sub-Total**
New York	Silver Creek	Washington	5,000	Yearling	5,000	
	Walnut Creek	Washington	5,000	Yearling	5,000	
	Canadaway Creek	Washington	20,000	Yearling	20,000	
	18 Mile Creek	Washington	40,000	Yearling	40,000	
	Chautauqua Creek	Washington	62,148	Yearling	62,148	
	Buffalo Creek	Washington	5,000	Yearling	5,000	
	Cayuga Creek	Washington	10,000	Yearling	10,000	
	Cattaraugus Creek	Skamania	25,000	Fall Fingerling	883	
	Cattaraugus Creek	Washington	244,080	Yearling	244,080	
	Buffalo River Net Pens	Washington	10,000	Yearling	10,000	
	Bison City R&G Club	Domestic	4,000	Yearling	4,000	
	Erie Basin Marina	Domestic	1,000	Yearling	1,000	
					407,111	**Sub-Total**
					1,968,877	**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 (80,000 fall fingerlings and 1,500 yearlings). Fisheries agency stocking of spring yearlings took place between 22 February and 23 May, with smolts averaging about 174 mm in length (Table 6.2).

TABLE 6.2. Yearling Steelhead stocking summaries for 2016 by fisheries agency.

Agency	Range of Dates Stocked	mean length (mm)	N of yearlings stocked
Michigan Dept. of Natural Resources	6 April - 27 April	198	66,000
New York Dept. of Environmental Conservation	4 April - 23 May	127	407,111
Ohio Division of Wildlife	25 April - 6 May	188	416,593
Pennsylvania Fish and Boat Commission	22 February - 13 April	186	1,002,763
		174	1,892,467

In 2016, NYSDEC staff continued to mark several lots of juvenile steelhead using a combination of fin clips and coded-wire tags (Table 6.3). Fin Clips included an adipose clip (15,930), a left ventral fin clip (15,000), coded-wire tag (CWT) only (15,760) and a combination adipose / CWT (15,548) marked fish. All marked fish were stocked into Chautauqua Creek on 22 April, 2016 in a continuing evaluation of smolt emigration as related to stocking size and location.

TABLE 6.3. Fin clips of Steelhead stocked in Lake Erie, 2000-2016.

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	-	-	-

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

Pilot studies were conducted by the NYSDEC Lake Erie Fisheries Research Unit in 2013 and 2014 to examine post-stocking emigration by juvenile steelhead and assess whether newly stocked Steelhead were detectable in predator diets. The results of these studies concluded that: 1) we could not detect nearshore predators (mainly Walleye and Smallmouth Bass) preying upon stocked Steelhead smolts, and 2) many stocked Steelhead apparently did not smolt due to their small size at stocking and failed to emigrate from the stream to the lake (Markham 2015). These studies demonstrated a need to pursue a more detailed investigation to examine the effects of fish size and stocking location on survival and out-migration behavior, with the ultimate goal of informing stocking practices to improve adult returns to the tributary fishery. The study design evaluated two size ranges of juvenile steelhead (<115 mm vs. >120 mm) and two stocking location (upstream vs. mouth). The portion of the investigation to evaluate juvenile emigration occurred in 2015 and 2016 with subsequent evaluation

of adult returns is lasting from Fall 2015 – Spring 2018. Detailed methods and study design can be found in Markham (2017).

The results from the emigration portion of this research project have been similar between two sampling years, and also consistent with results from a two-year pilot emigration project conducted in 2013 and 2014. However, the study design used in 2015 and 2016 has provided additional insights on the effects of size and stocking location on post-stocking residency. It is apparent that a portion of the steelhead stocked at the traditional upstream stocking location do not emigrate to the lake and remain stream residents at least during the spring through summer study period. This was especially noticeable with the upper small group. Steelhead from the upper small group were encountered throughout the stream five weeks after stocking, and their relatively high occurrence upstream from the stocking location suggested that smaller steelhead tended to move upstream post-stocking more so than downstream. The upper large group appeared to vacate the stocking site at a higher rate than the upper small group, and were scarce at all sample sites by the beginning of July, nine weeks post-stocking. However, a few individuals from the upper large group also exhibited a similar upstream movement behavior observed in the upper small group.

Steelhead stocked near the mouth of the stream appeared to vacate the stream within several weeks of stocking, especially the large group. However, the more extensive stream sampling conducted at the end of May, June, and July indicated that the lower small group exhibited similar upstream migration patterns as the upper small group. Some of these fish were sampled several miles upstream of their stocking location. Similar to the upper large group, a few individuals from the lower large group also exhibited upstream movement behavior.

Preliminary results from the samples of returning adults indicate that the majority (130 of 145; 90%) 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 (10 of 15 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.

Pennsylvania Fish and Boat Commission Adult Spawning Steelhead Survey

In response to declining tributary angler catch rates, the Pennsylvania Fish and Boat Commission staff has been monitoring adult steelhead trout returns to Godfrey Run (42.043058, -80.312541) , a small nursery stream used as a secondary source for feral broodstock in support of Pennsylvania's Steelhead Trout Hatchery Program. Godfrey Run is closed to angling, but fishing is allowed at the mouth of the tributary at the lakeshore.

Beginning in the fall of 2010, adult steelhead were sampled at a fish weir and measured (maximum total length), sexed, checked and scored for lamprey wounding, checked for gill lice (*Salmincola spp.)*, checked for fin clips and marked and released. As seen in Table 6.4, a total of 1,191 Steelhead have been observed during fall spawning runs over the last five years, with sample sizes ranging from 19 (in 2013) to 383 (in 2012). Sex ratio has averaged about 51% males to 49% females. The most skewed sex ratio was in 2013 when males represented 70% of the fish sampled, but inadequate sample size (N=19) precludes any valid explanation; males did represent as much as 61% of the samples in 2011 and 63% of the samples in 2013. Females were more prevalent in the samples in 2010 (51%), 2012 (53%), 2015 (52%) and 2016 (51%). In review of the last seven years, no trend in sex ratio is evident. One obvious trend has been a steadily decline in mean length of spawning run Steelhead Trout since 2010 (Figure 6.1). Average length has declined over 71mm since this assessment started in 2010.

TABLE 6.4: Sample size (N), % males, and mean lengths on of adult fall spawning run Steelhead Trout sampled at Godfrey Run 2010-2016, Erie County PA.

Year	N	% Male	Mean Length (mm)		
			Female	Male	Sexes Combined
2010	141	49%	617	630	623
2011	149	61%	605	618	613
2012	383	47%	609	564	588
2013	19	70%	574	569	571
2014	188	59%	584	564	572
2015	186	48%	569	557	563
2016	125	49%	591	522	552
	1,191	51%	597	575	585

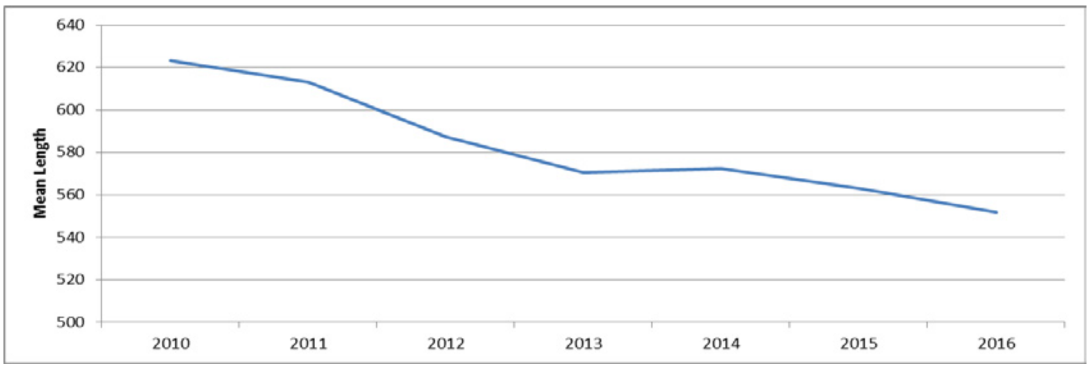

FIGURE 6.1: Mean length of adult Steelhead Trout returning to Godfrey Run 2010-2016, Erie County PA.

Mean length has declined in both male and female adult Steelhead Trout, but has been more pronounced in males. One factor influencing the drop in mean length, especially for males, is the relative increase in "jacks" (precocious males <450 mm) in the spawning runs; in the fall of 2010 and 2011, jacks represented about 2% of the Godfrey Run spawning population, but averaged about 12% of the spawning population between 2012 and 2015, and increased to a time series high of 20% in 2016 (Figure 6.2). Concurrently, the relative percentage of larger fish (>650 mm) averaged about 25% between 2010 and 2015, steadily declining until 2015 when only 4% of the fall run was composed of Steelhead larger than 650mm. In 2016, 19% of the Steelhead in the fall assessment of Godfrey Run were 650mm or larger.

An increase in the relative percentage of jacks may be a result of PFBC efforts to increase stocked smolt size, which has increased steadily since 2010, and met or exceeded the objective stocking length of 180mm the last 4 years. This could be indicative of increased smolt survival or the result of intensive culture which can result in high residualism (Sharp et al 2007), accelerated maturation and precociousness, especially in males (Bilton 1978, Seelbach et al. 1994, Tipping et al. 2003).

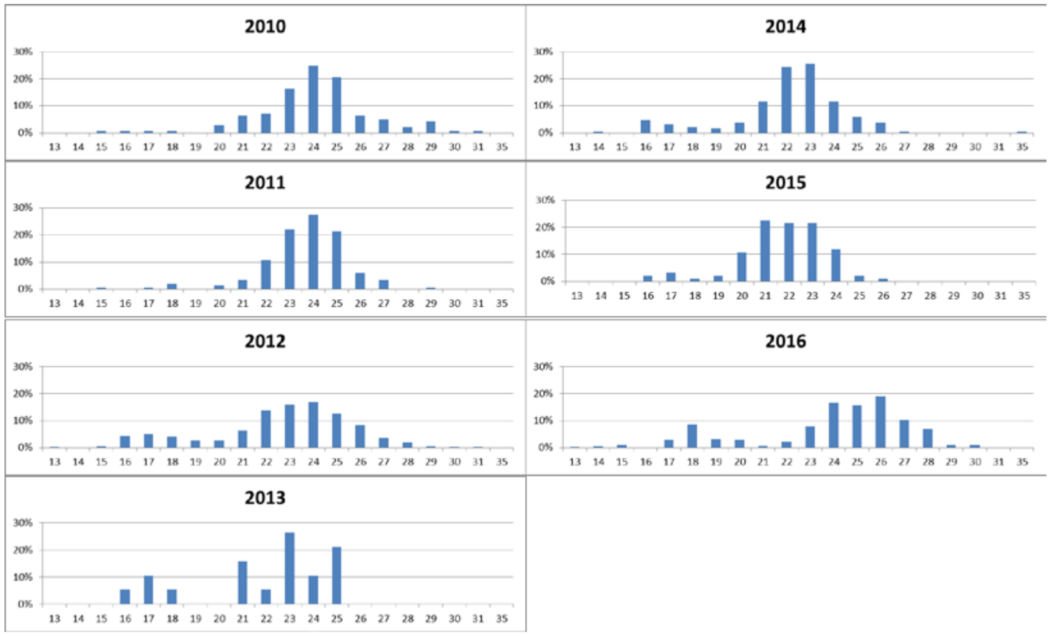

FIGURE 6.2: Length frequency (by 25mm bins) of adult Steelhead Trout returning to Godfrey Run 2010-2016, Erie County PA.

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 provide some measure of the relative abundance of adult Steelhead in Lake Erie.

The 2016 estimated Steelhead harvest from the summer open-water boat angler fishery totaled 4,835 fish across all US agencies, about a 25% decrease from 2015 (Table 6.5). The Ontario Ministry of Natural Resources and Forestry (OMNRF) has intermittently conducted open lake boat angler creel surveys, but no data was collected in 2016. Harvest decreased in all areas from 2015, New York harvest decreased 33%; Pennsylvania harvest fell 31% and Ohio harvest decreased 23% from 2015. No Steelhead harvest has been reported from Michigan waters since 2013. Among the US jurisdictions, over 80% of the reported harvest was concentrated in central basin waters of Ohio (66%) and Pennsylvania (15%). The west-central basin waters of Ohio accounted for 1% the harvest. The east basin accounted for 11% of the harvest, mostly in New York (9%) and some in Pennsylvania (2%). Some harvest by open lake boat anglers was recorded in the western basin in July and August and accounted for about 7% of the total lake wide harvest

A small amount of targeted effort for Steelhead, and small numbers of interviews contributing to the catch rate statistics, limit the application of these results. However, the catch rates do provide some measure of the overall performance of the Steelhead fishery.

Compared to 2015, the 2016 Steelhead catch rates decreased moderately in Pennsylvania but increased sharply in Ohio. Steelhead boat angler catch rates in 2016 were 0.12 Steelhead caught per angler hour in Pennsylvania waters, a 33% decrease from 2015 and 0.12 Steelhead caught per angler hour in Ohio waters, a 200% increase from 2015. The combined catch rate for 2016 (0.12 Steelhead/angler hr.) was about 31% below the long-term average of 0.18 Steelhead caught/angler hr. (Figure 6.4)

TABLE 6.5. Estimated harvest by open lake boat anglers in Lake Erie, 1999-2016.

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
mean	13,392	3,572	655	25,736	37	26,740

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

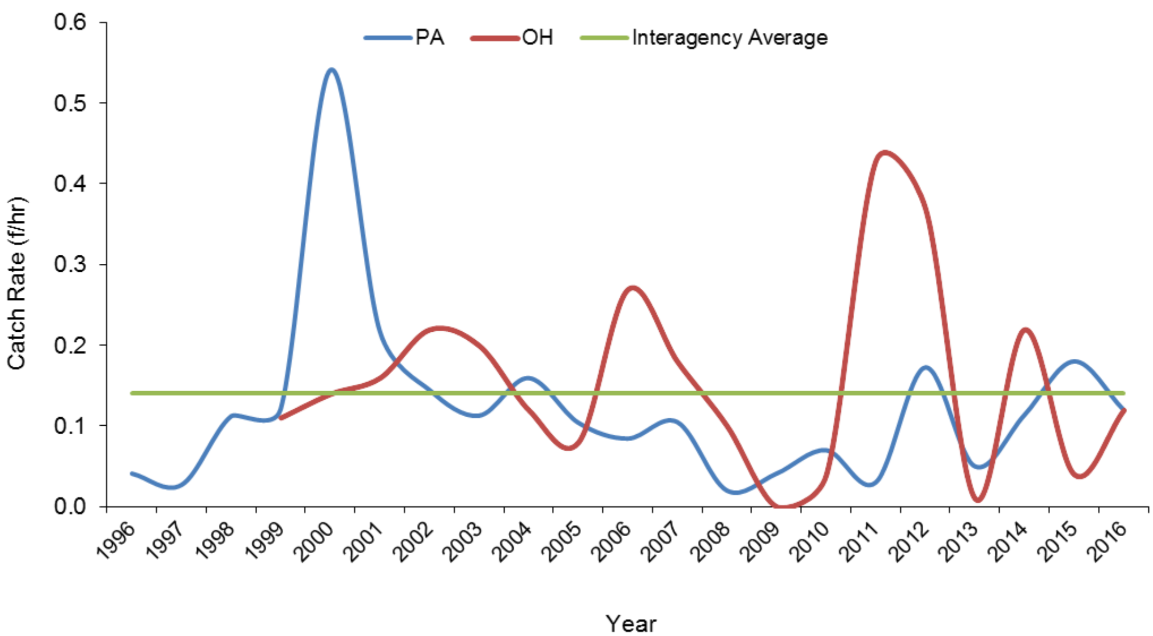

FIGURE 6.4. Targeted Steelhead catch rates (fish caught/angler hr.) in Lake Erie by open lake boat anglers in Ohio and Pennsylvania 1996-2016.

The OMNRF collected open water angler diary reports that can detail trends over time by area of the lake. In 2016, diarists reported 100 targeted Steelhead (Rainbow Trout) angler trips in west-central basin and 20 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.

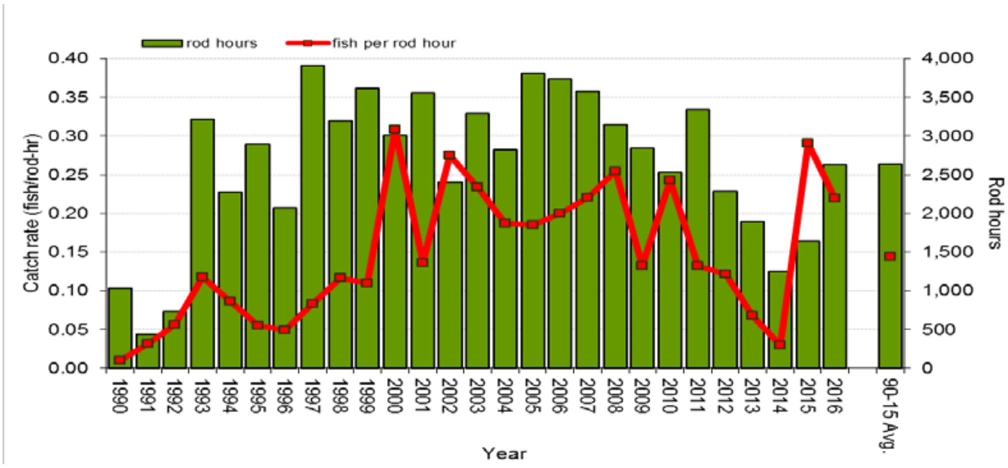

FIGURE 6.5. Targeted Steelhead effort and catch rates in Lake Erie's west-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2016.

Angler diary reports from Ontario in west-central basin waters show that rod-hours for Steelhead in 2016 increased 60% from 2015 and were near the 26-year (1990-2015) mean of 2,635 hours (Figure 6.5). The 2016 Steelhead catch rates in the west central basin (0.219 fish per rod-hour) were a 25% decline from 2015, but remained 53% higher than the long-term average of 0.144 Steelhead/rod-hr.

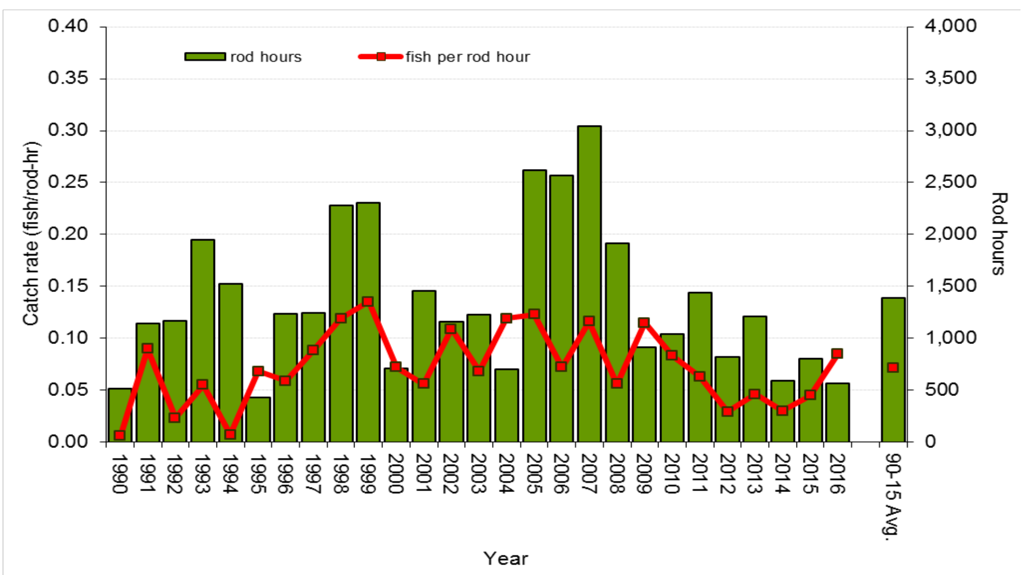

FIGURE 6.6. Targeted Steelhead effort and catch rates in Lake Erie's east-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2016.

The 562 rod-hours of effort recorded by anglers fishing the east-central basin for Steelhead was a slight decrease from 2015 (-30%) and 59% below the 26-year average of 1,384 rod-hours (Figure 6.6). The 2016 catch rate of 0.085 f/rod-hr nearly doubled from 2015 but remained 19% below the long-term average of 0.071 Steelhead/rod-hr.

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 6.7). 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.

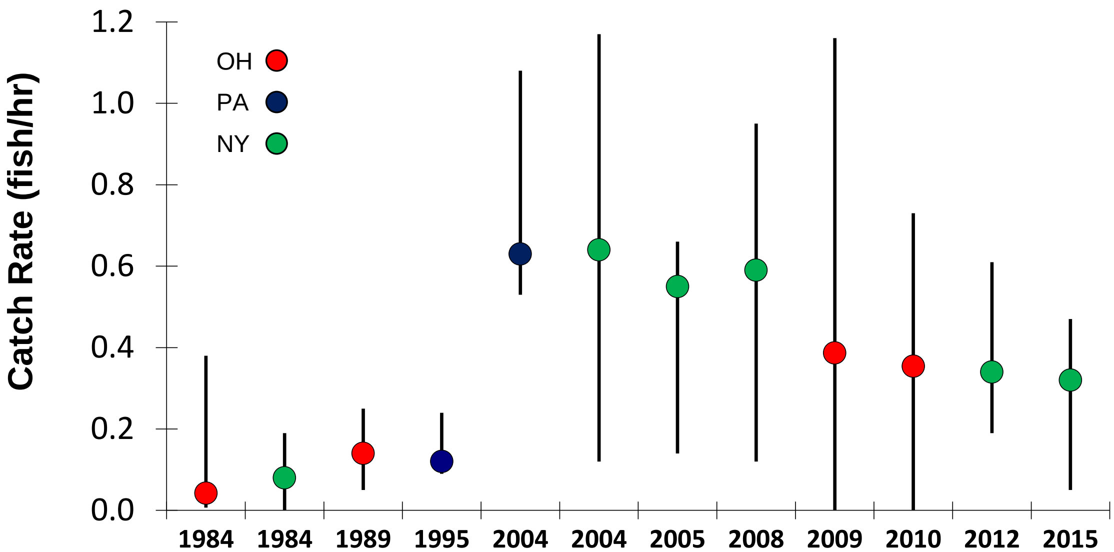

FIGURE 6.7. Targeted Steelhead catch rates (fish/angler hour) in Lake Erie tributary angler surveys by year and jurisdiction, 1984-2015.

NYSDEC Lake Erie Steelhead Management Plan

The NYSDEC completed and approved a Lake Erie Steelhead Management Plan in 2016 (Markham et al. 2016). This plan outlines New York's goals, objectives, and management strategies for the Lake Erie tributary fishery while remaining consistent with broader fish community goals and objectives shared by all Lake Erie jurisdictions. New York's overall goal is to maintain a high quality fishery that provides diverse angling experiences and broad angler satisfaction. Six objectives are listed in the plan to accomplish this goal: 1) maintain average catch rates of 0.33 fish/hour, 2) foster production of wild steelhead in areas with suitable water quality and habitat, 3) increase stream access, 4) protect and enhance stream habitat, 5) maintain simple and effective regulations, and 6) promote responsible stewardship of the resource. Some of the prominent strategies to achieve these objectives include: developing more effective stocking strategies, simplify angling regulations, improve steelhead access to high quality spawning areas, protect and improve habitat, expand angler access, and increase public outreach. Various surveys will be employed to evaluate the progress towards achieving plan objectives, and knowledge gained from ongoing scientific investigations will guide future management strategies. The completed plan can be viewed online at: http://www.dec.ny.gov/docs/fish_marine_pdf/lertmanageplan.pdf.

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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), Chris Vandergoot (USGS), Jim Markham (NYSDEC) and Zy Biesinger (USFWS)

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). Cisco is considered extirpated in Lake Erie, although commercial fishermen report catching individuals periodically (see *Status*, below). Their demise was mainly through over-fishing, although habitat degradation and competition likely contributed to recruitment failure (Greeley 1929, Hartman 1973, Scott and Crossman 1973). Siltation of spawning shoals, low dissolved oxygen, and chemical pollution are a few factors contributing to habitat degradation (Hartman 1973). The Cisco collapse also followed the introduction of both Rainbow Smelt (*Osmerus mordax*) and Alewife (*Alosa psuedoharengus*), and the expansion of these exotic species in the 1950s may have prevented any recovery of Cisco through competition and predation (Selgeby et al. 1978, Evans and Loftus 1987).

Numerous investigators have shown that Alewife and Rainbow Smelt have negative effects on coregonid populations in north-temperate lakes (Ryan et al. 1999). When Alewife and Rainbow Smelt stocks are depressed, it creates an opportunity for coregonids to have stronger year classes. There was some evidence to indicate that this had occurred for Lake Whitefish (Oldenburg et al. 2007) although recent declines in Lake Whitefish abundance and recruitment (See CWTG charge 2) muddy the issue. Ciscoes could be favored by these conditions. Rainbow Smelt abundance declined sharply in the 1990's and continues to remain low relative to the 1980s (Ryan et al. 1999 and Forage Task Group 2016). The most recent, acoustically derived, estimate of yearling-and-older Rainbow Smelt abundance is low (3,452/hectare; 2016) relative to a recent peak in 2009 (~12,000/hectare; Forage Task Group 2017). Alewives have never been very abundant in Lake Erie due to overwinter temperatures that frequently prove lethal (Ryan et al. 1999). An apparent natural recovery from historic lows of other coldwater species (i.e. Lake Whitefish and Burbot) in the early 2000s together with lower abundance of Rainbow Smelt relative to the 1980s had suggested an opportunity for the recovery of Cisco in Lake Erie. Unfortunately, now recognized poor recruitment for both Lake Whitefish and Burbot over the past 10+ years have called into question the window for recovery and created doubt about the potential for Cisco to recover on their own. It should be recognized that, although Rainbow Smelt population abundance in Lake Erie has declined from past decades, densities of this offshore pelagic feeder are still relatively high compared to other forage species (Forage Task Group 2016).

Current Status of Cisco

Cisco observations have been documented in 19 of the last 26 years, most recently in 2015. In 2016, three additional observations were reported but remain unconfirmed. Of the 47 individual fish examined in detail from this time period for which information is available, all but two were surrendered by commercial fishermen operating in Ontario waters. Recent reports and collections are detailed in Table 7.1. Individual Ciscoes have been caught in both trawl fisheries targeting Rainbow Smelt (15 observations) and gillnets targeting Yellow Perch and to a lesser extent White Bass and Lake Whitefish (33 observations combined, including 2016). These captures have occurred in all months that commercial vessels operate (March through December), in depths of water from 7 to 40 metres. They have been captured in all lake basins, however the highest number of occurrences (n=22) are associated with Long Point, near the north-shore division of the eastern and central basins (Figure 7.1). Gillnet and trawl fisheries contributed equally to the concentration of observations near Long Point. The three unconfirmed reports from the 2016 yellow perch gillnet fishery occurred near the base (May) and tip (June) of Long Point as well as in the east-central basin offshore from Port Stanley, ON (January).

It is impossible to assess relative abundance from fishery reports as they represent the passive submission of bycatch by the small number of fishers who recognize their importance. In contrast, Cisco records are rare from fishery agency assessment surveys, where catches are more thoroughly scrutinized by trained observers. The annual OMNRF Partnership index gillnet program, a spatially intensive survey of all Ontario waters has only one Cisco observation in its 27-year history (1990 near tip of Long Point, eastern basin). Similarly, an ODNR fall gillnet survey (30+ years; central basin since 1989) captured one mature female in 2000 close to Fairport, Ohio in the central basin.

Seasonal fish community assessment monitoring appears to lack 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.

An OMNRF onboard observer program intended to detail non-target bycatch in the commercial trawl fishery (2013) and gillnet fishery (2014; some trawls observed) did not result in any additional Cisco observations. Designed to observe and characterize the bycatch of all non-target fish species, the protocol was not ideally suited for capturing rare species. Unfortunately in each year, only a small portion of the total commercial harvest was examined due to logistics and staffing limitations.

Concerted efforts to target Cisco have been few and results 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).

Collectively, all of this suggests that the best approach to increasing observations/sample size in the future would involve either enhancing the Cisco recognition ability and motivation for reporting of the large commercial effort or focusing more targeted agency fishing at the "hot-spot" near Long Point. For the data that does exist, a range in total lengths (140-464 mm) and ages (1-9 yrs.; derived from scale samples) suggest that a number of year classes have contributed to recent observations. An outstanding question is whether these fish were produced internal or external to Lake Erie (see "Determining the source. .."; below).

Ongoing work within the Saint Clair-Detroit River System (SCDRS) may provide some insight into the possibility of immigration into Lake Erie from the Upper Lakes. Surveys conducted as part of a collaborative effort to assess the corridor have documented young (larval and juvenile) coregonine fishes within both the Saint Clair and Detroit Rivers. Two larvae were collected (12.0 mm TL) on May 11-12, 2010, and one on June 16, 2011, in the St. Clair River (Edward Roseman, USGS-GLSC, pers. comm.). Two of those were verified as Cisco through genetic analysis. In December 2011, eight young coregonids were collected in floating fyke nets in the Livingstone Channel of the Detroit River just downstream of Wyandotte, MI (Justin Chotti, USFWS, pers. Comm.). Seven of those were subsequently verified as Cisco. In December 2012, another juvenile coregonid was collected in the Detroit River.

In spring 2013, twenty-two Cisco larvae were captured using bongo nets in the Saint Clair River, and a further 39 were captured using D-frame nets in June and July. It should be noted that transient larvae of a variety of coldwater species were found throughout the main channel of the river in 2013, including Lake Whitefish, Bloater and a large number of Burbot larvae (Edward Roseman, USGS-GLSC, pers. comm.). Three Cisco larvae were also captured in the Detroit River main channel in 2013; possibly representing the first confirmation of larval Cisco in this part of the system.

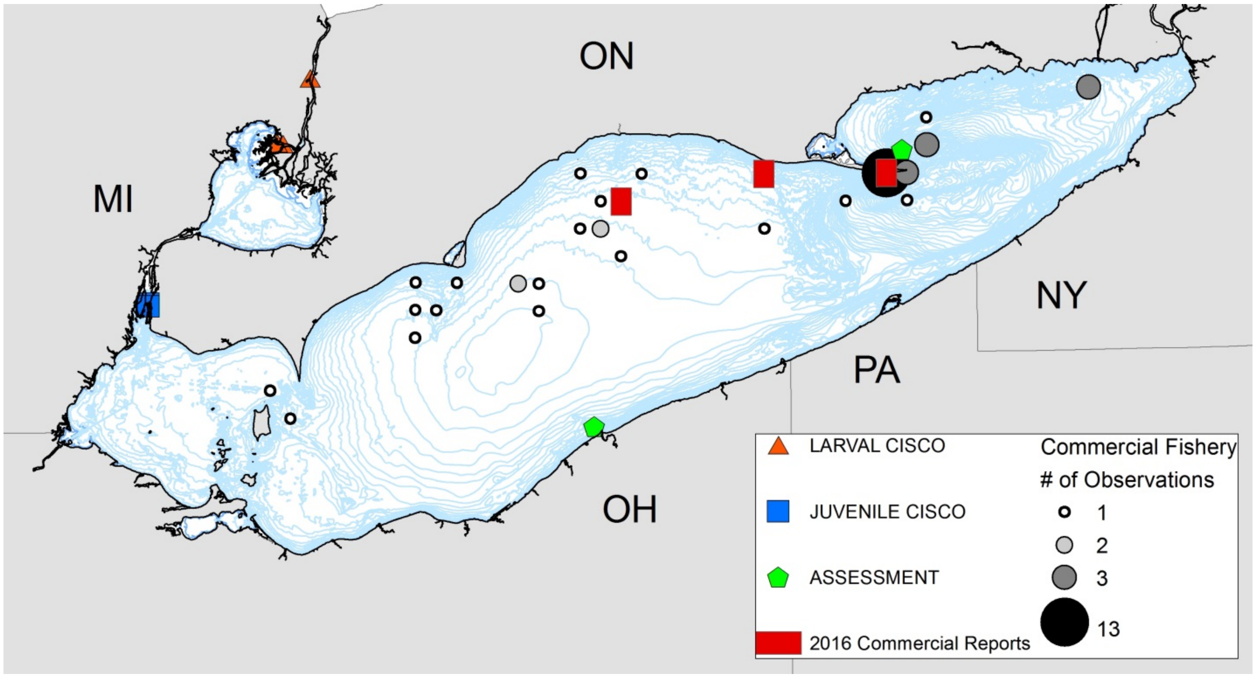

FIGURE 7.1. Cisco observations in Lake Erie and the Huron-Erie Corridor, 1995-2016. Commercial fishery observations are indicated with grey circles with size and shading indicating number of observations per 5' fishing grid. Locations of larval and juvenile Cisco observations (2010-11; USGS, USFWS) are indicated with triangles and squares, respectively. Locations of single observations from agency assessment surveys are shown with a green pentagon. NB – Three 5' grids from the 2016 commercial fishery indicate reported but unconfirmed observations.

TABLE 7.1. Sampling details from Cisco captured during commercial (C) and assessment (A) fishing efforts, 1990-2014. Length = Total Length (mm); Sex = female (F); male (M) or unknown (U). Target species is shown where known. *Three individuals, declared on Ontario Commercial Fish daily catch reports in 2016, remain unconfirmed.

Year	Month	Length	Sex	Gear	Depth	Source	Target Species
1990	SEP	260	F	GN	39	A	
1995	APR	443	F	GN	47	C	Whitefish
1996	APR	371	F	GN	41	C	Whitefish
1999	AUG	153	F	TR	21	C	rainbow smelt
1999	AUG	158	M	TR	21	C	rainbow smelt
1999	AUG	211	F	GN	26	C	lake whitefish
1999	MAY	323	M	U	U	U	
1999	SEP	140	M	TR	30	C	rainbow smelt
1999	SEP	U	F	TR	30	C	rainbow smelt
1999	SUMMER	156	F	U	U	A	
2000	SEP	238	UK	GN	U	A	
2001	OCT	173	U	TR	43	C	rainbow smelt
2002	SEP	315	F	TR	30	C	rainbow smelt
2002	SEP	170	F	TR	31	C	rainbow smelt
2003	AUG	278	F	GN	31	A	coldwater sp
2003	JUL	301	UK	GN	24	C	y perch
2003	JUN	341	F	GN	21	C	yellow perch
2003	MAY	298	M	GN	7	C	white bass
2003	SEP	298	M	TR	23	C	rainbow smelt
2003	SEP	222	M	TR	23	C	rainbow smelt
2004	JUN	U	U	GN	U	U	
2005	AUG	U	F	GN	18	C	walleye
2005	DEC	367	F	GN	U	C	yellow perch
2005	JUL	325	M	GN	U	C	yellow perch
2005	JUL	350	F	GN	U	C	yellow perch
2005	JUN	357	F	GN	24	C	yperch
2006	MAR	261	M	GN	U	C	yellow perch
2007	MAY	333	F	GN	38	C	yperch; wbass
2007	MAY	389	F	GN	9	C	white fish
2008	MAR	464	M	GN	21	C	white bass
2008	MAR	413	F	GN	20	C	white bass
2010	APR	438	F	GN	12	C	wbass
2010	JUN	322	M	GN	15	C	yellow perch
2010	JUN	355	F	GN	15	C	yellow perch
2010	JUN	366	F	GN	15	C	yellow perch
2011	APR	319	F	TR	37	C	rainbow smelt
2011	AUG	250	U	TR	23	C	rainbow smelt
2011	JUL	262	F	TR	21	C	rainbow smelt
2011	MAY	308	M	GN	11	C	yellow perch
2012	NOV	292	F	GN	16	C	yellow perch
2013	JUL	277	M	TR	21	C	rainbow smelt
2014	APR	335	U	GN	13	C	yellow perch
2014	MAY	330	F	GN	23	C	yellow perch
2015	JUL	408	F	GN	24	C	yellow perch
2015	JUL	309	M	TR	21	C	rainbow smelt
2015	JUL	285	F	TR	21	C	rainbow smelt
2015	JUN	342	M	GN	23	C	yellow perch
*2016**	*JAN*	*U*	*U*	*GN*	*21*	*C*	*yellow perch*
*2016**	*MAY*	*U*	*U*	*GN*	*15*	*C*	*yellow perch*
*2016**	*JUN*	*U*	*U*	*GN*	*21*	*C*	*yellow perch*

Impediments Document and Management Plan

Early attempts by the Lake Erie Coldwater Task Group to devise a management strategy for Cisco were hindered by information gaps and unresolved issues. Outstanding questions included:

- Do recently observed adult specimens represent a remnant stock?
- What is the population status of Cisco currently inhabiting Lake Erie? (There have been few directed surveys for Cisco in Lake Erie. Occurrences in fishery catches are very likely unrecognized or underreported.)
- What is the nature of constraints to Cisco and how does this compare to other coregonids which have shown mixed evidence of recovery across the Great Lakes (e.g. Lake Whitefish; 1990s in Lake Erie)?
- Is stocking a management option? Should we stock on top of a possible remnant population (if it exists)? What would represent a suitable broodstock?
- What are the genetic implications of stocking if a remnant population exists? Is there currently a genetic bottleneck?

In 2013, the LEC revised their charge to the task group; the group was to prepare a document detailing impediments to development of a management strategy. The document's purpose was to describe current knowledge and perceived impediments to Cisco rehabilitation, to determine if Cisco rehabilitation was feasible in the current state of Lake Erie, to identify research priorities for filling knowledge gaps, and provide direction for the development of a management plan. Since that time the Coldwater Task Group (CWTG) has reworked information from previous iterations of its draft management strategy into a draft document entitled "Impediments to the Rehabilitation of Cisco (*Coregonus artedi*) in Lake Erie." The document is divided into the following sections:

- Cisco Ecology, Population Structure, and Status
- Benefits of Rehabilitation
- Rehabilitation Impediments and Knowledge Gaps

This document is in currently in draft form, after having incorporated the most recent data, previously solicited reviews from the LEC as well as input gathered from an online survey of experts. Some of the document's proposed approaches to filling information gaps have been ongoing. Two of them, targeting Cisco in the fall at potential spawning locations, and targeting Cisco in fishery bycatch, have been documented previously (Forage Task Group 2015). In 2015 and 2016, considerable headway was made on perhaps the largest outstanding knowledge gap - determining the origin of the Cisco currently found in Lake Erie.

Determining the source of contemporary Lake Erie Cisco

In order to effectively ask questions about the relatedness of contemporary Lake Erie Ciscoes to Great Lakes populations, a comprehensive characterization of all possible source groups, both current and historic, would be necessary. Recently, reference information has been compiled based on both physical measures (Eshenroder et al., 2016) and on genetic characterization (Wendylee Stott, USGS Great Lakes Science Centre; pers. comm).

In January 2016, thirty-one whole fish specimens from recent Lake Erie collections were made available by the OMNRF for meristic and morphometric analysis as part of work to develop a guide to contemporary Cisco of the Great Lakes (Eshenroder et al. 2016). 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 *C. artedia* or *C. 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). Three other morphotypes were assigned: C. a*rtedia*-like (n=2); C. *albus*-like (n=2) and a type

that may represent a hybrid of swarm-Cisco and Lake Whitefish (n=2). Additional data made available by the OMNRF and Royal Ontario Museum, from nine samples collected in the 1990s, also revealed C. *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 *C. artedi* and *C. albus* as being “so scarce in Lake Erie [as to be classified] as extirpated”.

The morphometric findings diverge somewhat from the findings of a genetic comparison conducted in the 1990s which found that contemporary Lake Erie Ciscoes (n=9) were most similar to Lake Erie specimens from 1950s and 1960s, suggesting that a remnant of an original Lake Erie stock may exist (Rocky Ward, USGS Northern Appalachian Research Laboratory, Wellsboro, PA, unpublished data). The next closest genetic assignment for the contemporary Erie samples was contemporary L. Huron.

In 2015-16, another attempt was made to use genetic analysis (microsatellite markers) to assign contemporary Erie samples to Great Lake populations. The foundation for comparison was a database of Great Lakes Cisco genetic information, compiled by Dr. Wendylee Stott, and funded by the Great Lakes Restoration Initiative. By 2015, though still incomplete, genotypes had been constructed for historic samples from throughout the Great Lakes and contemporary samples from Lakes Huron, Ontario, and Superior. Additionally, a new characterization of “historic” Lake Erie samples from the 1920s was also available for comparison. The contemporary Great Lakes populations were determined to be genetically distinct though the differences were small. Preliminary results from 11 contemporary Lake Erie samples were made available in September 2015. The findings were less definitive than the 1990s genetic analysis, as *none of the fish assigned with confidence to any of the populations identified to date* (the other Great Lakes or to the historic Lake Erie samples from the 1920s).

Since the preliminary analysis was conducted, additional contemporary Lake Erie samples have been prepared and the genetic database has been updated to include: i) a better representation of contemporary Lake Huron C. *artedi* groups (broader spatial coverage); ii) a characterization of Lake Erie samples from the 1950s (see R. Ward results, above); and iii) deepwater Cisco from Lake Huron (see reference to Huron “swarm” Cisco, above). Additionally, work is underway to include samples from larval and juvenile Ciscoes, collected in the SCDRS, to the analysis in order to explore the question of immigration from the Upper Great Lakes as a source of contemporary L. Erie observations.

While there remain a number of opportunities to refine the classification and assignment of contemporary Lake Erie Cisco and to explore the theory of immigration from the Upper Lakes via the SCDRS (see Activities for 2017; below), the Coldwater Task Group feel that evidence to date is sufficient to conclude that **Cisco individuals currently recovered from Lake Erie are unlikely to represent an original historic archetype, specifically adapted to the lake**. Rather they likely represent an amalgam of sources, morphotypes and possible hybridizations. As such, the group will finalize the document “Impediments to the Rehabilitation of Cisco (*Coregonus artedi*) in Lake Erie” rather than delay further in order to include results from the ongoing genetic analysis. A final version will be presented to the Lake Erie Committee in April, 2017.

Activities for 2017

Genetic work is ongoing (W. Stott, USGS) with several components anticipated to be completed early in 2017. The full complement of 31 available contemporary Lake Erie samples will be assigned using the Great Lakes Cisco genetics database, updated to include representation from southern Lake Huron and Georgian Bay (previously Huron was singularly represented by individuals from Drummond Island) and, importantly, from several locations in 1950s Lake Erie. As these samples are from the same fish used in the morphometric analysis, assignments using the two techniques (physical / genetic) will be compared. To take into account the influence of deepwater forms and possible whitefish hybridization suggested by the “swarm” designations of the morphometric analysis, a suite of Great Lakes non-Cisco coregonine markers will be included in the analysis. “Bar-coding” will be used to positively identify coregonine individuals of unknown species. Examination of larval and juvenile samples from the SCDRS will shed light on the relationship between Huron, SCDRS, and Erie “populations”.

Stocking has become a key consideration when contemplating coregonid restoration in the Great Lakes, as evidenced by a recent draft planning document prepared by the USFWS for the lower lakes (Coregonid Restoration in the Lower Great Lakes: A Role for U.S. Fish & Wildlife Service, Northeast Region) and by discussions prompted by such initiatives as the Council of Lakes Committee-sponsored Coregonine Cisco Management Priority Setting Workshop held in December 2016. The anticipated completion of the CWTG's Cisco Impediments document together with a genetic- and morphometric-informed consensus about the presence of a unique genetic stock in Erie will provide a way forward for considering the future management of Cisco in Lake Erie.

Comparison of fish from the two historic periods on Erie (1920s and 1950s) will give an indication of genetic stability through time, as the last commercial fisheries were collapsing, further informing the likelihood that contemporary samples represent an Lake Erie archetype. These characterizations will provide a resource for use when contemplating suitable sources of extant broodstock should stocking be considered as a future management option. A potential source of Lake Erie Cisco (i.e., Lake Erie broodstock), was purportedly identified in 2016 in an inland lake in Pennsylvania; however, the legitimacy of this finding is scheduled to be investigated further in 2017.

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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

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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. This Charge 8 working group collaborated with the Data Deficient Work Group (DDWG) in December 2016 by sharing data, model results, drafts of the Charge 8 report, and discussing fishery requirements to meet certification.

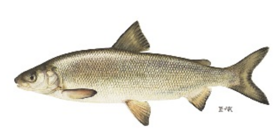
In 2016, the Charge 8 working group collaborated to finalize a statistical catch-at-age (SCAA) model configuration for Lake Whitefish, addressing model parameterization based on analyses, literature and expert opinion. Configuration decisions were made regarding fishery effort, data weighting (lambdas), age at full selectivity for each data series, catchability assumptions, and addressing data gaps.

The Charge 8 working group used water temperature and survey biological Lake Whitefish data from Lake Erie to estimate natural mortality for SCAA. Natural mortality =0.35 for sexes pooled based on the Pauly (1984) equation with mean water temperature experienced by Lake Erie Lake Whitefish (T =7.86 °C) and Von Bertalanffy growth parameters (L_∞ =61.6 cm, K=0.28). A summary of the model configuration is below in Table 8.1.

Table 8.1. Lake Whitefish statistical catch at age analysis model configuration.

Data Sources 1994 - 2016	Units	Lambda (λ)	Age at Full Selectivity	Catchability
Ontario commercial gill net harvest	harvest number at age 3 - 9+	1.0	6 - 9	
Ohio commercial trap net harvest*	harvest number at age 3 - 9+	0.5	7 - 9	
Ontario commercial gill net effort	large mesh gill net effort km with LWF in catch	0.5		constant
Ohio commercial trap net effort	number of trap lifts with LWF in catch	0.5		constant
Ontario Partnership gill net survey (central and east)	number per gang at age 3 - 9+	0.25	3 - 9+	constant

* missing trapnet age data assumes age composition of gill net fishery



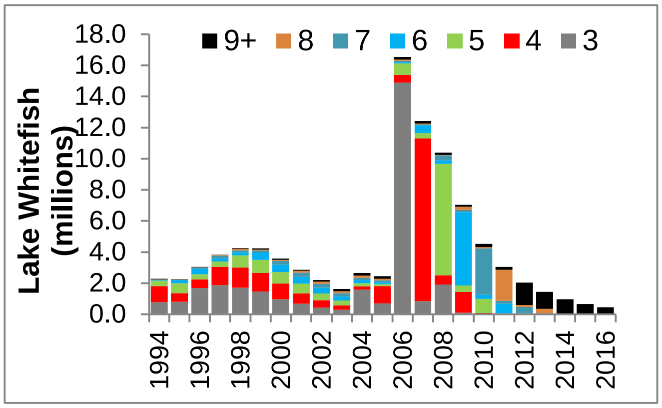


Figure 8.1. Statistical catch-at-age analysis population estimates for Lake Erie Lake Whitefish ages 3 to 9 and older (1993 - 2016).

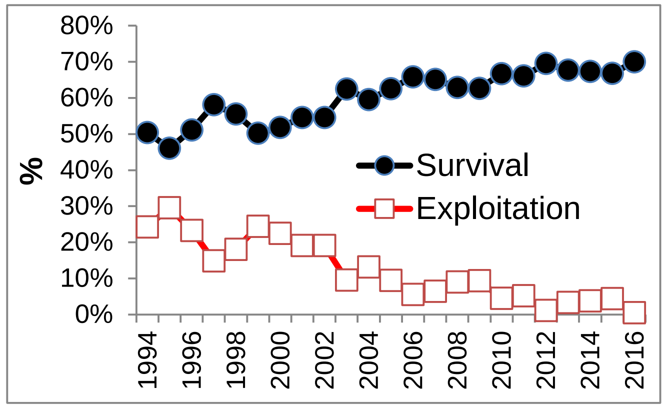


Figure 8.2 Statistical catch-at-age estimates of survival and exploitation for fully selected Lake Erie Whitefish (1993-2016).

SCAA population estimates of age 3 and older Lake Whitefish from 1994 describe a declining trend of abundance down to 443 thousand fish in 2016 (Figure 8.1). Lack of recruitment is apparent after the 2003 cohort, and to a lesser extent the 2005 cohort, appeared in fisheries during 2006 and 2008 respectively. Estimated increases in survival coincident with decreased exploitation also suggest that recruitment failure is the principal cause of decline. While surveys and fishery bycatch indicate potential future recruitment from the 2014 and 2015 year classes, their strength remains uncertain. The present low abundance is accompanied by estimated low spawner biomass which carries some risk as sufficient escapement is required to promote recovery. Recruitment of Lake Whitefish is believed to be influenced by environmental conditions and fish community interactions, factors which may be less favorable currently compared to historic periods. Mitigating and offsetting the impacts of these stressors present challenges for Lake Whitefish management in Lake Erie.

In consideration of knowledge gaps identified in Charge 8, the group recognized the benefits of Lake Whitefish tagging towards reducing uncertainty concerning survival, natural mortality, habitat use, spawning stock identification and productivity. Ohio DNR, USGS, USFWS and OMNRF are collaborating in a GLATOS Lake Whitefish acoustic telemetry tagging program which began in 2015 – 2016. This project is expected to contribute significantly to assessment and management of Lake Whitefish in the future.

Recommended options to support Lake Whitefish management are included in the draft Charge 8 report. Lake Whitefish ecology, historic and current management of Lake Whitefish in Lake Erie and the other Great Lakes are discussed.

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