2015 REPORT OF THE LAKE ERIE COLDWATER TASK GROUP

30 March 2016

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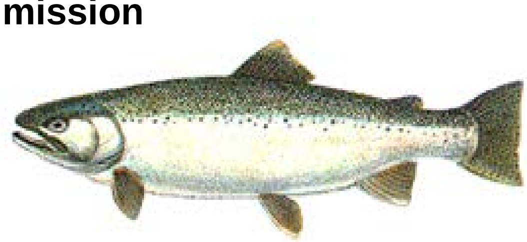
Presented to:

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. 2016. 2015 Report of the Lake Erie Coldwater Task Group, March 2016. 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 2015 – 2016 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 30-31 March 2016 in Niagara Falls, Ontario CA. 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 2016

Lake Erie Committee

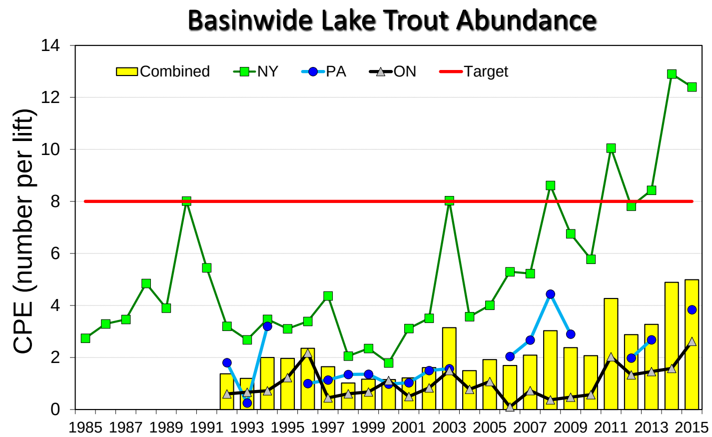
REPRESENTING THE FISHERY MANAGEMENT AGENCIES OF LAKE ERIE AND LAKE ST. CLAIR

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 2015-2016: (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.

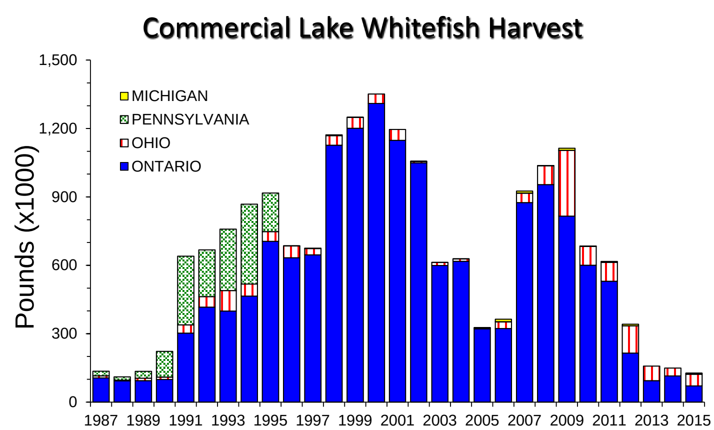
Lake Trout

A total of 847 Lake Trout were collected in 133 unbiased gill net lifts across the eastern basin of Lake Erie in 2015. High Lake Trout catches were recorded in all jurisdictions relative to the time series. Adults ages 5-7 dominated the catches with Lake Trout ages 10 and older only sporadically caught. Basin-wide Lake Trout abundance (weighted by area) was the highest value in the time series at 5.0 fish per lift, but remains below the rehabilitation target of 8.0 fish/lift. The adult (ages 5+) abundance index increased in 2015 to a time series high (3.7 fish/lift) and exceeded the target of 2.0 fish per lift for the second consecutive year. Klondike, Finger Lakes, and Lake Champlain strain Lake Trout comprise the majority of the population. Natural reproduction has not been documented in Lake Erie despite more than 30 years of restoration efforts.



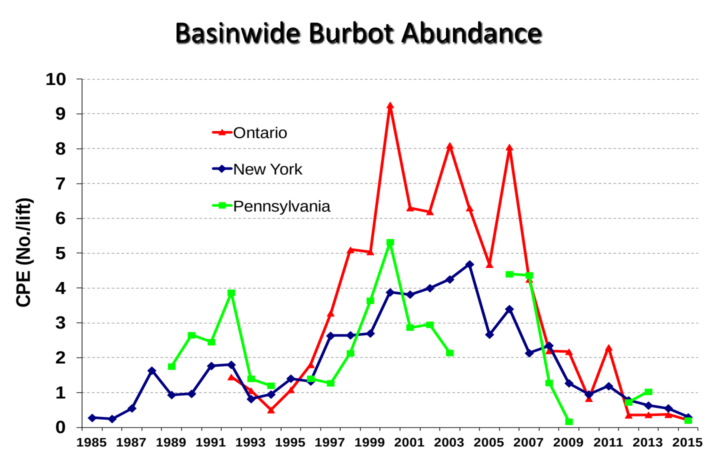
Lake Whitefish

Lake Whitefish harvest in 2015 was 126,243 pounds, distributed among Ontario (56%), Ohio (40%), Pennsylvania (3%) and Michigan (<1%). Catches in 2015 were comparable to low levels observed during the 1980s. Gill net fishery age composition ranged from 5 to 25. The 2003 year class (age 12) comprised the largest fraction (61%) of the Lake Whitefish gill net fishery. Gill net surveys caught Lake Whitefish from age 0 to 26, with age 12 most abundant. Central and east basin bottom trawl surveys caught young-of-the-year and yearling Lake Whitefish in 2015. The magnitude of influence these cohorts will have on the declining Lake Whitefish population is uncertain. Conservative harvest is recommended until Lake Whitefish spawner biomass improves.



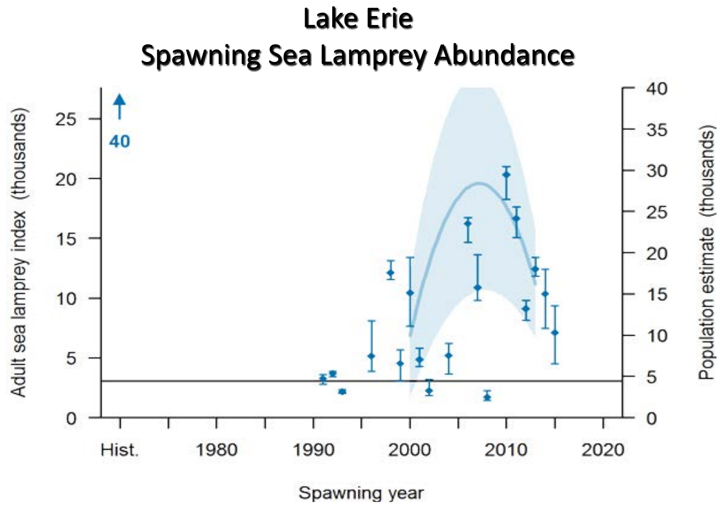
Burbot

Total commercial harvest of Burbot in Lake Erie during 2015 was 2,728 pounds (1,237 kg) of which 57% came in New York by two fishers. Burbot abundance and biomass indices from annual coldwater gillnet assessments remained at low levels in all jurisdictions in 2015, continuing a downward trend since the early-2000s. Agency catch rates during 2015 averaged 0.30 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 22 years in 2015. Ongoing low catch rates of Burbot in assessment surveys, the majority (53%) of the population being age-12+, 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 population.



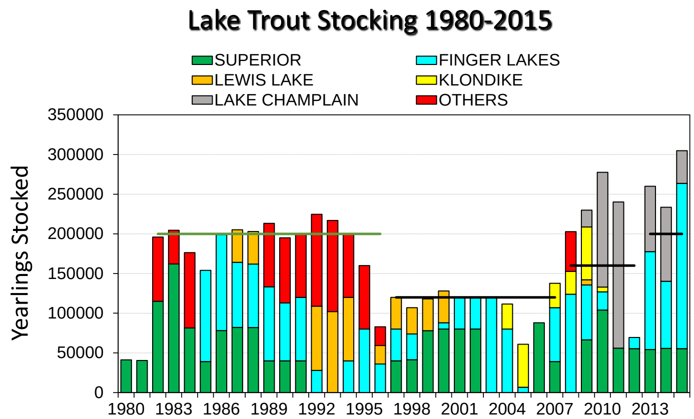
Sea Lamprey

The A1-A3 wounding rate on Lake Trout over 532 mm was 11.5 wounds per 100 fish in 2015. This was a 31% decrease from the 2014 wounding rate but over two times the target rate of five wounds per 100 fish. Wounding rates have been above target for 20 of the past 21 years. Large Lake Trout over 736 mm continue to be the preferred targets for Sea Lamprey; A4 wounding rates on this size group remained very high (98 wounds per 100 fish). The estimated number of spawning adult Sea Lamprey (7,112) was lower than 2014 estimates and the fifth consecutive annual decline. However, it is still well above the target population of 3,039. Comprehensive stream evaluations continued in 2015, including extensive surveys of Lake St. Clair and the Detroit River, to determine the source of the Lake Erie population.



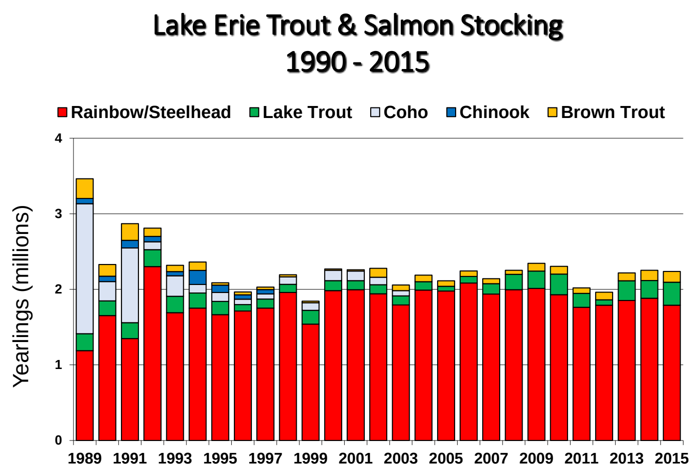
Lake Erie Salmonid Stocking

A total of 2,235,499 salmonids were stocked in Lake Erie in 2015. This was a 1% decrease in the number of yearling salmonids stocked compared to 2014, and was equivalent to the long-term average since 1990. Minor decreases in stocking numbers were observed for Steelhead, but Lake Trout stocking was at its highest stocking effort since directed stocking began in 1982. Although Brown Trout make up only 6% of all trout stockings, the numbers stocked increased 3% from 2014. By species, there were 304,819 yearling Lake Trout stocked in all three basins of Lake Erie; 141,013 Brown Trout stocked in New York and Pennsylvania waters, and 1,789,667 Steelhead/Rainbow Trout stocked across all five jurisdictional waters.



Steelhead

All agencies stocked yearling Steelhead in 2015. The summary of Steelhead stocking in Lake Erie by jurisdictional waters for 2015 is: Pennsylvania (1,079,019; 60%), Ohio (421,740; 24%), New York (153,923; 9%), Michigan (64,735; 4%) and Ontario (70,250; 4%). Steelhead stocking in 2015 (1.790 million) represented a 5% decrease from 2014 and 3% lower 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 6,460 Steelhead across all US agencies in 2015, essentially equal to 2014 estimates. Estimates for Ontario were not available in 2015. Overall, this harvest was lower than average harvest from 2008-14. Overall open lake catch rates remain near the long-term average, but effort remains minimal. Tributary angler surveys, which is where the majority (>90%) of the targeted fishery effort for Steelhead occurs, found catch rates of 0.32 fish/hour in New York during 2014-15.



Cisco

Cisco, considered extirpated in Lake Erie, have been reported in small numbers (1-7) in 18 of the past 21 years. Of the 47 observations since 1995, all but two were surrendered by commercial fishermen operating in Ontario waters including four surrendered in 2015. None were captured in 2015 in assessment gear. The question arises from these recent captures whether these specimens represent a remnant stock or are transients from Lake Huron. A genetic analysis conducted in the early 2000's using only 9 samples determined those sample fish were most likely from a remnant stock. However, new efforts are underway using genetics, morphometrics, and meristics approaches to characterize these contemporary samples. Preliminary results of this research suggests that the recent samples are unlike historically described Lake Erie cisco and may be a hybridization of deepwater forms similar to what is found in Lake Huron. This research is expected to continue during 2016 with a final determination as to the origin of these contemporary samples. A technical document "Impediments to the Rehabilitation of Cisco (*Coregonus artedi*) in Lake Erie" is expected to be completed in 2016.

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 (OMNRF), Chuck Murray (PFBC), and Richard Kraus (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.

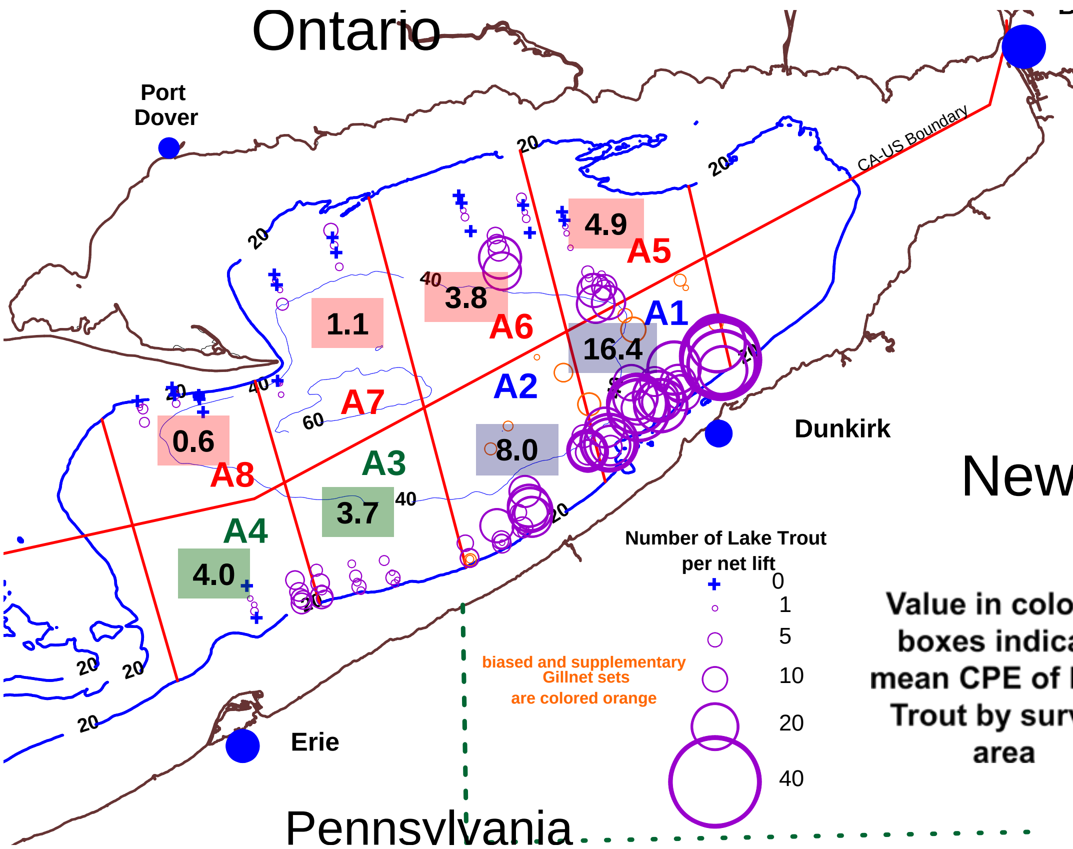


FIGURE 1.1. Standard sampling areas (A1-A8) used for assessment of Lake Trout in the eastern basin of Lake Erie, 2015, and catch per effort of Lake Trout in each area. Circles represent the number of Lake Trout per net lift.

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.

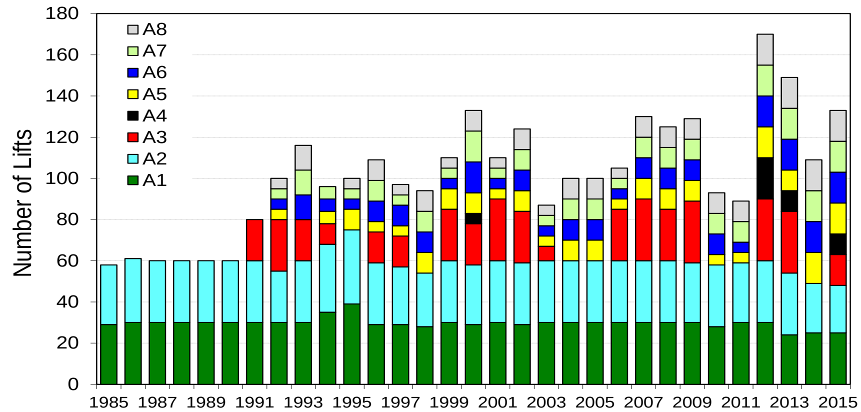


FIGURE 1.2. Number of unbiased coldwater assessment gill net lifts by area in the eastern basin of Lake Erie, 1985-2015.

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 2015 by the combined agencies was 133 unbiased standard Lake Trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 48 lifts by the NYSDEC, 25 by the PFBC, and 60 by USGS/OMNRF. NYSDEC moved 10 of their standard 60 lifts to new locations in 2015 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 2016).

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 2015 (Figure 1.1), collecting a total of 847 Lake Trout in 133 unbiased lifts. Areas A1 and A2 again produced the highest catch per unit effort (CPE) values (Figure 1.1), 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 this stocking area.

Lake Trout ranging from ages 1 to 30 were captured in 2015 and represented nineteen age-classes (Table 1.1). Adult cohorts ages 5-7 were the most abundant and represented 74% 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 only 4% of the overall catch. Two fish from the 1985 cohort (age 30) were caught in 2015, 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 2015.

A) Lean Strain

AGE	SEX	NUMBER	MEAN LENGTH (inches TL)	MEAN WEIGHT (pounds)	PERCENT MATURE
1	Combined	1	242	132	0
2	Male	2	560	2531	0
	Female	2	423	867	0
3	Male	33	538	2002	73
	Female	18	531	1757	6
4	Male	12	607	2513	100
	Female	5	624	2860	60
5	Male	145	671	3804	100
	Female	120	688	4113	97
6	Male	125	697	4151	100
	Female	99	707	4461	100
7	Male	56	725	4586	100
	Female	44	732	4901	100
8	Male	41	759	5142	100
	Female	35	749	5286	100
9	Male	15	783	6311	100
	Female	22	765	5789	100
12	Male	11	842	7377	100
	Female	2	810	6888	100
13	Male	3	847	7971	100
	Female	3	783	5878	100
14	Male	2	791	5652	100
	Female	5	832	7494	100
15	Male	1	891	7908	100
	Female	1	832	7664	100
19	Male	1	866	8314	100
	Female	0	---	---	---
24	Male	1	897	8026	100
	Female	0	---	---	---
26	Male	1	753	4142	100
	Female	0	---	---	---
27	Male	1	862	7200	100
	Female	0	---	---	---
30	Male	0	---	---	---
	Female	2	959	9724	100

B) Klondike Strain

AGE	SEX	NUMBER	MEAN LENGTH (inches TL)	MEAN WEIGHT (pounds)	PERCENT MATURE
5	Male	1	625	2866	100
	Female	1	616	3192	100
7	Male	38	661	3597	100
	Female	28	663	3810	100
8	Male	2	705	4478	100
	Female	5	674	4097	100
9	Male	5	670	3395	100
	Female	1	635	3130	100
11	Male	2	745	5079	100
	Female	0	---	---	-----

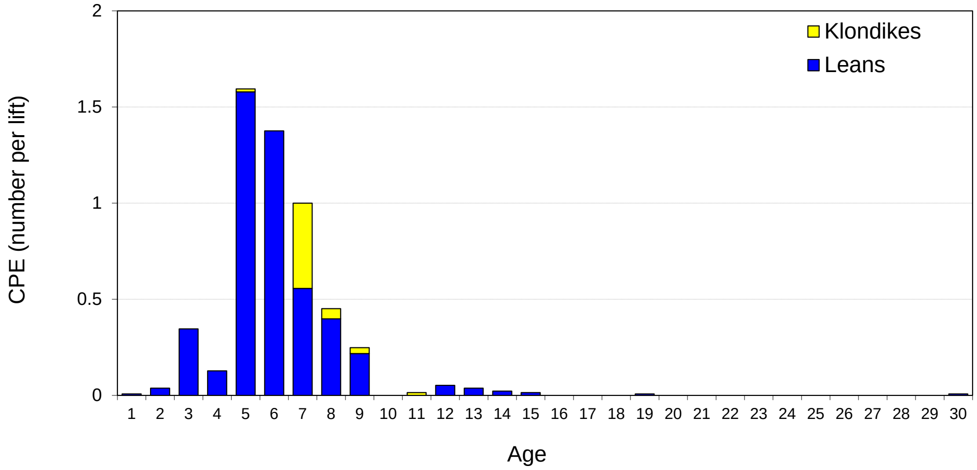


FIGURE 1.3. Relative abundance (number per lift) at age of Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie 2015.

The overall trend in area-weighted mean CPE of Lake Trout caught in standard nets in the eastern basin slightly increased in 2015 to 5.0 fish per lift (Figure 1.4). This was the highest abundance in the time series and continues a general trend of increasing Lake Trout abundance since 2000. Increases in relative abundance were observed in both PA and ON waters in 2015. Abundance estimates were slightly lower in NY waters compared to the series high value observed in 2014. Basin-wide abundance still remains well below the rehabilitation target of 8.0 fish/lift (Markham et al*.* 2008).

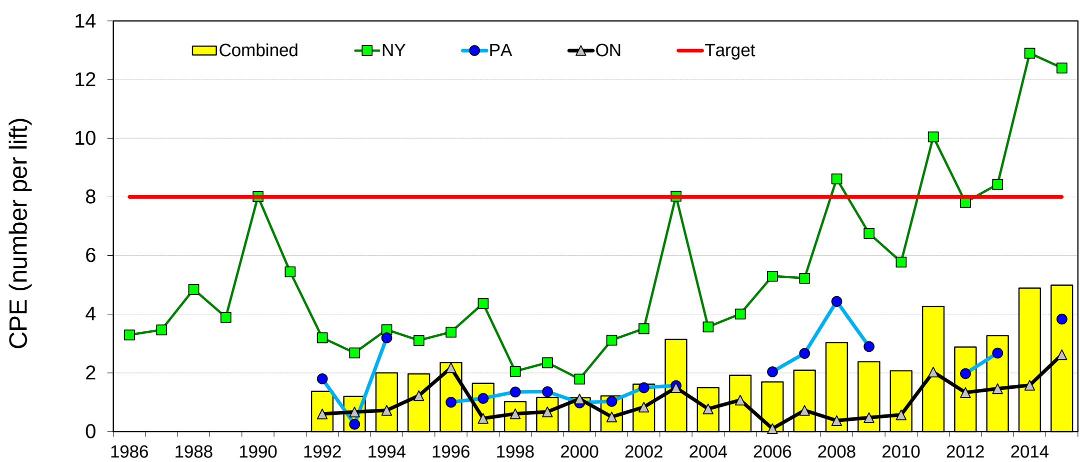


FIGURE 1.4. Mean CPE (number per lift) by jurisdiction and combined (weighted by area) for Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1986-2015.

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 sixty one (61) Lake Trout were caught in Partnership index gear among surveys in the east-central basin (1), Pennsylvania Ridge (1) and the east basin (59).The Lake Trout index in the east basin (0.97 fish/lift) was above the time series mean (0.41 fish/lift) while catch rates in Pennsylvania Ridge (0.06 fish/lift) were below average (0.21 fish/lift; Figure 1.5). Coded-wire tags were retrieved from 48 Lake Trout, revealing the following strains: Slate Island (27), Lake Champlain (17), Finger Lakes (2), Klondike (1) and one (1) unknown strain (Finger Lake or Superior). Variability of abundance estimates in this survey is high due to lower sample sizes in hypolimnetic waters, especially in the Pennsylvania Ridge area.

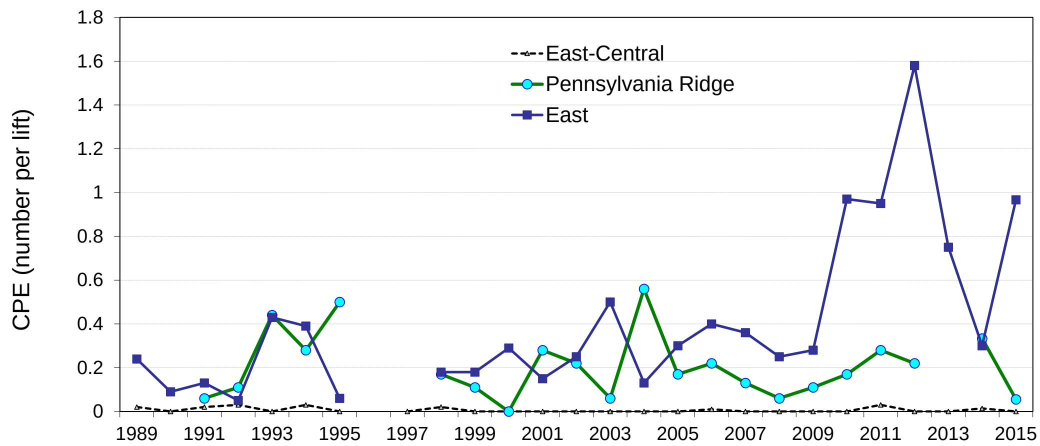


FIGURE 1.5. Lake Trout CPE (number per lift) by basin from the OMNRF Partnership Index Fishing Program, 1989-2015. Includes canned (suspended) and bottom gill net sets, excluding thermocline sets.

The relative abundance of adult (age-5 and older) Lake Trout caught in standard assessment gill nets (weighted by area) in the Coldwater Assessment Survey serves as an indicator of the size of the Lake Trout spawning stock in Lake Erie. Adult abundance increased to 3.7 fish per lift in 2015 (Figure 1.6). This was the highest adult abundance index in the series and above the basin-wide rehabilitation target of 2.0 fish/lift for the second consecutive year (Markham et al. 2008). The increase in adult abundance was mainly due to a relatively high abundance of age-5, age-6, and age-7 Lake Trout (see Figure 1.3).

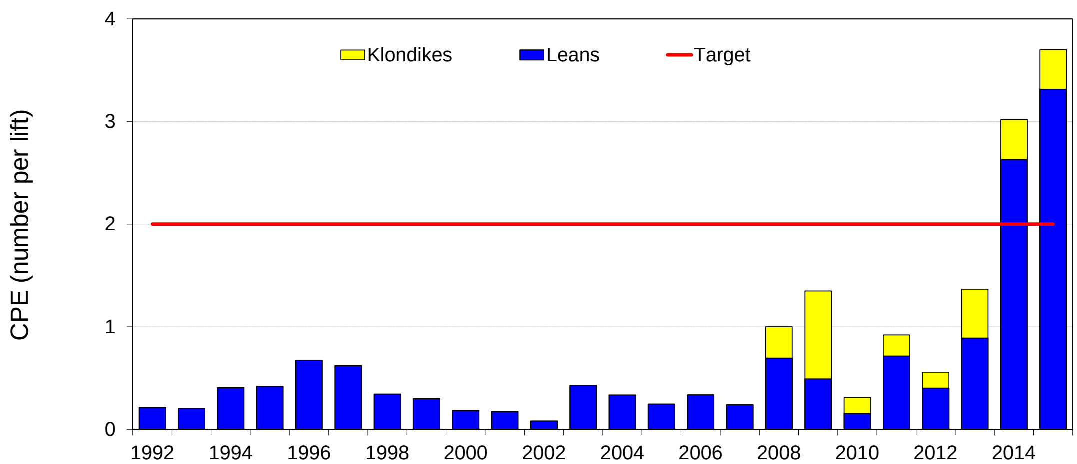


FIGURE 1.6. Relative abundance (number per lift; weighted by area) of age-5-and-older Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2015.

The relative abundance of mature females $\geq$age-6, an index of repeat-spawning females ages six and older weighted by area, also increased in 2015 to 1.307 fish per lift (Figure 1.7). Similar to the age-5+ adult index, this was also the highest index value in the time series and above the rehabilitation plan basin-wide target of 0.50 fish/lift for adult female abundance for the second consecutive year (Markham et al. 2008). The increase in mature females age-6+ was mainly due to a relatively high abundance of age-6 and age-7 Lake Trout (see Figure 1.3).

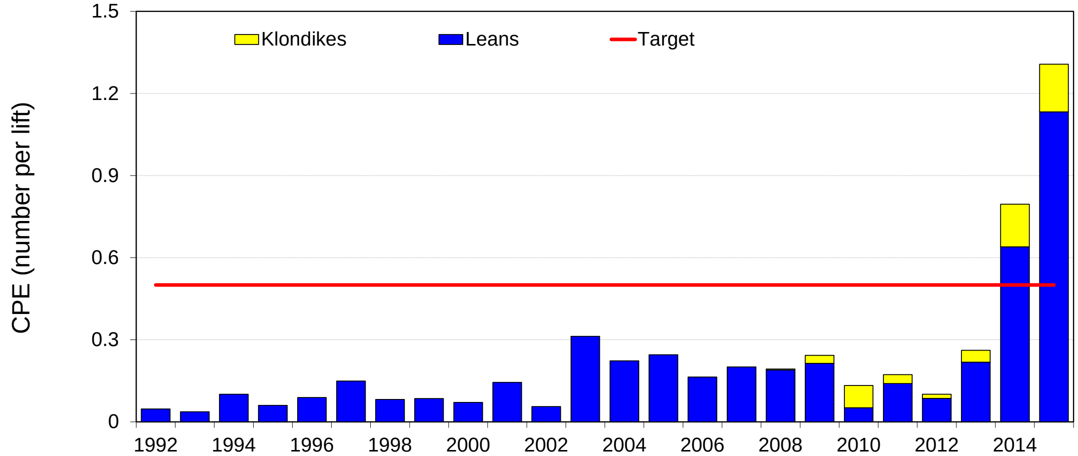


FIGURE 1.7. Relative abundance (number per lift weighted by area) of mature female Lean strain and Klondike strain Lake Trout age-6-and-older in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2015.

Strains

Five different Lake Trout strains were found in the 890 fish caught with either hatchery-implanted coded-wire tags (CWTs) or fin-clips in 2015 (Table 1.2). Similar to last year, the majority of the trout (96%) were comprised of three strains: Lake Champlain (LC; 61%), Finger Lakes (FL; 26%) and Klondike (KL; 9%). These have been the most stocked strains in Lake Erie over the past ten years. Slate Island (SI; 3%) and Apostle Island (AI; >1%) strains were the only other strains sampled in 2015. Strain composition is not uniform throughout the east basin and regional differences from specific areas are apparent. For example, SI strain Lake Trout comprised 50% of the catch from area A7, which is adjacent to Nanticoke Shoal and where the SI strain is exclusively stocked. The FL strain continues to show the most consistent returns at older ages; 90% (N=162) of Lake Trout age-8 and older were FL strain fish.

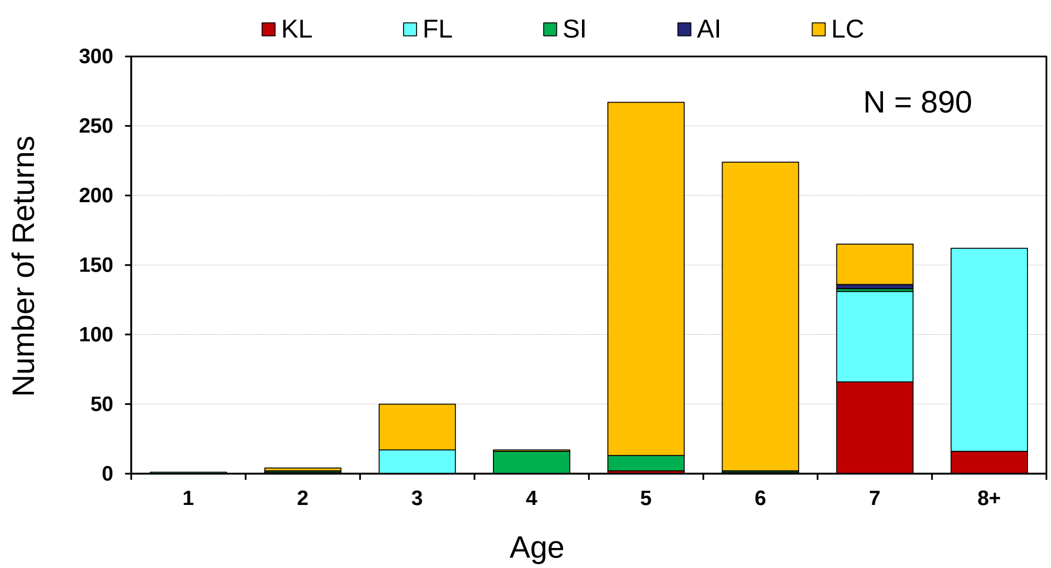


FIGURE 1.8. Number of Lake Trout by stocking strain and age collected in gill nets from the eastern basin of Lake Erie, August 2015. Stocking strain codes are: KL = Klondike, FL = Finger Lakes, SI = Slate Island, AI = Apostle Island, LC = Lake Champlain.

Survival

Estimates of annual survival (S) for individual cohorts at ages 4 through 11 were calculated by strain and year class using a 3-year running average of CPE. 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 high mortality prior to Sea Lamprey treatment efforts. 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 0.60 (60%) or higher (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 levels of sea lamprey predation. 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. More recent estimates from the 2005 year class of FL strain indicate lower survival rates although estimates from 2006 and 2007 are within the ranges previously observed for this strain during the period of successful lamprey control. Estimates of the 2003, 2004, and 2006 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 2007 year class of KL strain fish.

Mean overall survival estimates were above the target of 60% or higher (Lake Trout Task Group 1985; Markham et al. 2008) for the FL strain but below target for the Lewis Lake (LL), SUP, and KL strains. The Finger Lakes strain, the most consistently stocked lake trout strain in Lake Erie, had an overall mean survival estimate of 0.73. Mean overall survival for all strains combined was 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, 1985–2015. 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	**LL**	**SUP**	**FL**	**KL**	**ALL**
1983		0.687			0.454
1984		0.619	0.502		0.533
1985		0.543	0.594		0.578
1986		0.678			0.634
1987		0.712	0.928		0.655
1988		0.726	0.818		0.679
1989		0.914	0.945		0.766
1990		0.789	0.634		0.709
1991	0.616				0.615
1992	0.568				0.599
1993			0.850		0.646
1994					0.649
1995					0.489
1996			0.780		0.667
1997		0.404	0.850		0.549
1998		0.414			0.364
1999		0.323	0.76		0.431
2000		0.438	0.769		0.655
2001		0.225	0.696		0.522
2002			0.693		0.633
2003			0.667	0.242	0.585
2004				0.485	0.420
2005*			0.369		0.629
2006*			0.884	0.553	0.883
2007*			0.737	0.703	0.917
MEAN	**0.592**	**0.575**	**0.734**	**0.496**	**0.610**

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 1.9 and 1.10). Mean lengths and weights were at or below average from 1986-1998, but increased above average from 1999-2008. Both mean length and mean weight of both age-3 and age-5 Lake Trout were at or near the series average in 2015.

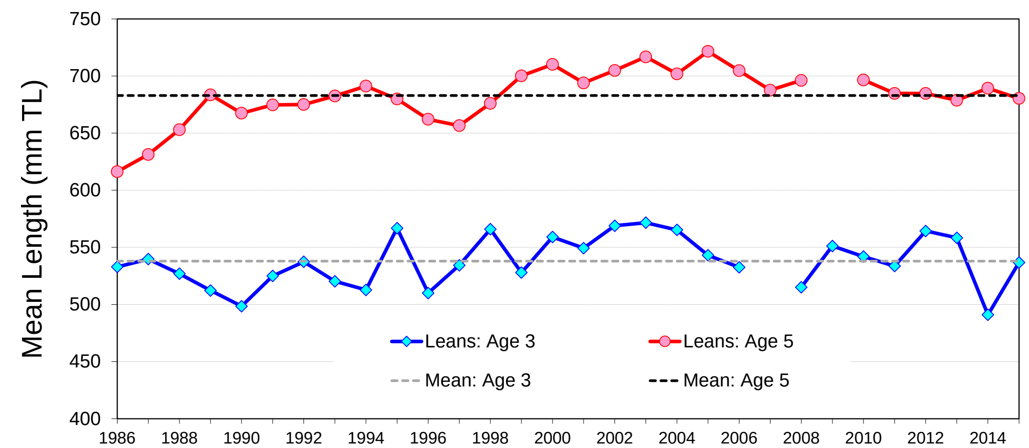


FIGURE 1.9. Mean length (mm TL) of age 3 and age 5 Lean strain Lake Trout sampled in assessment gill nets in the New York waters of Lake Erie, August, 1986-2015.

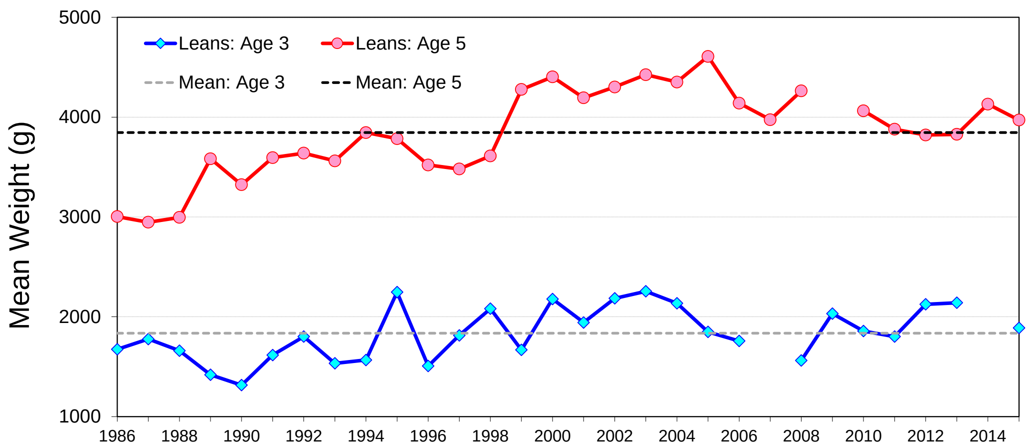


FIGURE 1.10. Mean weight of age-3 and age-5 Lean strain Lake Trout sampled in assessment gill nets in the New York waters of Lake Erie, August, 1986-2015.

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 remained above the series average for both males and females in 2015 (Figure 1.11). Condition coefficients for both sexes show an increasing trend from 1993-2000, and have remained high and relatively steady since.

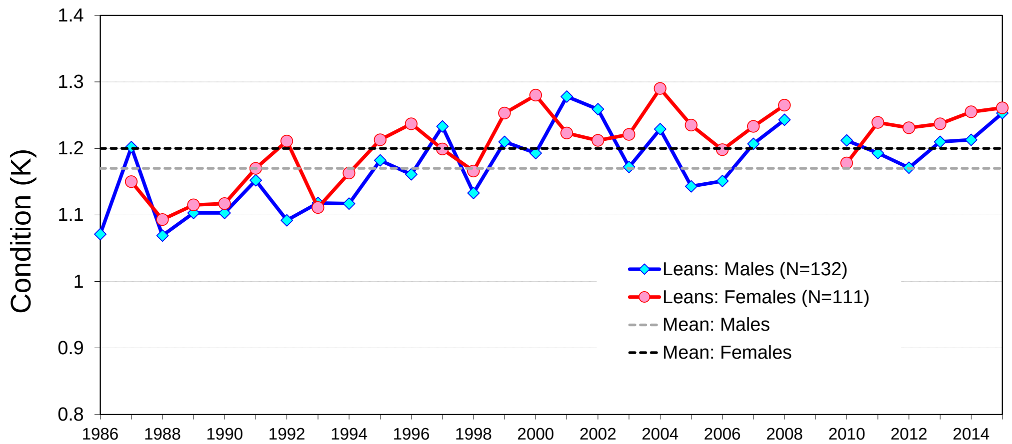


FIGURE 1.11. Mean coefficients of condition for age-5 Lean strain Lake Trout, by sex, collected in eastern basin assessment gill nets in Lake Erie, August 1986-2015.

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 809 Lake Trout were harvested in New York waters out of an estimated catch of 3,343 in 2015 (Figure 1.12). This was the highest estimated catch of Lake Trout in the New York waters of Lake Erie since 1996, and the second highest estimated harvest. An estimated harvest of 105 Lake Trout occurred in Pennsylvania waters in 2015 (Figure 1.12). This was above the series average of 88 fish per year and only the fourth year harvest was detected since 2006. Overall Lake Trout catch in Pennsylvania waters was estimated at 784 fish in 2015.

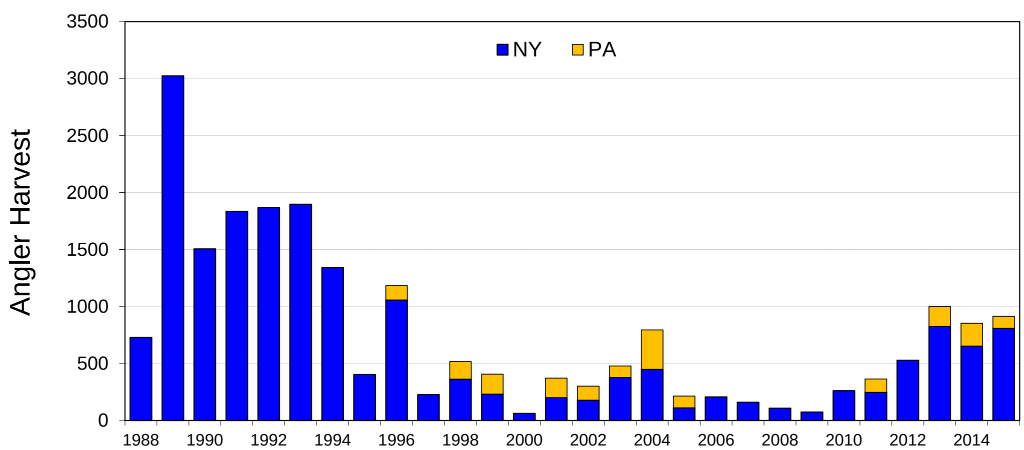


FIGURE 1.12. Estimated Lake Trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2015.

Natural Reproduction

Despite more than 30 years of Lake Trout stocking in Lake Erie, no naturally reproduced Lake Trout have been documented. Six potentially wild fish (no fin clips; no CWT's) were caught in eastern basin coldwater gill net surveys in 2015, making a total of 67 potentially wild Lake Trout recorded over the past 15 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 2015 Lake Trout model estimated the Lake Erie population at 327,218 fish and the adult (age-5 and older) population at 78,426 fish (Figure 1.16). 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.

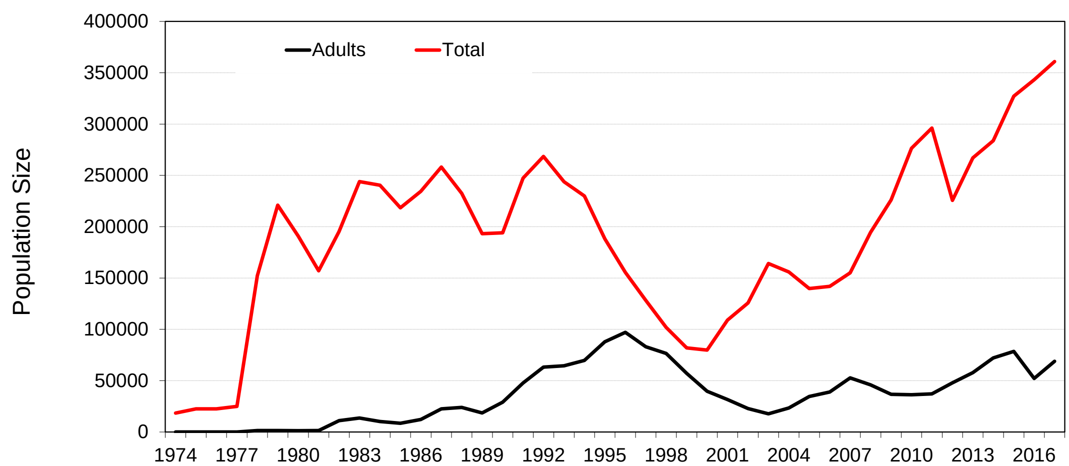


FIGURE 1.16. Projections of the Lake Erie total and adult (ages 5+) Lake Trout population using the CWTG Lake Trout model. Future projections for 2016-2017 were made using low rates of Sea Lamprey mortality with proposed stocking rates. The model estimated the lakewide Lake Trout population in 2015 at 327,218 and the adult population at 78,426.

Diet

Seasonal diet information for Lake Trout is not available based on current sampling protocols. Diet information was limited to fish caught during August 2015 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, occurring in 98% and 92% of Lean and Klondike strain Lake Trout stomachs, respectively (Table 1.4). Round Goby were the second most common diet item observed, occurring in 6% of Lean strain and 4% of Klondike strain stomach samples. Similar to past years, Rainbow Smelt remain the preferred prey item for Lean strain Lake Trout when they are abundant. However, in years of lower adult Rainbow Smelt abundance, Lake Trout appear to prey more on Round Goby. Klondike strain Lake Trout have usually had higher percentages of Round Goby in their diets compared to Lean strain Lake Trout (Coldwater Task Group 2011). Yellow Perch and White Perch were the only other identifiable fish species found in Lake Trout stomachs in 2015. One yearling Lake Trout had also consumed invertebrates.

TABLE 1.4. Frequency of occurrence of diet items from non-empty stomachs of Lean (N=521) and Klondike (N=24) strain Lake Trout collected in gill nets from eastern basin waters of Lake Erie, August 2015.

PREY SPECIES	Lean Lake Trout (N=521)	Klondike Lake Trout (N=24)
Rainbow Smelt	511 (98%)	22 (92%)
Round Goby	31 (6%)	1 (4%)
Yellow Perch	3 (>1%)	
White Perch	1 (>1%)	
Invertebrates	1 (>1%)	
Unknown Fish	3 (>1%)	1 (4%)
Number of Empty Stomachs	205	36

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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 2015 was 126,243 pounds (Figure 2.1). Ontario accounted for 56% of the lake-wide total, harvesting 70,885 pounds, followed by Ohio (40%; 51,066 lbs.). Nominal commercial harvest occurred in Pennsylvania (4,025 lbs) and Michigan (267 lbs), and none in New York (Figure 2.2). Total harvest in 2015 was 15% lower than the total harvest in 2014. Lake Whitefish harvest decreased in Ontario by 38%, but increased 47% in Ohio relative to 2014.

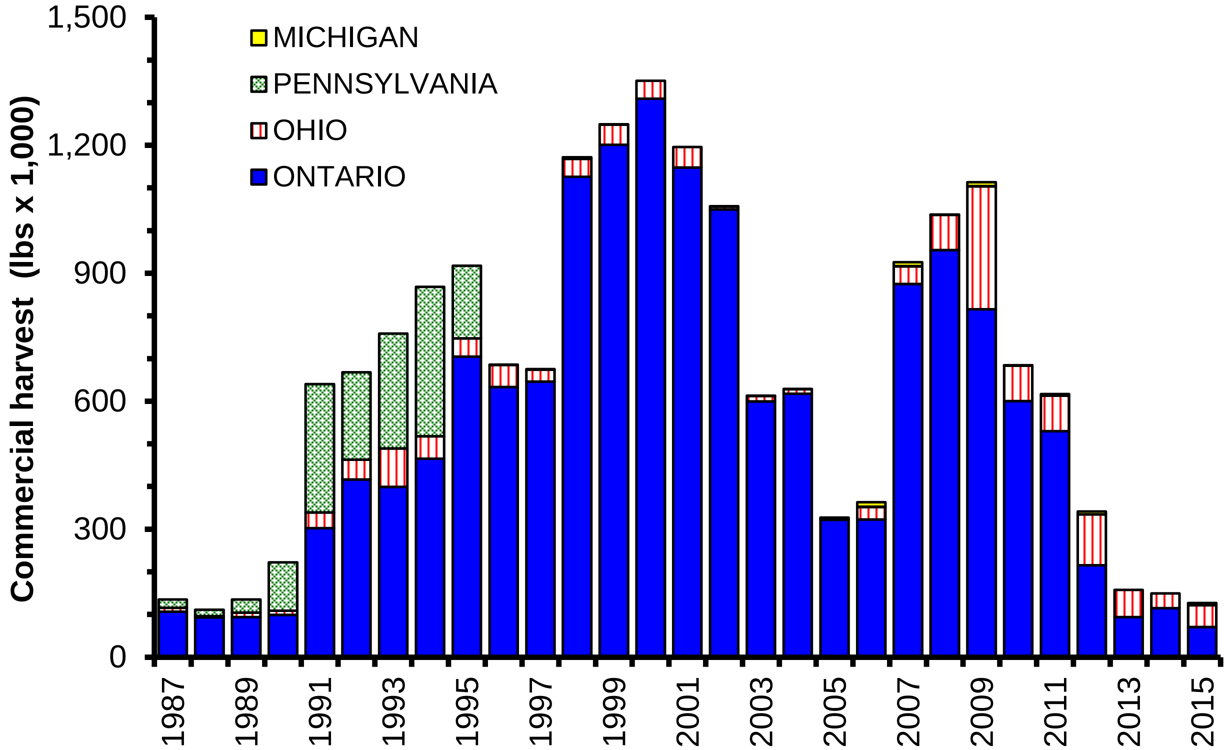

FIGURE 2.1. Total Lake Erie commercial Lake Whitefish harvest from 1987-2015 by jurisdiction. Pennsylvania ceased gill netting in 1996, and Michigan resumed commercial fishing using trap nets in 2006, excluding 2008.

Ontario's 2015 harvest represented 71% of their 2015 quota (100,000 lbs), which was set at the lowest level since 1986 (36,600 lbs). The reported Lake Whitefish harvest includes 2,071 pounds of Lake Whitefish surrendered from individual quotas that were attained. The majority (99%) of Ontario's 2015 Lake Whitefish harvest was taken in gill nets. The remainder (955 pounds) was caught in Rainbow Smelt trawls. The largest fraction of Ontario's Whitefish harvest (71%) was caught in the west basin (Ontario-Erie Unit OE1) followed by OE2 (22%), with the remaining harvest distributed eastward among units OE3 (6%), OE4 (1%) and OE5 (<1%). Maximum harvest in 2015 was distributed west of Pelee Island (Figure 2.2). Harvest in OE1 from October to December represented 85% of Ontario's Lake Whitefish harvest. Peak harvest occurred during October in OE1 (20,306 lbs), OE2 (8,423) and OE3 (1,422). In eastern Lake Erie, the minimal Lake Whitefish harvest from OE4 was highest in September (664 lbs) and during April-May in OE5 (201 lbs). There was no reported effort targeting Lake Whitefish during 2015 in Ontario waters; the harvest was mainly caught in fisheries seeking Walleye (83%) and White Bass (15%), with the remaining 2% landed in Rainbow Smelt, White Perch and Yellow

Perch fisheries. During the late fall-early winter spawning season, Lake Whitefish harvest in western Lake Erie during November and December (25,783 pounds) accounted for 37% of Ontario's annual harvest.

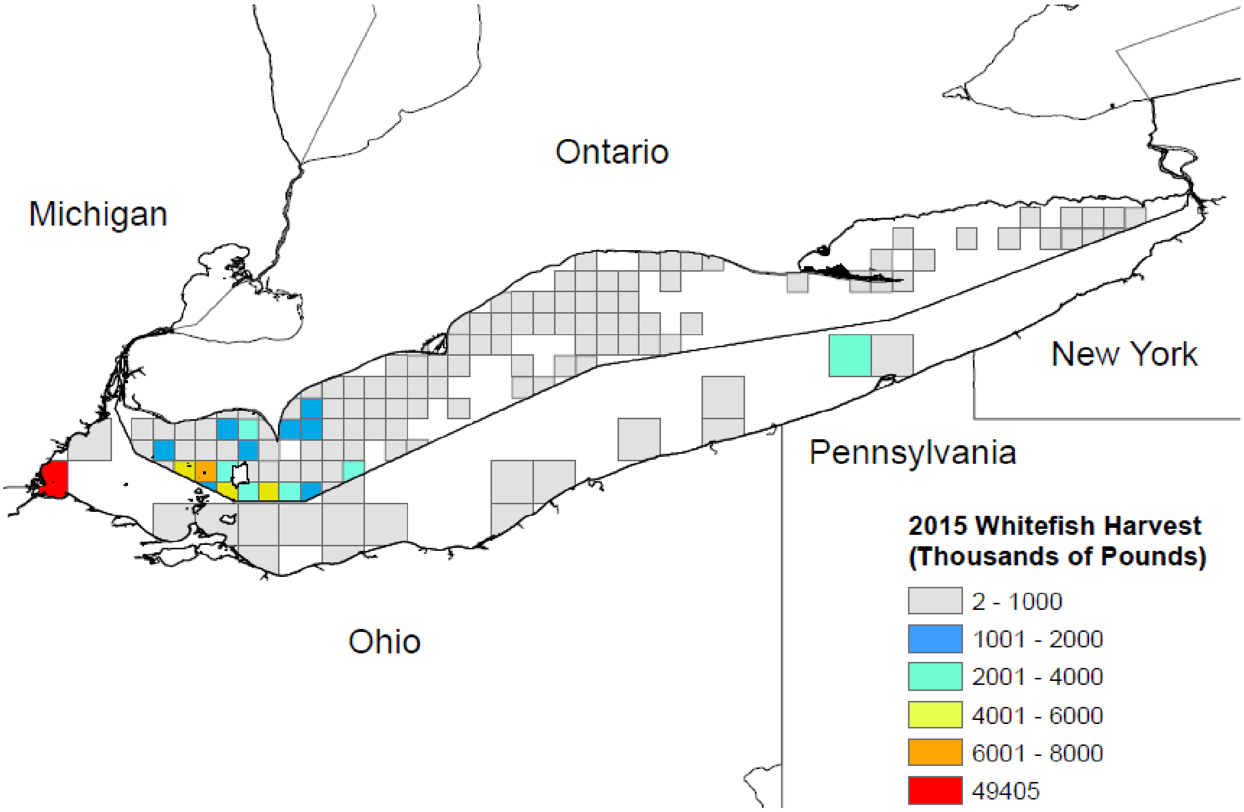

FIGURE 2.2. Lake Erie commercial harvest of Lake Whitefish in 2015 by 5-minute (Ontario) and 10-minute (Ohio) grids. No Lake Whitefish harvest was reported in New York in 2015.

As there was no reported targeted gill net harvest or effort in 2015, 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 2014-2015 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 44% from 2014, whereas catch rates based on effort with Lake Whitefish in the catch declined 43%. In both cases, 2015 catch rates were the lowest in their respective 1998-2015 time series.

In Ohio waters during 2015, 98% of the Lake Whitefish trap net harvest occurred in the west basin, with the remaining harvest divided between central basin districts D2 (0.6%) and D3 (1.4%). Lake Whitefish were harvested from 1,405 Ohio trap net lifts in 2015, with lifts distributed among District 1 (60%), District 2 (20%) and District 3 (20%), respectively. The majority of Ohio's Lake Whitefish harvest occurred during November (91%), followed by December (6%), in the western basin. Ohio's remaining Lake Whitefish harvest occurred in the central basin (2%), mainly during May and June. Lake Whitefish yield in 2015 from Ohio trap nets was greatest near the mouth of the Maumee River (49,180 pounds, Figure 2.2). Ohio trap net catch rates in 2015 (36 lbs / lift) increased 40% from 2014 (26 lbs / lift) and exceeded the 1996-2014 time series average (34 lbs/lift) (Figure 2.4).

Ohio's Lake Whitefish trap net fishery effectively targets the spawning migration of Lake Whitefish, as indicated by the proportion of harvest taken during the spawning season (November-December) (Figure 2.5). The catch rate in 2015 (156 lbs / lift) was highest in grid 801, adjacent to Maumee Bay, where Lake Whitefish aggregate to spawn (Figure 2.6). The concentration of effort on this spawning stock should be monitored continuously to assess its' status and ensure sustainability.

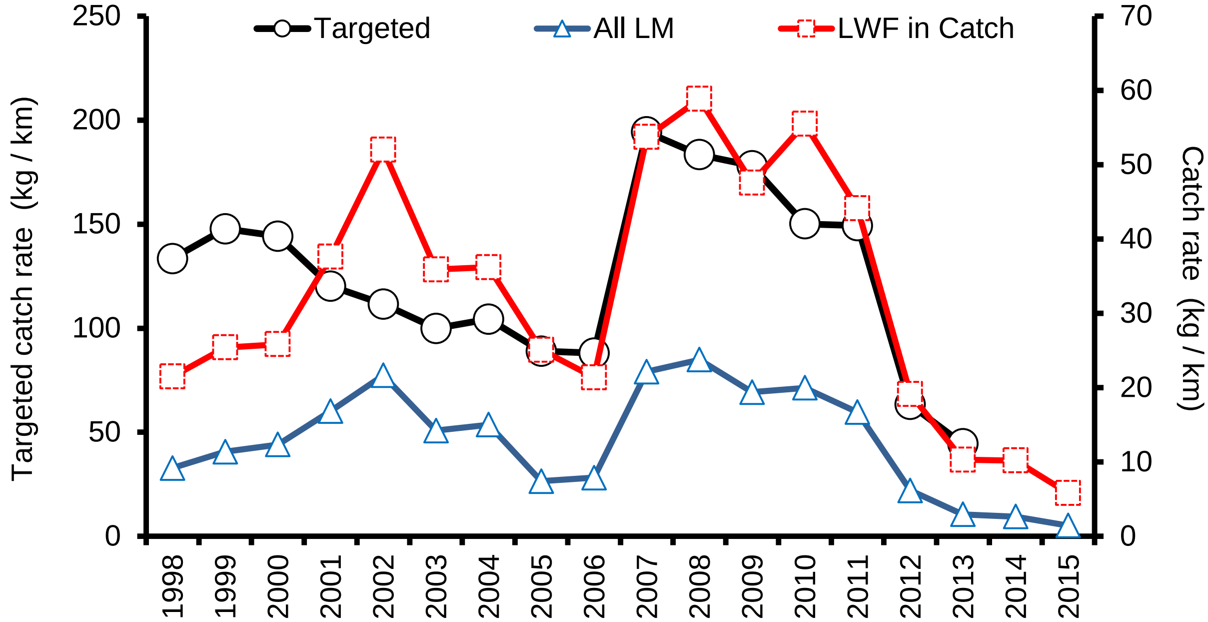

FIGURE 2.3. Lake-wide Ontario annual commercial large mesh gill net catch rates according to three forms of effort 1998-2015. Targeted Lake Whitefish catch rate (kg/km; left axis), catch rate relative to all large mesh gillnet fished (kg/km; right axis), and catch rates from large mesh effort with Lake Whitefish in the catch (kg/km; right axis). No targeted Lake Whitefish effort or harvest in 2014, 2015.

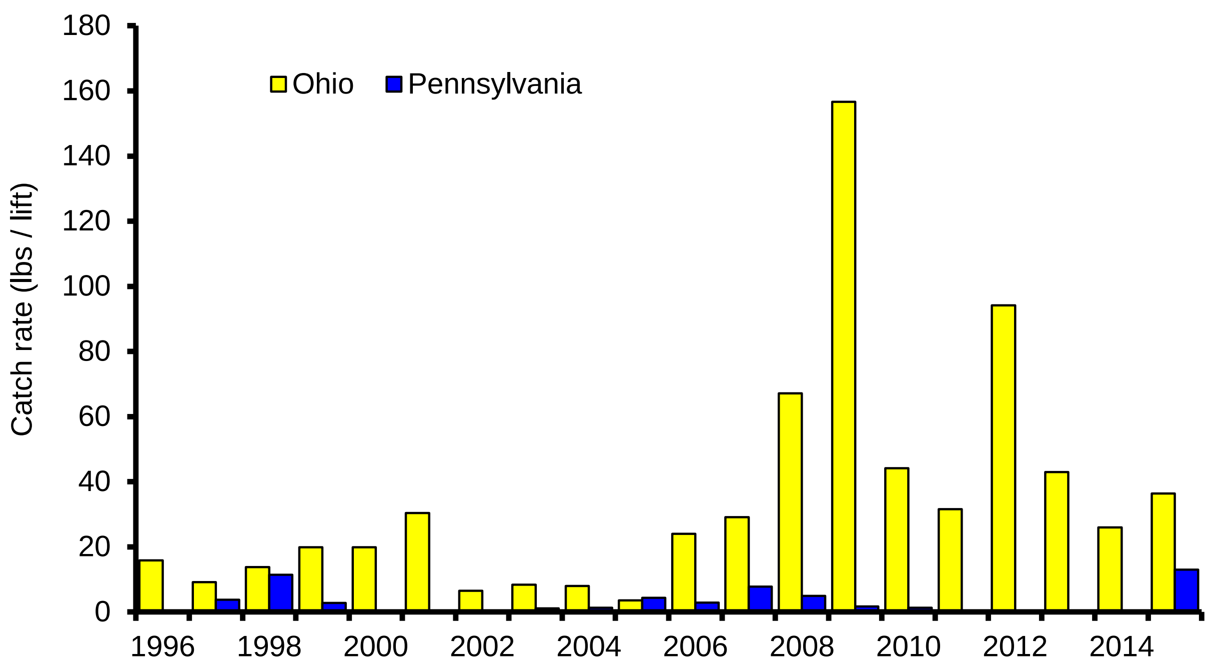

FIGURE 2.4. Lake Whitefish commercial trap net catch rates in Ohio and Pennsylvania (lbs / lift), 1996-2015. Zero harvest for PA in 2011-2014.

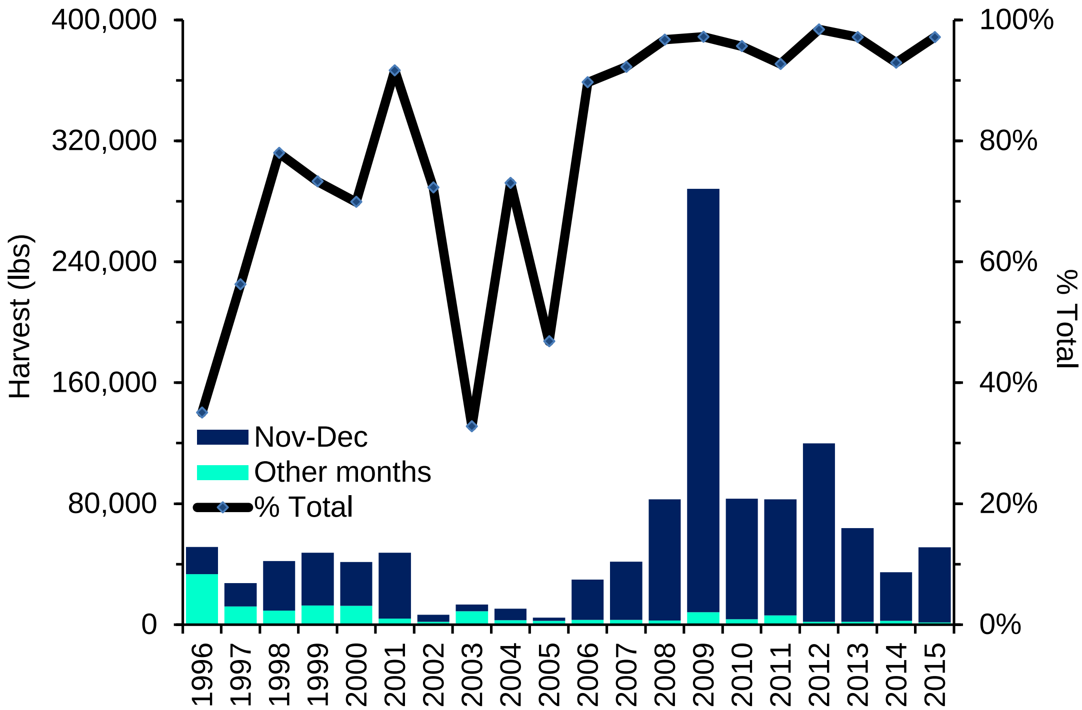

FIGURE 2.5. November and December harvest of Lake Whitefish in Ohio waters of Lake Erie, 1996-2015.

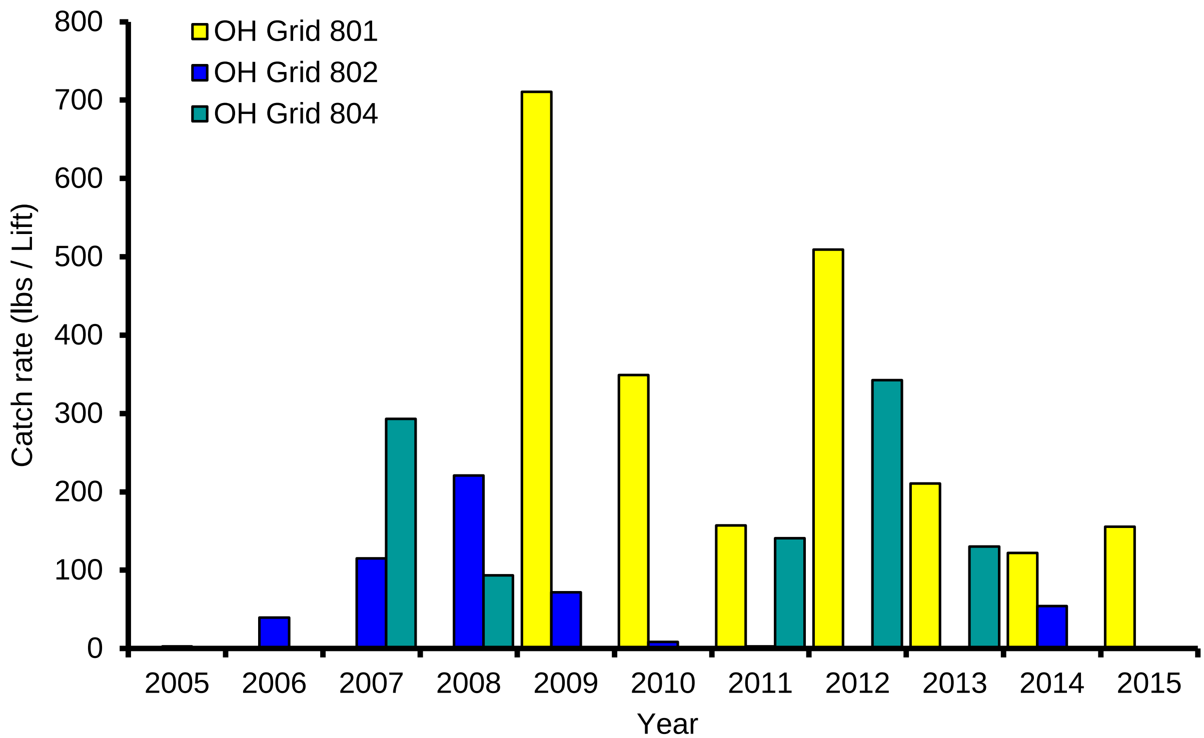

FIGURE 2.6. Ohio Lake Whitefish commercial trap net catch rates (pounds per lift) by grid in western Lake Erie. No harvest from grids 802 and 804 in 2015.

Ontario's west basin fall Lake Whitefish fishery in 2015 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, White Bass and Rainbow Smelt trawl fishery harvest monitoring using otoliths and scales (N=399; Figure 2.8). Results are presented for comparison from OMNRF supplementary 2015 fall incidental harvest monitoring reliant on scale ages (N=115; Figure 2.8). Based on standard harvest monitoring, Ontario's whitefish harvest in 2015 consisted of Lake Whitefish from ages 0 to 25. The strong 2003 cohort (age 12) was most abundant, representing 61% of the Lake Whitefish harvest assessed by standard sampling in 2015 (Figure 2.8). Lake Whitefish age compositions from Walleye and White Bass fisheries were similar, while supplementary incidental monitoring exhibited several differences that may be attributed to ages interpreted exclusively from scales (Figure 2.8). One young of the year (age 0) Lake Whitefish was collected from a commercial Rainbow Smelt Trawl sample (Figure 2.8).

The age composition of the 2015 Lake Whitefish commercial fishery in Ohio was not assessed in 2015.

The landed weight of roe from Ontario's 2015 Lake Whitefish fishery was 580 pounds, much of which came from OE1 during October (50%) and November (33%). The remaining fraction of roe was collected primarily from OE2 (15%) during October, with minimal amounts collected in November in OE 2 (2%) and OE3 (<1%). The approximate landed value of the roe was CDN$ 1,562.

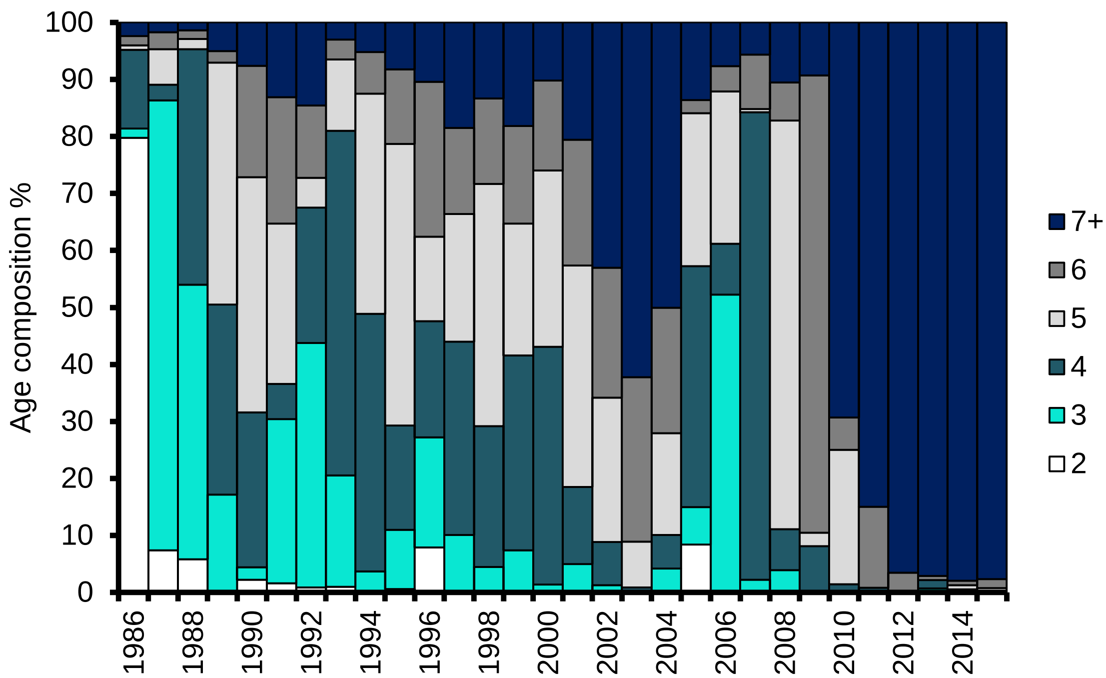

FIGURE 2.7. Ontario fall commercial Lake Whitefish harvest age composition in statistical district 1, 1986-2015, from effort with gill nets ≥3 inches, October to December.

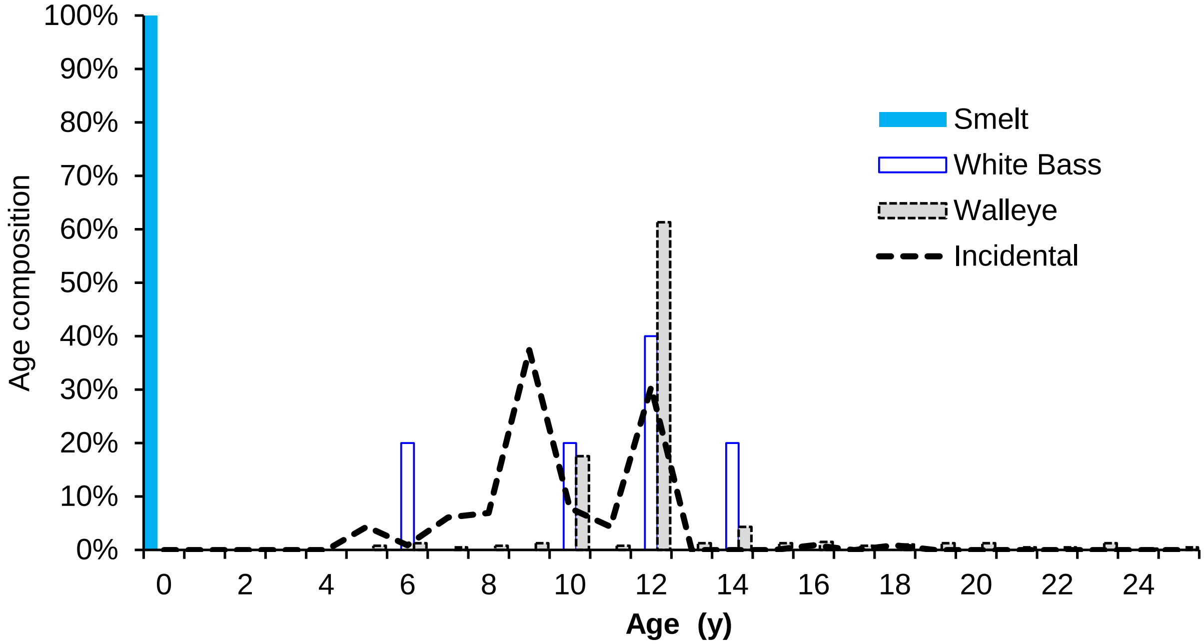

FIGURE 2.8. Age composition (otoliths, scales) of Lake Whitefish caught commercially in Ontario waters of Lake Erie in 2015 by other target species fisheries: Smelt Trawl (N=1), White Bass (N=5) and Walleye (N=393). Sex Composition: Male 64%, Female 36%, Unknown 0.3%; N=399. Supplementary fall commercial incidental assessment in west and central Lake Erie (dotted line) using scale ages only N=115.

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 2015 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 (133 lifts) during 2015 (0.03 LWF/lift) dropped 95% from 2014 (0.63 LWF/lift) and was lowest in the 31 year time series 1985-2015 (Figure 2.9). Catch rates in NY CWA nets during 2015 (0.04 LWF/lift) were marginally better than in ON waters (0.03 LWF/lift) whereas no Lake Whitefish were caught in Pennsylvania waters (0 LWF/lift). Four Lake Whitefish were caught in standard CWA nets during 2015. None of the four Lake Whitefish caught in CWA netting exhibited Sea Lamprey wounds or scars.

Partnership catch rates of Lake Whitefish ages 0 to 2 was 0.04 LWF/gang in 2015 (Figure 2.9). Catch rates for ages 3 and older Lake Whitefish caught in 2015 Partnership surveys dropped to 0.03 LWF/gang from 0.04 LWF/gang in 2014. None of the Lake Whitefish caught in 2015 were from the east basin. In addition to ten Lake Whitefish caught in Partnership Index gear in 2015, four additional Lake Whitefish were 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 0 to 14, with ages 0 (2015 year class) and 12 (2003 year class) equally represented (40%; Figure 2.10). Whitefish ages 10 and 14 each comprised 10% of index catches. The four Lake Whitefish caught in auxiliary gear included ages 8,10,12 and 13. Of 10 adult Lake Whitefish examined, one had an A4 wound (10 A4 wounds / 100 fish).

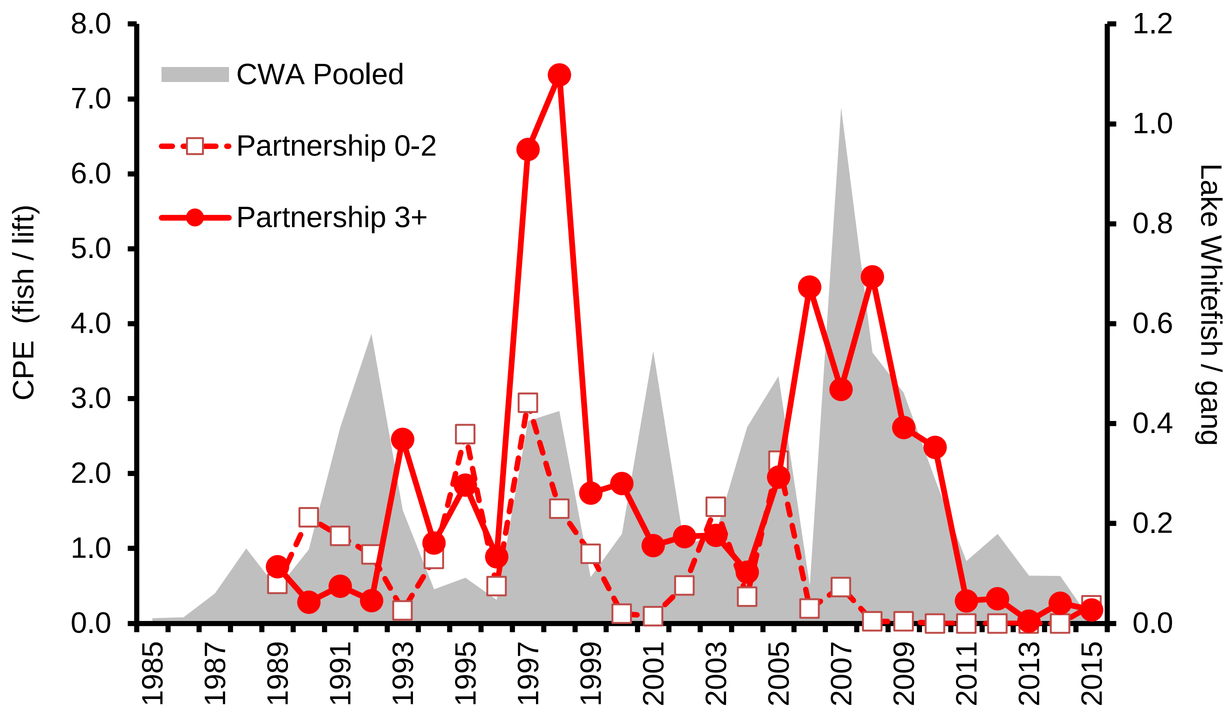

FIGURE 2.9. Catch per effort (number fish/lift) of Lake Whitefish caught in standard coldwater assessment gill nets (CWA) in New York, Ontario and Pennsylvania waters, weighted by number of lifts (grey area). Partnership index catch rates (WF/gang) for ages 0-2 (dots) and ages 3 and older (squares) (second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

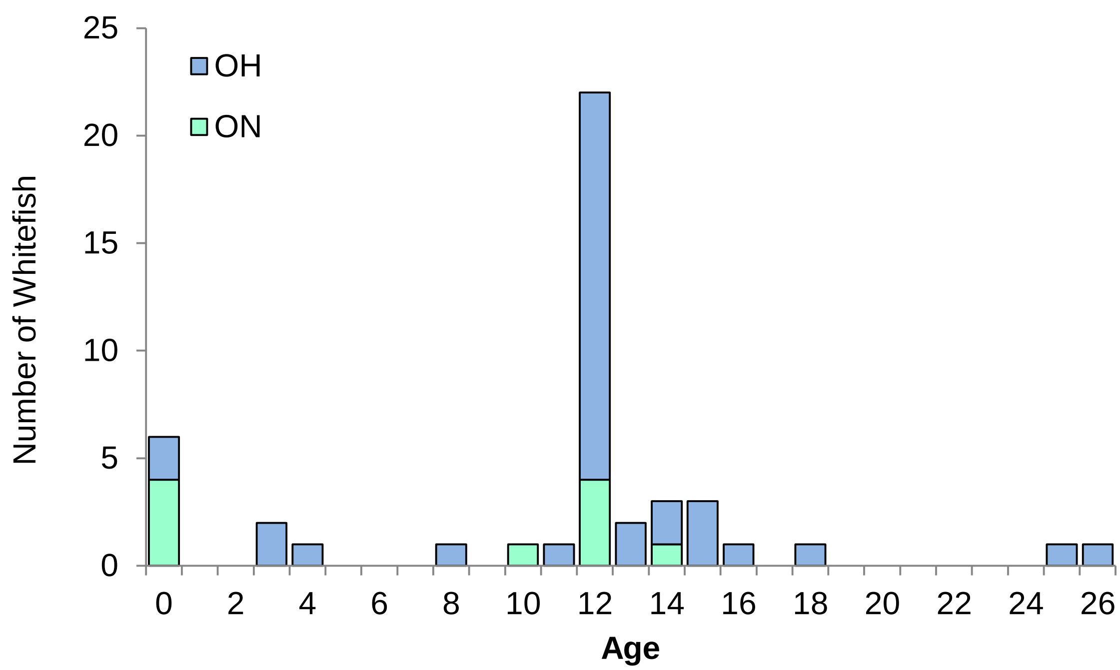

FIGURE 2.10. Age-frequency of Lake Whitefish collected from gill net surveys in Ohio (ODNR/USGS) and Ontario (Partnership index), 2015 (N=46).

Nineteen Lake Whitefish were captured in ODNR gill net assessment surveys and 17 were caught in USGS surveys in 2015. These fish ranged in age from 0 to 26 years with age-12 most abundant (50%) (Figure 2.10). Younger ages included 0, 3 and 4 while older; less abundant age groups present were ages 13-16,18 and 25-26. As with the Ontario catches, the strong 2003 year-class (age 12) were well represented, as well as some fish from the 1989-1990 and 1999-2002 year-classes.

Ohio trawl surveys in the central basin (Ohio Districts 2 and 3) of Lake Erie encounter juvenile Lake Whitefish in August and October. The catches can be considered as an index, describing the presence and magnitude of year classes. In 2010 and 2015, trawls were completed only during October in both districts. In 2015, young of the year (0.4 LWF/ha) and yearling (0.2 LWF/ha) Lake Whitefish were the highest since 2003 (Figure 2.11) and were caught at the same rates in Districts 2 and 3. Juvenile Whitefish were absent from Ohio trawls from 2008 to 2013, after which YOY were caught (0.2 LWF/ha) in the 2014 District 3 August trawl survey and subsequently in 2015.

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 2015 was completed, indicating the presence of 14 young of the year, one yearling and no older Lake Whitefish (Figure 2.11).

The New York trawl time series indicated the presence of age 0 Lake Whitefish periodically from 1992-2015 (Figure 2.11). In the last 2 years of the survey, YOY have been caught at comparable rates: 2014 (0.1 LWF/ha) and 2015 (0.09 LWF / ha). Annual catch rates of zero were frequent in the New York trawl time series (71% of years), resulting in high percentiles for the 2014 (78th) and 2015 (74th) year classes. As with Ohio and Pennsylvania time series, the 2003 trawl catch rate in New York was high.

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 2015.

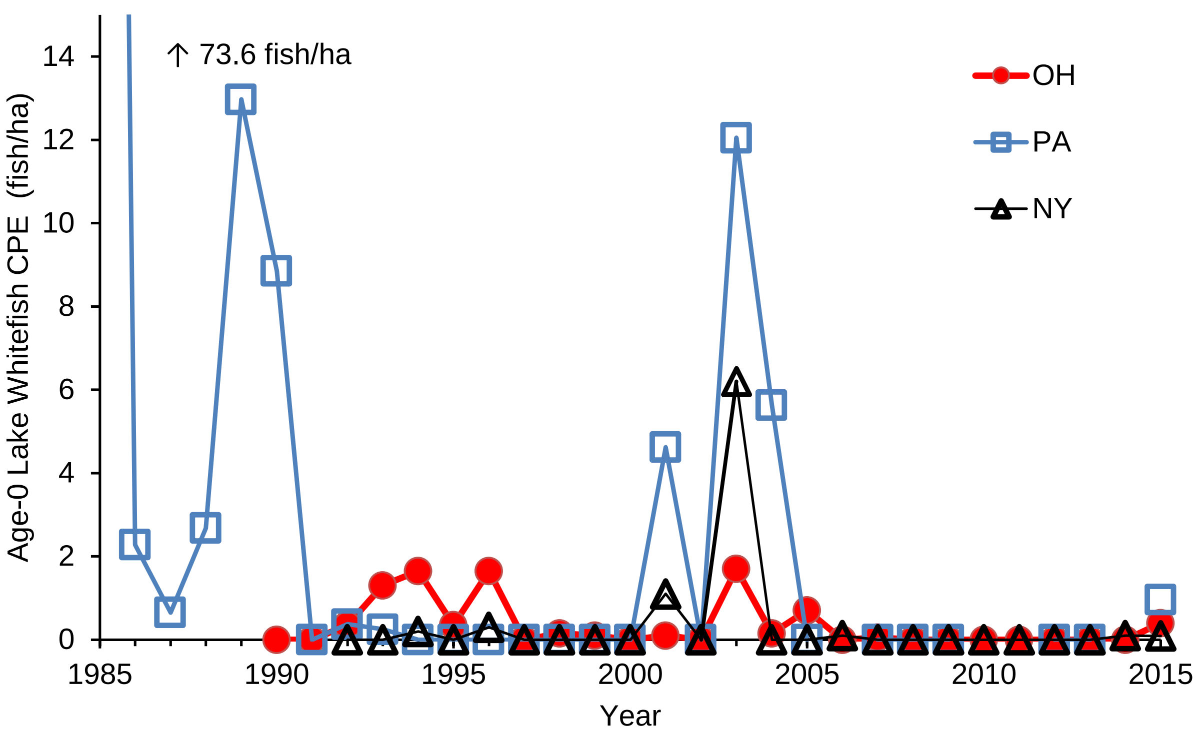

FIGURE 2.11. Mean age-0 Lake Whitefish catch per hectare in Ohio, Pennsylvania and New York fall assessment trawls. Ohio data are means for October trawls in District 2 and 3. Age-0 catch rate for Pennsylvania in 1985 (73.6 fish/ha) exceeds axis range.

Growth and Diet

Trends in condition are presented for Lake Whitefish sampled by ODNR in Ohio waters (Figure 2.12) and Ontario MNRF (Figure 2.13). For Lake Whitefish collected from Ohio commercial trap net and gillnet surveys, condition of males (mean K = 1.006) was slightly below Van Oosten and Hile's (1947) historic condition reference value (1.015; Figure 2.12), as was female mean condition in 2015 (K = 1.111) compared to the historic mean (K = 1.131). Lake Whitefish ages 4 and older collected during the fall from Ontario waters in 2015 had mean condition (K) values of 1.13 for females and 1.07 for males, situated near or above historic average conditions respectively (Van Oosten and Hile 1947; Figure 2.13). Lake Whitefish used for Ontario condition analyses included age-4 and older fish that were not spent or running, collected during October to December from commercial samples, Partnership index nets and Partnership auxiliary gear.

Only limited diet data were available from 2015: four age-0 and two age-1 Lake Whitefish, split evenly between Ohio Districts 2 and 3. YOY Lake Whitefish ate primarily Eurycercinae (50.2%) and Sphaeridae (46%) in District 2 and Chironomidae (35% pupae and 32% larvae) and Sphaeridae (26%) in District 3. Yearling Lake Whitefish ate mostly Sphaeridae (95% in D2, 81% in D3), along with some Isopoda (17%) in D3.

Fishery and survey assessment in 2015 described the continued decline of Lake Erie's adult Lake Whitefish population. Trawl and gill net assessment surveys provide some description of juvenile Lake Whitefish abundance, albeit variable within and between surveys when tracking cohort strength over successive years. Recent assessment suggests that 2014 and 2015 year class strength may be at least moderate based on the presence of juveniles in multiple trawl and gill net surveys, along with incidental harvest in commercial Rainbow Smelt trawls. Recruitment of these cohorts to Lake Whitefish fisheries may not begin until 2017-2018 and will not achieve full vulnerability until fish are age 5 or 6 in years to come. Since Lake Whitefish maturity and vulnerability to fisheries are somewhat synchronized, spawner biomass may remain low until fisheries improve. Continued conservative harvests are recommended until spawner biomass improves. Total Lake Whitefish harvest in 2015 (126 thousand pounds) was the lowest observed since 1988 (111 thousand pounds). Ontario's incidental harvest attained 71% of Lake Whitefish quota (100 thousand pounds) with no targeted harvest of Lake Whitefish in 2015. Ohio 2015 trapnet harvest (51 thousand pounds) was 68th percentile since 1987 while OH 2015 trapnet catch rates were 74th since 1996, suggesting that the Maumee River stock may be at a moderate level. With an assumed harvest mean weight (ON OH fisheries combined) of 2,246 g (N=544), the total estimated harvest in 2015 was 25,463 Lake Whitefish. Biological reference points and implications of this harvest level will be explored in the CWTG Charge 8 report in 2016.

Environmental factors, such as winters duration or severity, may play a role in Lake Whitefish population dynamics, especially for Lake Erie, at the southern end of their native range. Indeed, research on Lake Whitefish in other systems has suggested that cold winters and spring warming rates, among other factors, increase recruitment success. A preliminary analysis of winter severity on age-0 Lake Whitefish trawl indices from Ohio, Pennsylvania and New York supports this hypothesis. More work needs to be done to determine how data sets are combined, which metric to use for winter severity, and to include other variables (e.g., spring climatic conditions). In 2016, the Coldwater Task Group will be collaborating with the Data Deficient Working Group in support of improved Lake Whitefish assessment and management.

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.

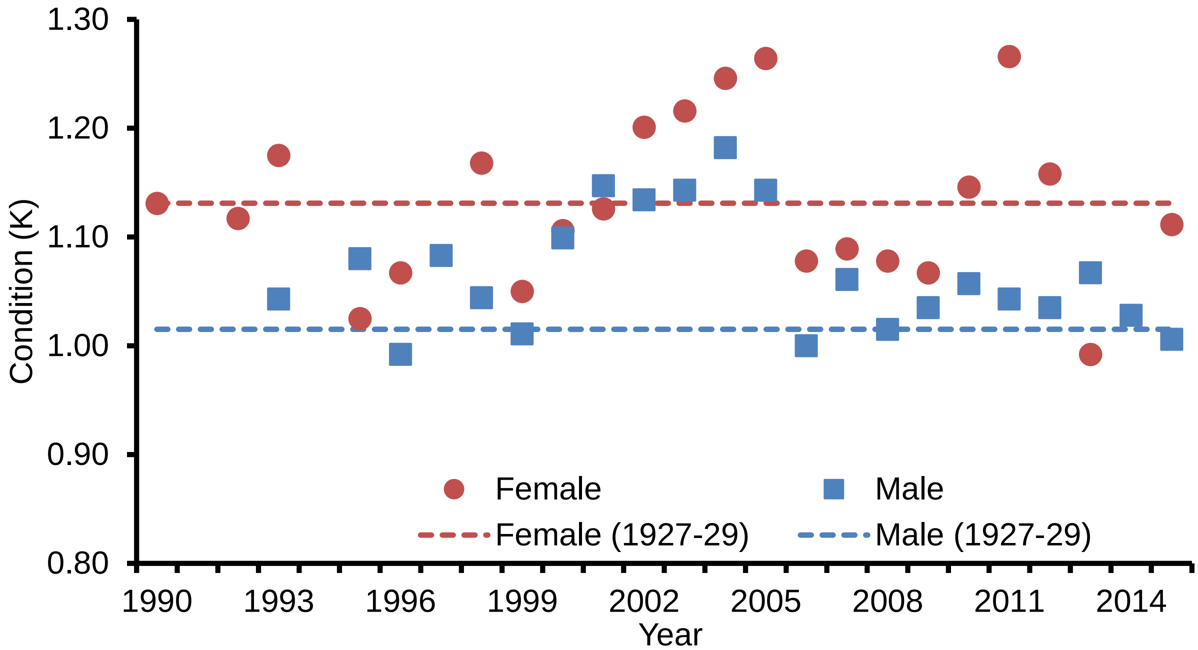

FIGURE 2.12. Mean condition (K) factor values of Lake Whitefish obtained from Ohio DNR and USGS fishery and survey data (Aug-Dec) from 1990-2015. Sample sizes in 2015 were: Males N=74 and Females N=84. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

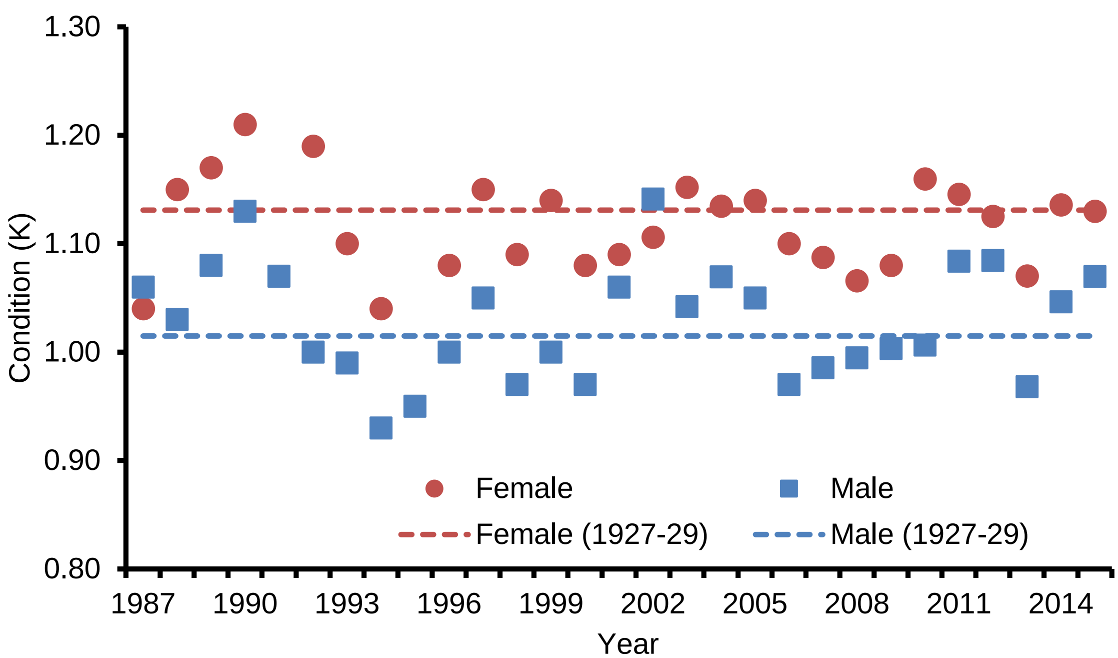

FIGURE 2.13. Mean condition (K) factor values of age 4 and older Lake Whitefish obtained from Ontario commercial and partnership survey data (Oct-Dec) by sex from 1987-2015. Samples sizes in 2015 were: Males N=92 and Females N=58. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

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

Tom MacDougall (OMNRF), Richard Kraus (USGS), and Zy Biesinger (USFWS)

Commercial Harvest

The commercial harvest of Burbot by the Lake Erie jurisdictions was relatively insignificant through the late 1980's, 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. In 1999, a market was developed for Burbot in Ontario, leading the industry to actively target this species. As a result, the commercial harvest in Ontario increased dramatically (Table 3.1). However, this opportunistic market did not persist, resulting in declining annual harvests. 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 recent years, the majority of the commercial Burbot harvest occurs in the east basin with minimal harvest occurring in Ohio waters and the western and central basins of Ontario waters.

The total commercial harvest for Lake Erie in 2015 was 2,728 pounds (1,237 kg) of which 57% came from New York waters (Table 3.1). All jurisdictions, except New York, recorded less than 1,000 lbs of commercial Burbot harvest. The Ontario harvest is now from by-catch in other fisheries. Most of the Burbot caught by the Ontario commercial fishing industry in 2015 was by-catch in trawls from the Rainbow Smelt fishery (64%), followed by the Walleye (21%) and Yellow Perch (15%) fisheries.

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 in Ontario waters and the inter-agency summer Coldwater Assessment in New York, Ontario, and Pennsylvania waters. The Ontario Partnership Index Fishing Program 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 Partnership index gill nets averaged less than 0.5 Burbot/lift (Figure 3.2). Burbot abundance increased rapidly after 1993, especially in the Pennsylvania Ridge area and in the eastern basin, reaching a peak of about 4.2 Burbot/lift in 1998. Burbot numbers in the central basin also peaked in 1998, but at a much lower catch rate of 0.5 Burbot/lift. 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 by 2005. Catch rates in the eastern basin since 1998 have been variable but exhibited an overall decreasing trend with record low numbers observed in 2015. Only three Burbot were captured in 2015; one on the Pennsylvania Ridge and two in the eastern basin (Figure 3.2).

An examination of bottom set gill net catches from combined sample locations in the eastern basin and Pennsylvania Ridge of the Ontario Partnership assessment data shows that the numeric abundance of Burbot (CPE as fish/lift) increased approximately eight-fold from 1993 to 1998, whereas the biomass CPE did not peak until 2003, some five years after maximum numeric abundance was observed (Figure 3.3). Burbot number and biomass have steadily decreased after reaching their respective peaks. In 2015, both abundance measures were at their respective time-series minima (Figure 3.3).

Numeric abundance of Burbot from Coldwater assessment gill netting showed similar patterns to the Partnership Index Program. Burbot abundance increased sharply after 1993, peaking in 2000 in all eastern basin jurisdictions except New York, where peak abundance was not observed until 2004 (Figure 3.4). Burbot catch rates were highest in Ontario waters during most years from 1996 to 2007, the period when Burbot catch rates were 2 or more per lift in all jurisdictions. Burbot abundance has continued to decrease throughout the eastern basin in recent years. Burbot catch rates were less than 0.3 fish/lift across all jurisdictions in 2015 (Figure 3.4).

TABLE 3.1 Total Burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2015.

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

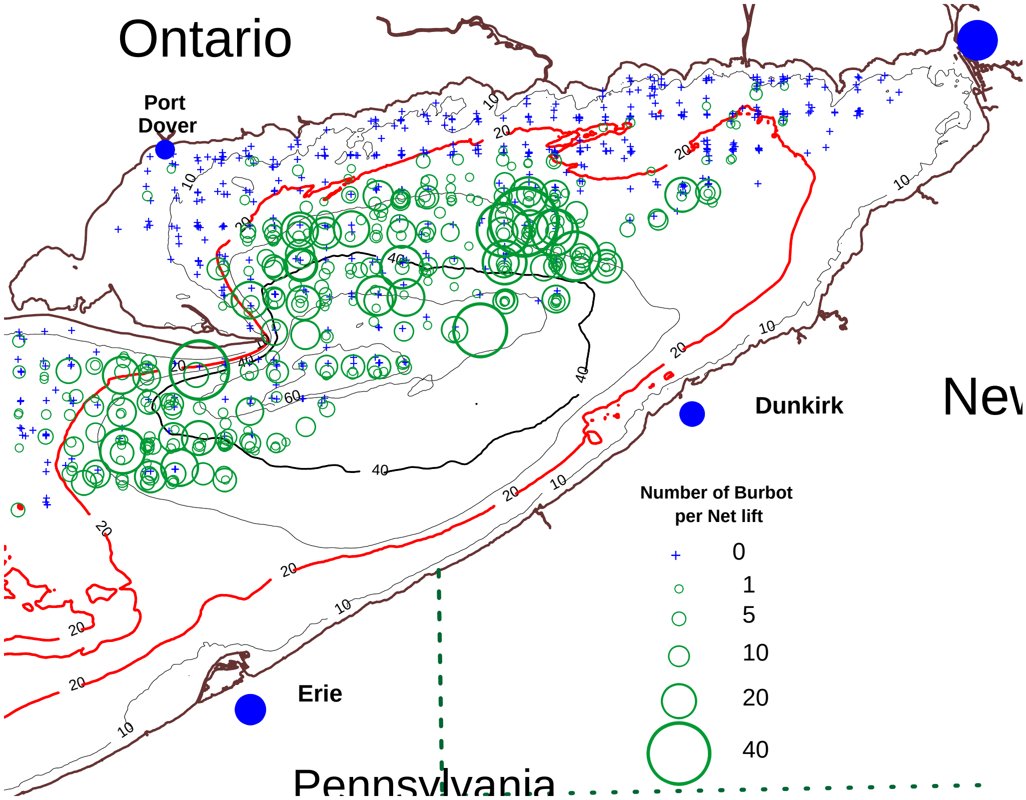

FIGURE 3.1 Distribution of eastern basin Burbot catches (Number per lift) in Ontario Partnership gill nets during August surveys of eastern Lake Erie, 1989 - 2015.

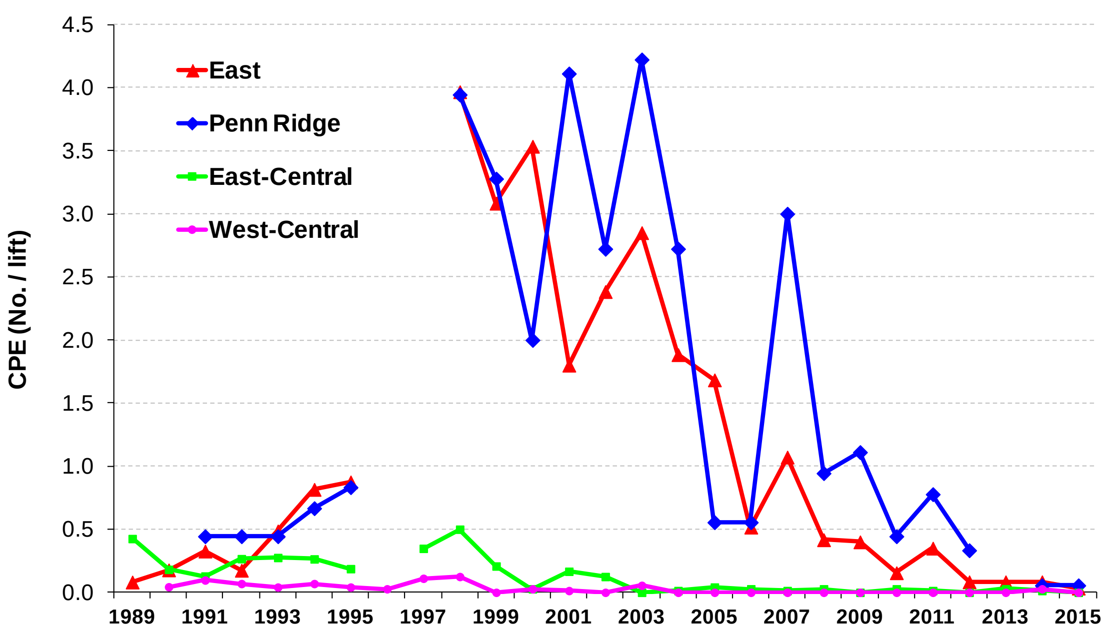

FIGURE 3.2 Burbot CPE (number per lift) by basin from the Ontario Partnership surveys 1989–2015 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets). Pennsylvania Ridge was not sampled in 2013.

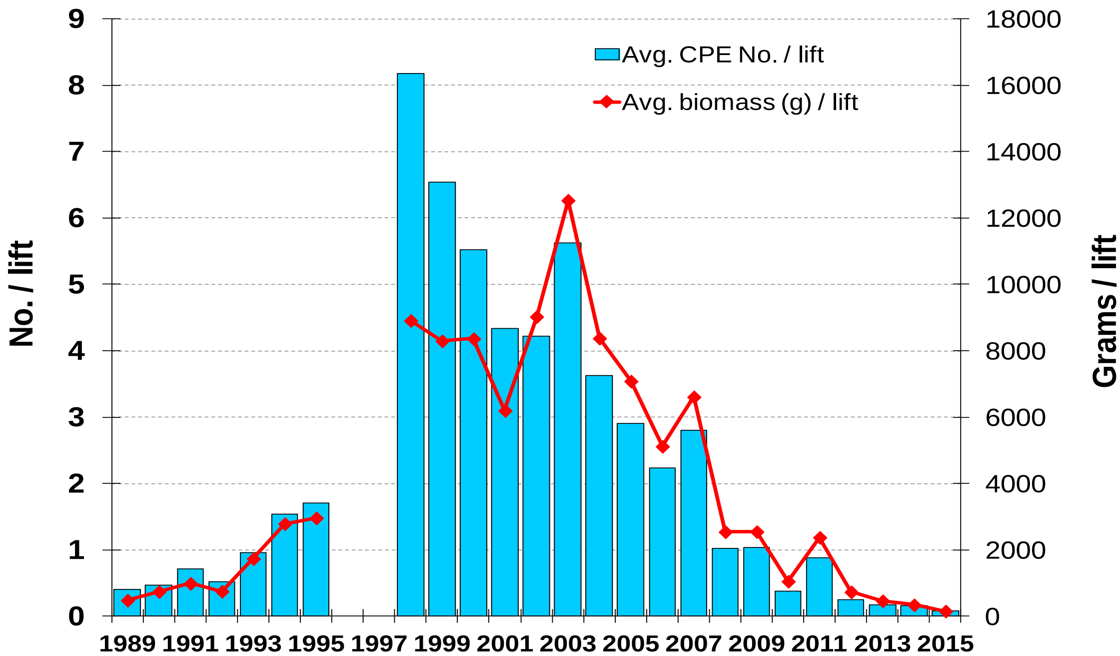

FIGURE 3.3 Average catch rate (CPE as number per lift) and biomass (grams per lift) of Burbot in Ontario waters of eastern Lake Erie, Ontario Partnership gill net survey 1989–2015 (includes only bottom sets, all mesh sizes; PA-ridge and eastern basin sample sites). Pennsylvania Ridge was not sampled in 2013.

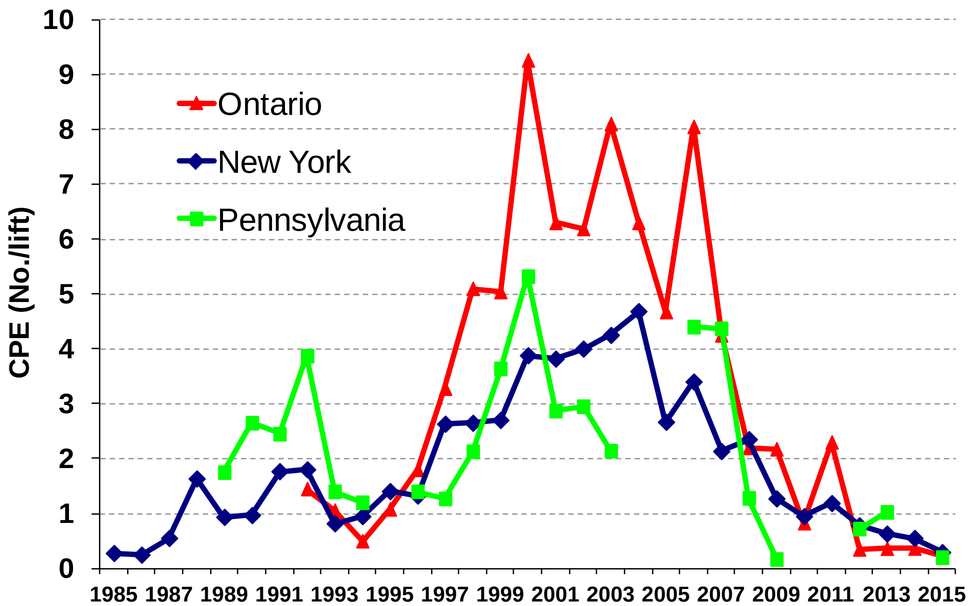

FIGURE 3.4 Average Burbot catch rate (number of fish/lift) from multi-agency summer Coldwater Assessment gill nets by jurisdiction in eastern Lake Erie, 1985-2015.

In general, Burbot biomass CPE has followed a similar pattern as numeric abundance except that Burbot catches in summer coldwater gill net assessments in Ontario and Pennsylvania did not reach maximum biomass until six or more years after maximum numeric abundance was observed (Figure 3.5). The 2011 uptick in Burbot biomass CPEs in Ontario (7.0 kg/lift) and New York (3.7 kg/lift) was not sustained and since 2012 Burbot catch rates in these two regions have decreased to the lowest points in their respective time series (Figure 3.5). The biomass CPE in Pennsylvania declined to a series low in 2009, increased in 2012 and 2013, and then decreased again in 2015 to the second lowest value in the series. Pennsylvania was not surveyed in 2010, 2011, or 2014.

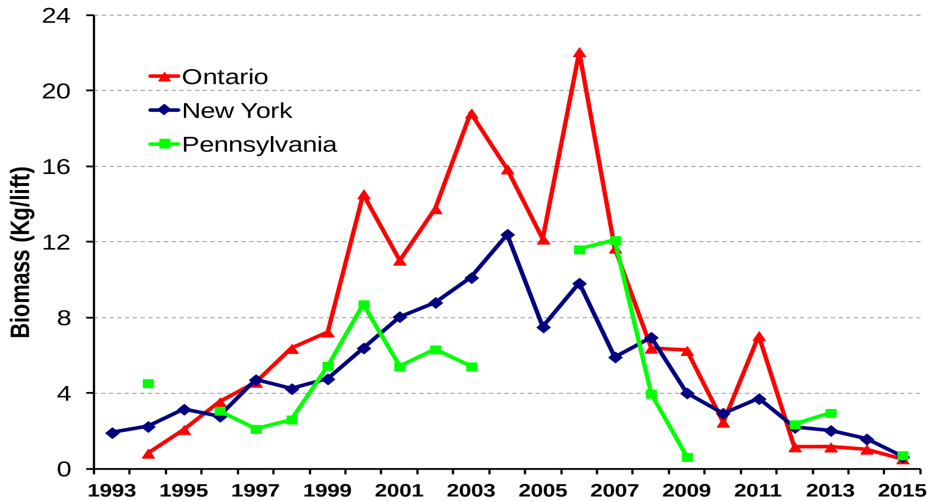

FIGURE 3.5 Average Burbot biomass (kg/lift) from summer multi-agency summer coldwater gill net assessment by jurisdiction, 1993-2015.

Age and Recruitment

Burbot ages have been estimated using otoliths for fish caught in coldwater assessment gill nets in Ontario waters since 1997 and for the entire eastern basin survey area since 2011. The use of otolith thin-sections is recommended as the best approach for accurate age determination of Burbot (Edwards et al. 2011). The age distribution of Burbot ranged from 3 to 22 years in 2015 (Figure 3.6). Burbot older than 12 years have represented over 50% of the catch since 2011 (53% in 2015). Following a general trend of increasing mean age of Burbot (in Ontario) from 1997 to 2013, the mean age has declined over the past two years from a peak of 15.4 in 2013 to 9.2 in 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), and evidence of recent recruitment remains scarce. The youngest individuals captured during 2015 coldwater index netting were three 3-year olds (Figure 3.6). Stapanian et al. (2010) suggested that recruitment during 1997-2007 was negatively associated with abundance of yearling and older Yellow Perch when the Burbot were age-0, and positively associated with the number of days below 2°C during winter (the spawning and egg development phases). Burbot have the highest reproductive success at water temperatures between 0°C and 2°C, and are susceptible during early life to predation by Yellow Perch. A sustained downward trend in catch rates, an increasing trend in mean age, and persistent low recruitment signal continuing troubles for this population. More importantly, efforts to reduce mortality (e.g., through Sea Lamprey control) on the remaining spawning stock would help ensure that this population can exploit favorable conditions for recruitment in future years.

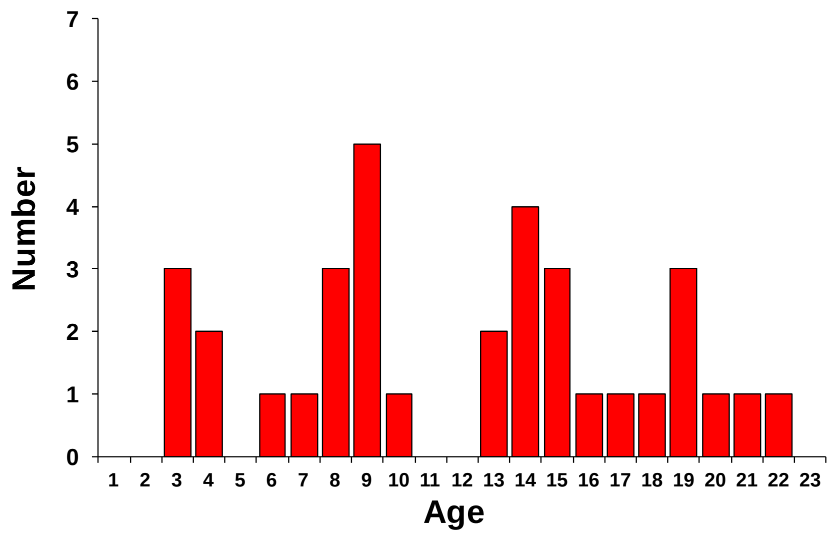

FIGURE 3.6 Age distribution of Burbot caught in multi-agency summer coldwater gill net assessment in eastern Lake Erie, 2015 (N=34).

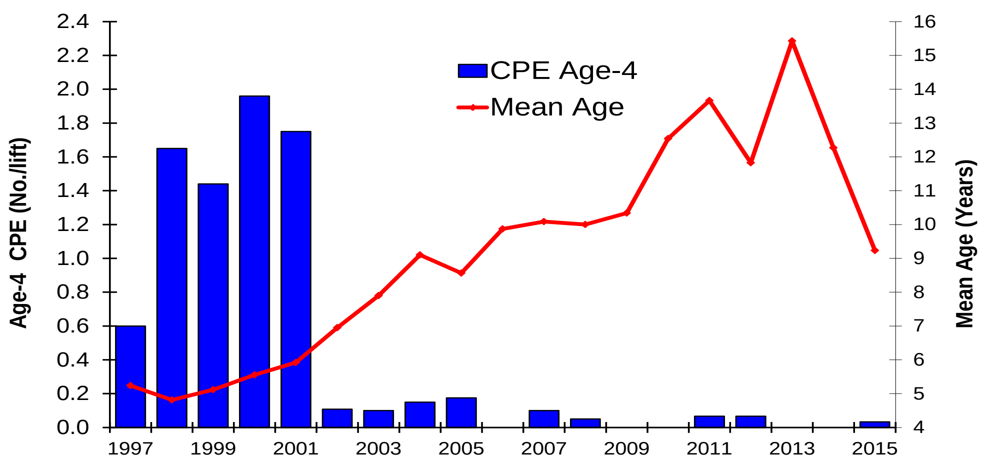

FIGURE 3.7 Mean age and average CPE of age-4 Burbot caught in multi-agency summer coldwater gill net assessment in Ontario waters of eastern Lake Erie during 1997-2015.

Growth

Mean total length of Burbot decreased for the second year in a row in Ontario and New York in 2015, in sharp contrast to a predominately increasing trend since the late 1990's (Figure 3.8). Average weight of Burbot decreased in Ontario for the third year in a row and also decreased in New York for only the second time since 1997 (Figure 3.9). However, increasing average size remains the dominant trend since about 1998 and reflects the increasing mean age of the Burbot population.

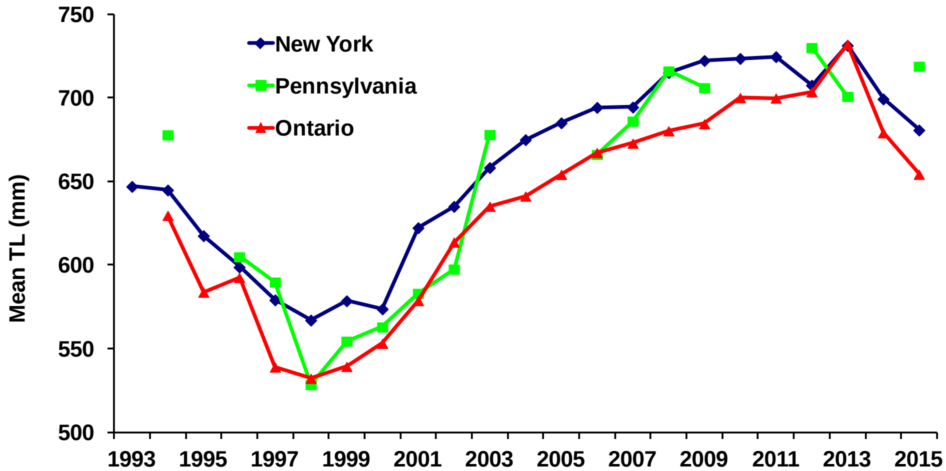

FIGURE 3.8 Average total length (TL, mm) of Burbot caught in multi-agency summer gill net assessments by jurisdiction in eastern Lake Erie during 1993-2015.

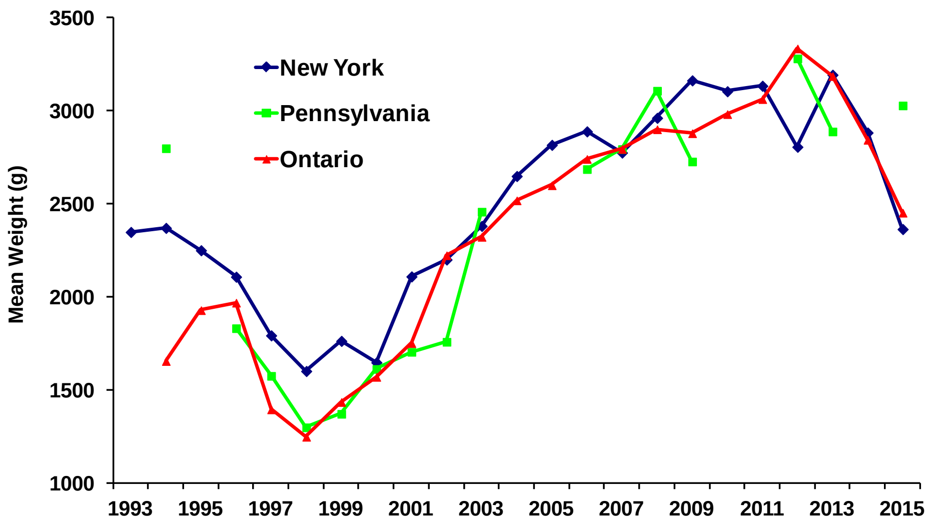

FIGURE 3.9 Average weight (g) of Burbot caught in multi-agency summer gill net assessments by jurisdiction in eastern Lake Erie during 1993-2015.

Diet

Diet information was limited to fish caught in Ontario and New York waters during August 2015 multi-agency coldwater assessment gill nets in the eastern basin of Lake Erie; no diet data were collected from fish caught in Pennsylvania waters nor those from the Ontario Partnership Index Fishing Program. Analysis of Burbot stomach contents in 2015 revealed a diet comprised mostly of fish (Figure 3.10). Burbot diets continued to be diverse, with four different identifiable fish species found in non-empty stomach samples including Round Goby (67%), Rainbow Smelt (29%), Yellow Perch (4%) and Emerald Shiner (4%). Unidentifiable fish species were present in 8% of the samples.

Round Gobies have increased in the diet of Burbot since they first appeared in the eastern basin in 1999. They were the main diet item for Burbot in nine of the last 13 years. Smelt were the dominant prey in 2005, 2009, 2011, and again in 2012. Size-at-age of Burbot has increased since Round Gobies became a significant component of the Burbot's diet (Stapanian et al. 2011). This increase in size is thought to be associated with reduced competition for food among juvenile Burbot during low recruitment years.

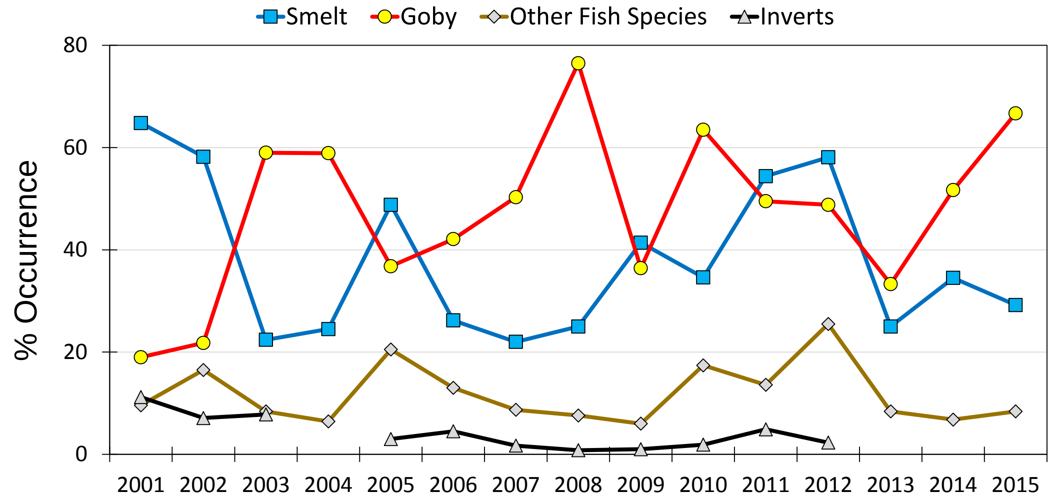

FIGURE 3.10. Frequency of occurrence of diet items from non-empty stomachs of Burbot sampled in multi-agency coldwater assessment gill nets from the eastern basin of Lake Erie, August, 2001-2015. Unknown includes fish remains that could not be identified to species.

Reproductive Anomalies

Observations of large, yellow-brown, hardened masses in a few Burbot ovaries were detected in 2012. Observations in subsequent years indicated that they occurred sporadically in the female ovaries, and black spots were also observed on some of the male testes as well. Hardened masses were not observed in 2015 due to the absence of female burbot in the interagency samples, but black spots were still evident on some of the males. Pennsylvania submitted Burbot samples from 2014 and 2015 to the US Fish and Wildlife Service Lamar Fish Health Center for pathology analysis. The results found some lesions and a bacterial infection (*Yersinia ruckeri*) on a single Burbot ovary, but the hardened masses were not observed in these samples. Archived samples with masses, collected in 2012 and 2013, have been sent to the USGS Western Fisheries Science Center Fish Health Laboratory for histopathology. The identity and origin of the anomalous masses, and significance, is still unknown at this time.

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Stapanian, M.A., L.D. Witzel, and W.H. Edwards. 2011. Recent changes in growth of Burbot in Lake Erie. Journal of Applied Ichthyology 27 (Supplement 1): 57-64.

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 118 A1-A3 wounds were found on 1030 Lake Trout greater than 532 mm (21 inches) total length in 2015 during coldwater assessment gill netting, equaling a wounding rate of 11.5 wounds per 100 fish (Table 4.1; Figure 4.1). This was a 31% decrease from the 2014 wounding rate of 16.6 wounds per 100 fish. The current wounding rate remains over two 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 (12.5 wounds/100 fish) while Lake Trout greater than 736 mm (29 inches) total length (TL) were slightly less (11.2 wounds/100 fish; Table 4.1). Conversely, the 23 Lake Trout in the 432-532 mm (17-21 inch) size category did not have any wounds in 2015.

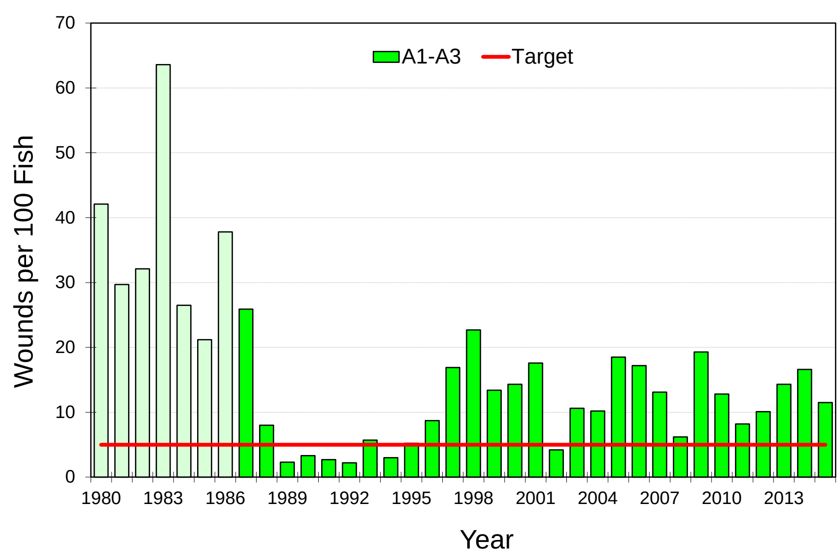

FIGURE 4.1. Number of fresh (A1-A3) Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2015. The target rate is 5 wounds per 100 fish. Lighter shading indicates pre-treatment years.

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	23	0	0	0	0	0.0	0.0
533-634	106	1	3	2	15	5.7	14.2
635-736	665	3	29	51	291	12.5	43.8
>736	259	3	7	19	253	11.2	97.7
>532	1030	7	39	72	559	11.5	54.3

Finger Lakes (FL), Klondike (KL), and Lake Champlain (LC) strain Lake Trout were the most sampled strains in 2015, and they accounted for the majority of the fresh (A1-A3) and healed (A4) Sea Lamprey wounds (Table 4.2). Overall, A1-A3 wounding rates were over two times as high on KL strain Lake Trout compared to FL and LC strain Lake Trout; FL and LC A1-A3 wounding rates were nearly identical. A4 wounds were the highest on KL strain fish. However, almost all Lake Trout >736 mm TL were FL 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. Lake Champlain strain Lake Trout have only been stocked in Lake Erie for the past seven years and are just reaching size ranges that are especially vulnerable to Sea Lamprey. Early indications from A1-A3 wounding rates indicate that these fish perform better than Superior strains of Lake Trout and are similar to FL strain Lake Trout in their susceptibility to attacks.

TABLE 4.2. Frequency of Sea Lamprey wounds observed on Lake Trout greater than 532 mm (21 inches), by strain, collected from assessment gill nets in the eastern basin of Lake Erie, August 2015. AI=Apostle Island, FL=Finger Lakes, KL=Klondike, LC=Lake Champlain, LO=Lake Ontario, 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	3	33.3	100.0
FL	221	3	4	15	183	10.0	82.8
KL	84	2	7	11	83	23.8	98.8
LC	528	2	21	34	190	10.8	36.0
LO	1	0	0	0	4	0.0	400.0
SI	31	0	1	0	0	3.2	0.0

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 2015, there were no A1-A3 wounds on the 30 burbot sampled in the New York waters of Lake Erie. A4 wounding rates were 13.3 wounds per 100 fish, which was the fourth highest value in the time series.

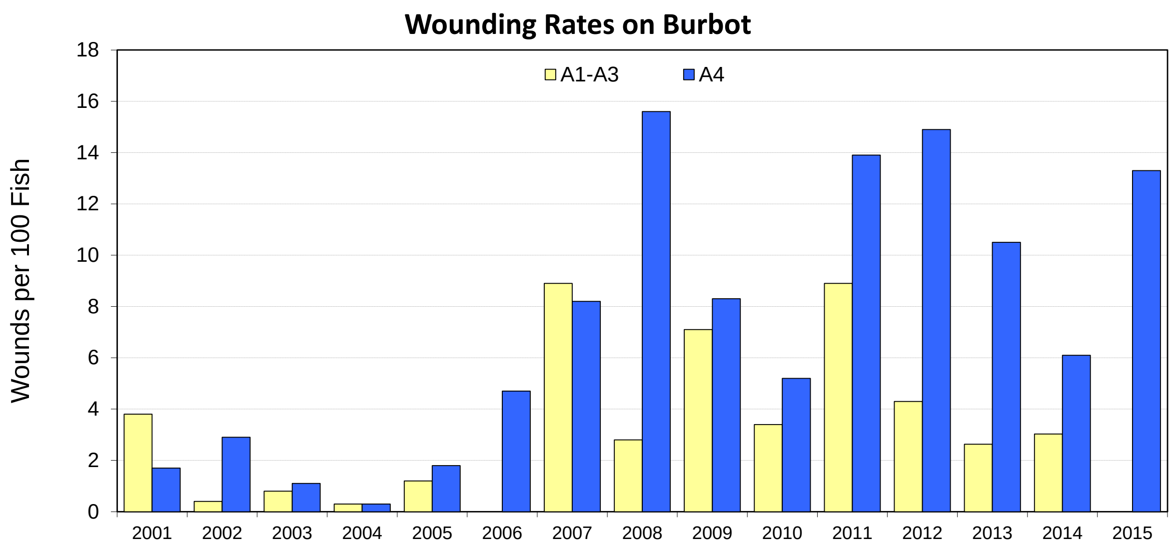

FIGURE 4.2. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Burbot (all sizes) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2015.

Lake Whitefish Wounding Rates

Reliable counts of Sea Lamprey wounds on Lake Whitefish have been recorded in New York since 2001. Wounds on Lake Whitefish were first observed in 2003, coincident with depressed adult Lake Trout abundance (see Charge 1). Only two Lake Whitefish were caught in 2015 assessment netting in New York and neither of these fish had any sea lamprey wounds (Figure 4.3).

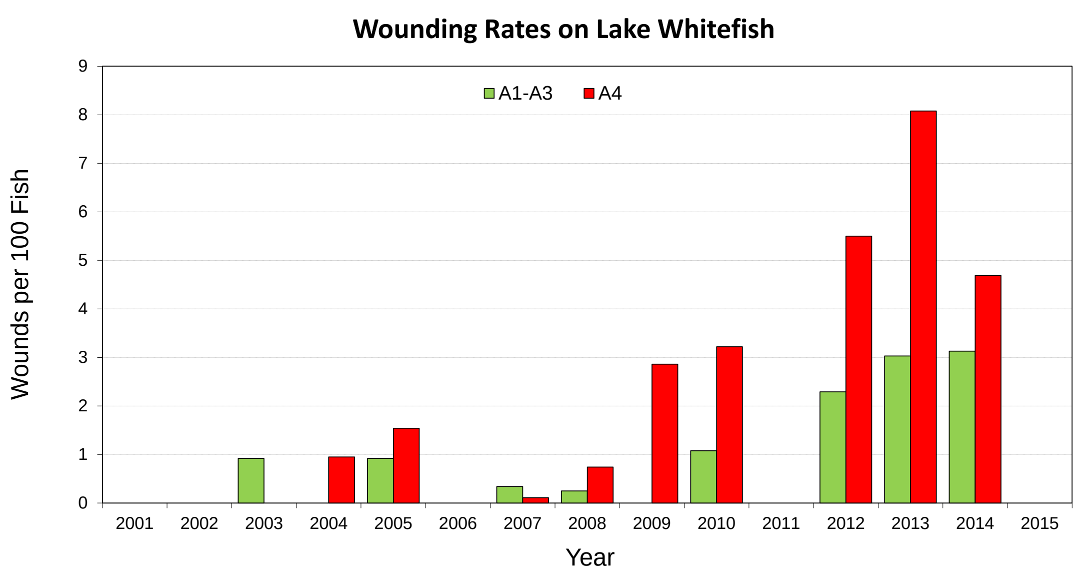

FIGURE 4.3. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Lake Whitefish (all sizes) sampled in assessment gill nets in the New York waters of Lake Erie, August, 2001-2015. Note only two Lake Whitefish were sampled in 2015 and neither possessed sea lamprey wounds.

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 or disease surveillance collections (Table 4.3). Wounding rates on these surveys vary. In 2010 through 2012, Pennsylvania began a more directed survey during their annual fall Steelhead run to address this data gap; however, this data was not collected in 2013 or 2014. In 2015, wounding statistics on Steelhead were recorded during a tributary angler survey in the New York tributaries and during a research project sampling conducted on Chautauqua Creek, NY. Total wounding rates (A1-A4 + B wounds) on Steelhead from these surveys were 3.1 and 10.9 wounds/100 fish, respectively.

TABLE 4.3. Frequency of Sea Lamprey wounds observed on Steelhead from various Lake Erie tributary surveys, 2003-2015.

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	4 A1-A3; 5 A4
Fall 2010 Directed Wounding Survey	PA	142	26	2.8	18.3	4 A1-A3; 5 A4; 17 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	40	2.5	9.9	10 A1-A3; 9 A4; 21 B1-B4
2014-15 Tributary Creel Survey	NY	161	5	N/A	3.1	All wounds combined
Fall 2015 Chautauqua Creek	NY	129	14	0	10.9	0 A1-A3; 11 A4; 3 B1-B4

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 2015. 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.

Lake Trout (61) collected from index and auxiliary gear in 2015 were examined for wounds and scars. There were no A1-A3 wounds or scars observed on any Lake Trout in 2015. The fraction of Lake Trout observed with A4 wounds was 4/61 or (0.07). By strain of Lake Trout, 12% of Slate Island Lake Trout and 8% of clipped Lake Trout lacking coded wire tags had A4 wounds while remaining strains did not exhibit any scars or wounds. Sea Lamprey wounds (A 4) were also recorded on other fish species including Lake Whitefish, Walleye, White Perch, and Common White Sucker (Figure 4.6).

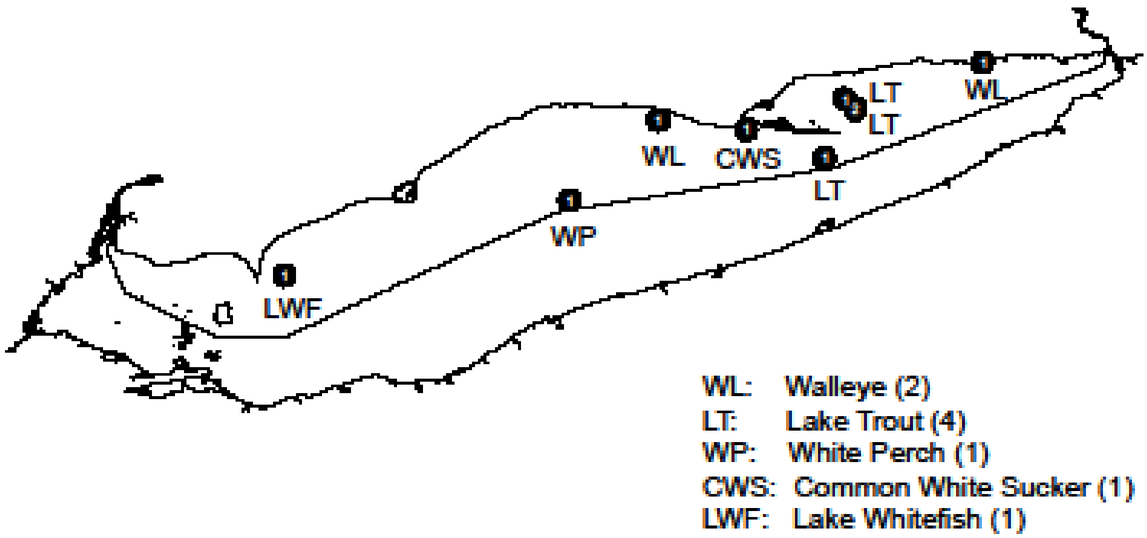

FIGURE 4.4. Number of fish with A 4 Sea Lamprey wounds during Lake Erie Partnership Index gill netting 2015. Symbol labels indicate number of fish with wounds. Includes index and auxiliary gear.

2015 Sea Lamprey Control Actions

Lampricide Control

Lampricide applications were conducted in 7 streams (6 U.S., 1 Canada, Table 4.4). Paint Creek, a tributary to the Clinton River, and Komoka Creek, tributary to the Thames River were both treated for the first time. The entire infested distribution on Conneaut Creek was successfully treated for the first time, including 3.2 miles further upstream than the historical upper application point. A treatment of Crooked Creek was added to the end of the field season due to results of late summer assessments that captured numerous large ammocetes and juveniles.

Three tributaries to Lake Erie in New York State were scheduled to be treated by Department of Fisheries and Oceans, Canada. Big Sister Creek was treated for the first time. Canadaway Creek was treated for the first time since 1986. Cayuga Creek (tributary to the Buffalo River) treatment was not completed due to unfavorable environmental conditions.

Assessment

Assessments were conducted to search for new populations of Sea Lamprey larvae or to monitor existing populations in 58 tributaries (35 U.S., 23 Canada) and one offshore lentic area. Surveys to detect new larval populations were conducted in 34 tributaries (16 U.S., 18 Canada). No new populations were detected. (Appendix 4.1).

During the 2015 field season, 2.4 ha of the St. Clair River were surveyed with gB, including the upper river and the three main delta channels for the purpose of discovering previously undetected larval hot-spots. The total catch of 24 Sea Lampreys was scattered throughout the river with no new high density areas. A total of 1.1 ha of the Detroit River was surveyed with gB by Department of Fisheries and Oceans and United States Fish and Wildlife Service crews during our periodic routine assessment (every third year). The Detroit River continues to have no larval Sea Lamprey production. Survey crews also completed the second of a two year deep-water electrofishing project in waters adjacent to Walpole Island First Nation (WIFN) on the St. Clair River. No lampreys were collected in 2015 and only seven Sea Lamprey larvae were found in 2014.

TABLE 4.4. Lake Erie lampricide treatments during 2015.

Tributary	Date	Distance Treated (km)
Canada		
Thames R.		
Komoka Cr.	Aug-16	2.9
United States		
Big Sister Cr.	Apr-13	26.2
Canadaway Cr.	May-22	3.1
Crooked Cr.	Oct-11	14.5
Racoon Cr.	Apr-28	4.2
Conneaut Cr.	Apr-24	110.9
Clinton R.		
Paint Cr.	May-12	10.9
Total for Lake		**172.7**

Surveys to evaluate habitat and determine presence/absence of native or Sea Lampreys were conducted in the Cuyahoga River, Ohio, upstream from Brecksville and Gorge dams. The surveys were required as a part of a barrier removal request. Larval habitat was limited and no lampreys were detected.

A total of 2,486 adult Sea Lampreys were captured in five tributaries in 2015 (2 U.S., 3 Canada; http://www.glfc.org/sealamp/catchdb/index.html) compared to 5,816 caught during 2014. The index of adult Sea Lamprey abundance was 7,112 (95% CI; 4,521-9,341), which was greater than the target of 3,039 (Figure 4.5).

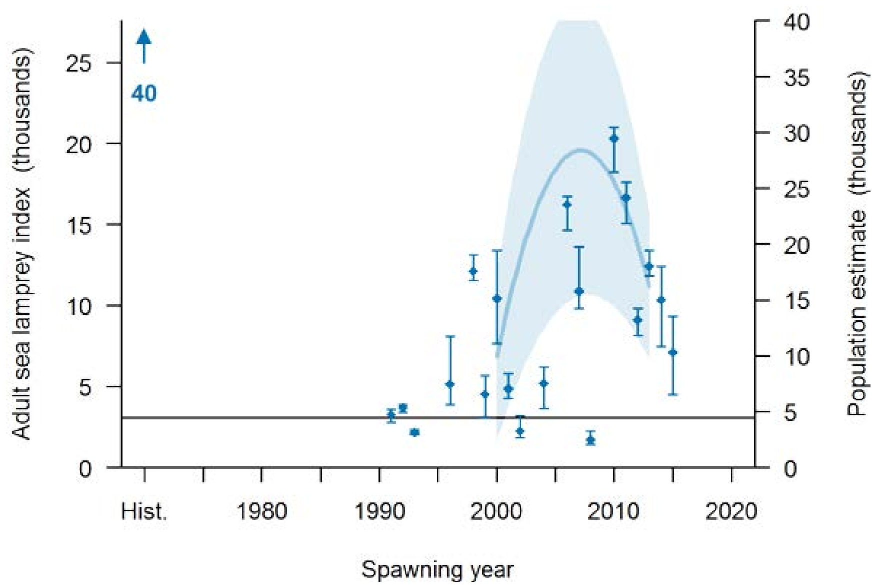

FIGURE 4.5. Index estimates with jackknifed ranges (vertical bars) of adult Sea Lampreys, including historic pre-control abundance (as a population estimate) and the five-year moving average (line) with 95% CIs (shaded area). The population estimate scale (right vertical axis) is based on the index-to-population estimate conversion factor of 1.45. The adult index in 2015 was 7,100 with jackknifed range (4,500-9,300). The point estimate was above the target of 3,000. The index target was estimated as the mean of indices during a period with acceptable marking rates (1991-1995).

Barriers

During 2015, field crews visited 139 barrier sites on U.S. tributaries to Lake Erie to perform barrier inspections and to ground truth the current barrier inventory data within the Barrier Inventory and Project Selection System (BIPSS) database.

Fish community assessment surveys were conducted on two Canadian tributaries to Lake Erie: Clear Creek and Big Creek (Venison Creek). The purpose of this work was to evaluate the condition of fish communities within streams where purpose built Sea Lamprey barriers exist.

Grand River –The U.S. Army Corps of Engineers (USACE) is the lead agency administering a project to construct a Sea Lamprey barrier to replace a deteriorated structure in Harpersfield, Ohio. Project partners include the Commission, Service, Ohio Department of Natural Resources, and Ashtabula County. The USACE developed several alternatives, including: status quo, onsite rebuild, or rebuild further downstream. The USACE selected an onsite rebuild as the preferred alternative and completed the Detailed Project Report (DPR). The USACE District Headquarters approved the release of the DPR and the public review period closed on July 10.

Cattaraugus Creek **–** The USACE, along with project partners Erie County and New York Department of Environmental Conservation have approved the selected plan for the Springville Dam Ecosystem Restoration Project, restoring connectivity to approximately 70 miles of Cattaraugus Creek upstream of the Springville Dam. The selected plan will lower a portion of the existing spillway, but will still serve as a Sea Lamprey barrier. A rock riffle ramp with seasonal trapping and sorting operation is included in the design.

Barrier removals/modification – Consultations to ensure blockage at barriers were conducted with partner agencies for three sites in two streams during 2015 (Table 4.5).

TABLE 4.5. Status of concurrence requests for barrier removals, replacements, or fish passage projects in Lake Erie tributaries.

Mainstream	Tributary	Lead Agency	Project	SLCP Position	Comments
Cuyahoga R.		OSMP[1]	Gorge Plant Dam	Pending	First blocking
Cuyahoga R.		Ohio EPA	Brecksville Dam	Pending	Ineffective barrier
Black R.		MIDNR[2]	Wingford Dam	Do not concur	First blocking

[1]Ohio Summit Metro Parks
[2]Michigan Department of Natural Resources.

Risk Management

No activity to report.

2016 Sea Lamprey Control Plans

Lampricide Control

Lampricide applications are planned for 4 (3 U.S., 1 Canada) streams - the Grand River, Canadaway, and Cattaraugus Creeks (U.S) and the main stem of Catfish Creek (Canada). The main stem of Catfish Creek is scheduled to be treated for the first time in 2016.

Assessment

Larval assessments are planned on 54 streams (34 U.S., 20 Canada, Appendix 4.1), and 2.4 hectares of gB assessment is planned on the St. Clair River, continuing to outline hotspot distributions, detect and to monitor abundance. Additional assessment planned on the upper Thames River beyond the Springbank Dam in London, Ontario to inform prior to the consideration to remove or remediate the deteriorating dam.

Adult assessments are planned on Big Otter, Big, Youngs, and Cattaraugus creeks and the Grand River (2 U.S., 3 Canada).

Barriers

Big Otter Creek – A meeting between the owner of the Black Bridge railway crossing dam and Department staff concerning the retrofit of this structure to prevent the passage of spawning lampreys was conducted in September 2015. Based on the favorable response, a detailed engineering study including geotechnical investigation and structural integrity is planned for 2016.

Grand River – The USACE expects to continue with the design phase once the Project Partnership Agreement is signed by all parties. Construction is targeted for 2017.

Cattaraugus Creek – The USACE, along with project partners Erie County and New York Department of Environmental Conservation expect to continue with planning for the Springville Dam Ecosystem Restoration Project to restore connectivity to approximately 70 miles of Cattaraugus Creek upstream of the Springville Dam. Construction is targeted for 2018.

Risk Management

The Risk Management Team and the USGS Upper Midwest Environmental Sciences Center will conduct field tests 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 to two 518 m^2 plots in the Middle Channel of the St. Clair River (Lake St. Clair).

A Sea Lamprey production potential study is planned for Big Creek. This investigation is intended to evaluate the production potential for Sea Lamprey upstream from critical barriers by sampling habitat and native lamprey populations as a surrogate for Sea Lampreys.

References

Lake Trout Task Group. 1985. A Sea Lamprey management plan for Lake Erie. Report to the Great Lakes Fishery Commission, Lake Erie Committee, Ann Arbor, Michigan, USA.

Markham, J.L., Cook, A., MacDougall, T., Witzel, L., Kayle, K., Murray, M., Fodale, M., Trometer, E., Neave, F., Fitzsimons, J., Francis, J., and Stapanian, M. 2008. A strategic plan for the rehabilitation of Lake Trout in Lake Erie, 2008-2020. Great Lakes Fish. Comm. Misc. Publ. 2008-02.

APPENDIX 4.1. Larval Sea Lamprey assessments of Lake Erie tributaries during 2015 and plans for 2016.

Stream	History	Surveyed in 2015	Survey Type[1]	Results	Plans for 2016
Canada					
St. Clair R.	Positive	Yes	Evaluation	Positive	Evaluation
Talford Cr.	Negative	Yes	Detection	Negative	
Thames R. (Komoka Cr.)	Positive	Yes	Evaluation	Positive	Evaluation
Thames R. (Tribs)	Negative	Yes	Detection	Negative	Detection
Little R.	Negative	Yes	Detection	Negative	
Detroit R.	Negative	Yes	Detection	Negative	
Unnamed Cr.	Negative	No			Detection
Mill Cr.	Negative	Yes	Detection	Negative	
Unnamed Cr.	Negative	Yes	Detection	Negative	
Stink Cr.	Negative	Yes	Detection	Negative	
Sturgeon R.	Negative	Yes	Detection	Negative	
Hillman Cr.	Negative	No			Detection
East Two Cr.	Negative	Yes	Detection	Negative	
Morden Drain	Negative	Yes	Detection	Negative	
Unnamed Cr.	Negative	No			Detection
Sixteenmile Cr.	Negative	Yes	Detection	Negative	
Ox Cr.	Negative	Yes	Detection	Negative	
Brock Cr.	Negative	Yes	Detection	Negative	
McKay Cr.	Negative	Yes	Detection	Negative	
Unnamed Cr.	Negative	Yes	Detection	Negative	
Tyrconnell Cr.	Negative	Yes	Detection	Negative	
Talbot Cr.	Negative	No			Detection
Kettle Cr.	Negative	Yes	Detection	Negative	
East Cr.	Positive	Yes	Evalutaion	Negative	
Catfish Cr.	Positive	Yes	Evaluation	Positive	Evaluation
Silver Cr.	Positive	No			Evaluation
Big Otter Cr.	Positive	Yes	Evaluation	Positive	Distribution
South Otter Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Clear Cr.	Positive	Yes			Evalution
Big Cr.	Positive	Yes	Evaluation	Positive	Distribution
Unnamed Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Forestville Cr.	Positive	No			Evaluation
Normandale Cr.	Positive	No			Evaluation
Fishers Cr.	Positive	No			Evaluation
Youngs Cr.	Positive	Yes	Evaluation	Negative	

APPENDIX 4.1. *continued*

Stream	History	Surveyed in 2015	Survey Type[1]	Results	Plans for 2016
Canada *continued*					
Unnamed Cr.	Negative	No			Detection
Stoney Cr.	Negative	Yes	Detection	Negative	
Evans Cr.	Negative	Yes	Detection	Negative	
Unnamed Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Black Cr.	Negative	Yes	Detection	Negative	
Welland R.	Negative	No			Detection

Stream	History	Surveyed in 2015	Survey Type[1]	Results	Plans for 2016
United States					
Niagara R.	Positive	No			Evaluation
Buffalo R.	Positive	Yes	Evaluation	Negative	Evaluation
Rush Cr.	Negative	No			Detection
Eighteenmile Cr.	Negative	Yes	Detection	Negative	
Big Sister Cr.	Positive	Yes	Treat-Eval	Positive	Evaluation
Delaware Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Cattaraugus Cr.	Positive	Yes	Evaluation/Dist	Positive	Treat-Eval
Cattaraugus Cr. (estuary)	Positive	No			Evaluation
Silver Cr.	Negative	Yes	Detection	Negative	
Halfway Br.	Positive	No			Evaluation
Merritt Winery Creek	Negative	No			Detection
Canadaway Cr.	Positive	Yes	Evaluation/Dist	Positive	Evaluation
Walker Cr.	Negative	Yes	Detection	Negative	
Chatauqua Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Eightmile Cr.	Negative	Yes	Detection	Negative	
Gannondale Academy Cr.	Negative	Yes	Detection	Negative	
Elk Creek	Negative	Yes	Detection	Negative	
Seven Mile Creek	Negative	No			Detection
Cascade Creek	Negative	No			Detection
Nursery Rd. Creek	Negative	No			Detection
Crooked Cr.	Positive	Yes	Evaluation/Barrier	Positive	Treat-Eval
Racoon Cr. (PA)	Positive	Yes	Treat-Eval	Negative	Evaluation
Conneaut Cr.	Positive	Yes	Treat- Eval	Negative	Evaluation
Turkey Creek	Negative	Yes	Detection	Negative	

APPENDIX 4.1. ***continued***

Stream	History	Surveyed in 2015	Survey Type[1]	Results	Plans for 2016
United States *continued*					
Wheeler Cr.	Positive	Yes	Evaluation	Negative	
Arcola Cr.	Negative	Yes	Detection	Negative	
Grand R. (OH)	Positive	Yes	Evaluation/Dist	Positive	Treat-Eval
Grand R. (OH) lentic	Negative	No			Evaluation
Chagrin R.	Positive	Yes	Evaluation/Dist	Negative	Evaluation/Dist
Euclid Cr.	Negative	Yes	Detection	Negative	
Cuyahoga River	Negative	Yes	Detection	Negative	
Cranberry Cr.	Negative	Yes			Detection
Anderson Cr. (Erie Co. OH)	Negative	Yes	Detection	Negative	
Huron R. (East & West Br.)	Negative	Yes	Detection	Negative	Detection
Rye Beach Creek	Negative	No			Detection
Muddy Cr.	Negative	Yes	Detection	Negative	
Meadow Brook	Negative	No			Detection
Portage R.	Negative	Yes	Detection	Negative	Detection
La Carpe Cr.	Unknown	No			Detection
Touissant River	Negative	No			Detection
Huron R. (Barrier)	Negative	Yes	Detection	Negative	Detection
Black R. (MI)	Positive	Yes	Evaluation	Negative	Evaluation
Mill Cr. (Black R.)	Positive	Yes	Evaluation	Negative	Evaluation
Pine R. (St. Clair Co.)	Positive	Yes	Evaluation	Negative	Evaluation
Belle R.	Positive	Yes	Evaluation	Negative	Evaluation
Swan Cr. (East & West)	Negative	No			Detection
Clinton R.	Positive	Yes	Evaluation	Positive	Evaluation
St. Clair R.	Positive	Yes	Evaluation	Positive	Evaluation
Detroit R.	Negative	Yes	Detection	Negative	

[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.

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

Altogether, 301,937 yearling Lake Trout were stocked in Lake Erie in 2015, which exceeded the current Lake Trout stocking goal of 200,000 yearlings by over 100,000 and was the highest annual stocking effort since directed stocking efforts began in 1982 (Figure 5.1). For the third consecutive year, Lake Trout stocking occurred in each of the Lake Erie basins: yearling Lake Trout were stocked in Ohio at both Catawba (41,357) and Fairport Harbor (41,194), in Pennsylvania at the Northeast Access Area (40,865) and East Avenue Boat Launch (41,284), and in New York offshore of Dunkirk (41,234) and in Barcelona Harbor (40,633). In addition, the Ontario Ministry of Natural Resources and Forestry stocked 55,370 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 81,702 fall fingerling Lake Trout (Finger Lakes strain) were stocked at Catawba (40,778) and Fairport (40,924) Ohio in October 2015 in a continuing evaluation of the best time and lifestage to stock Lake Trout in the west and central basins of Lake Erie.

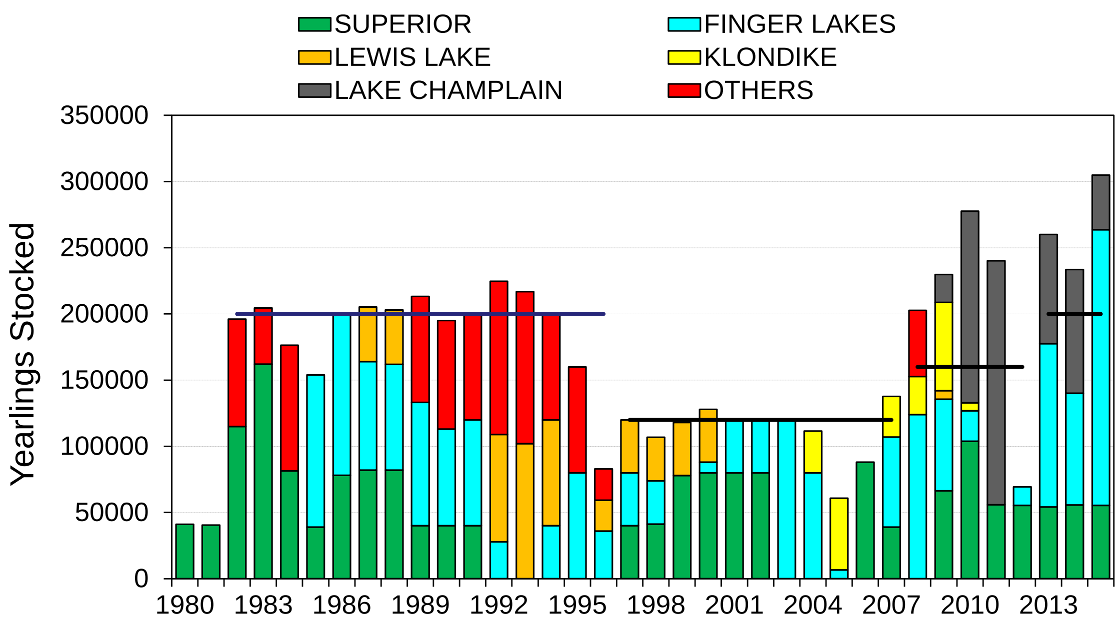

FIGURE 5.1. Lake Trout (in yearling equivalents) stocked by all jurisdictions in Lake Erie, 1980-2015, by strain. Stocking goals through time are shown by black lines dark lines; the current stocking goal is 200,000 yearlings per year. Superior includes Superior, Apostle Island, Traverse Island, Slate Island, and Michipicoten strains; Others include Clearwater Lake, Lake Ontario, Lake Erie, and Lake Manitou strains.

Stocking of Other Salmonids

In 2015, over 2.2 million yearling trout were stocked in Lake Erie, including Rainbow/Steelhead Trout, Brown Trout and Lake Trout (Figure 5.2). Total 2015 salmonid stocking decreased about 1% from 2014, and was equivalent to the long-term average (1990-2014). 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 1,789,667 yearling Rainbow/Steelhead Trout were stocked in 2015, accounting for 80% of all salmonids stocked. This was a 5%

decline in Steelhead stocking from 2014 and 3% lower than the long-term (1990-2014) average of 1,851,501 yearling Steelhead. About 60% of all Steelhead stocking occurred in Pennsylvania waters, followed by 24% in Ohio waters, 9% in New York waters and 4% in Michigan and Ontario waters. Steelhead stocking increased 24% in Ontario, increasing from 56,700 yearling Rainbow Trout in 2014 to 70,250 in 2015, the most stocked since 1999. Steelhead stocking also increased slightly (1%) in Pennsylvania waters. Steelhead stocking numbers declined 41% in New York waters, 5% in Michigan waters, and 2% Ohio waters relative to 2014. The large decline in New York was due to a non-disease related hatchery mortality event. A full account of Rainbow/Steelhead Trout stocked in Lake Erie by jurisdiction for 2015 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.

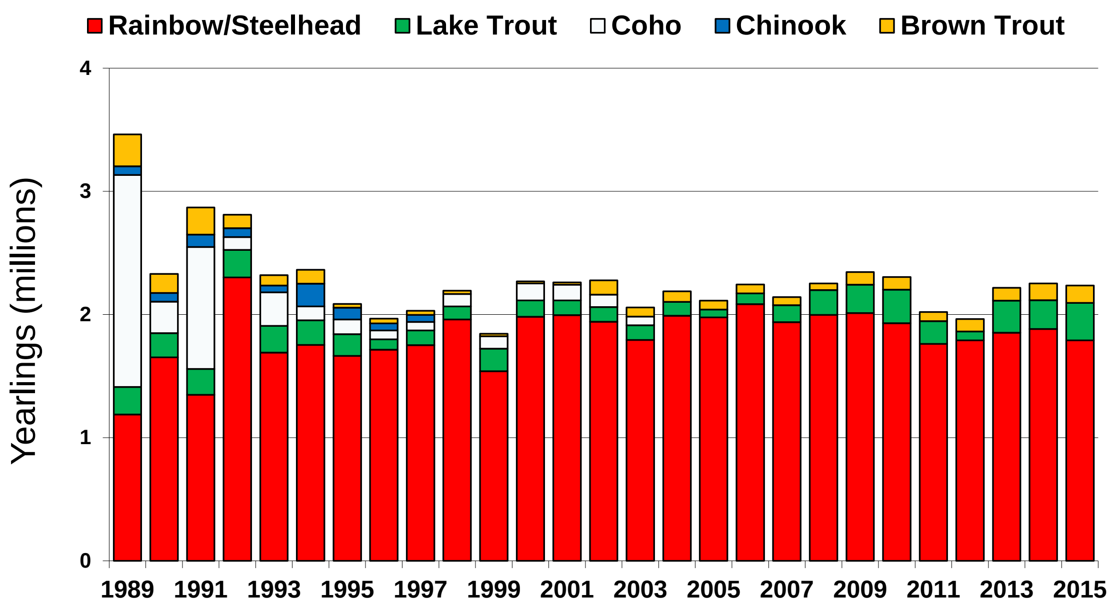

Figure 5.2. Annual stocking of all salmonid species (in yearling equivalents) by Lake Erie by all agencies, 1989-2015.

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 141,013 yearlings in 2015. This was a 3% increase from 2014 and a 74% increase over the long-term (1990-2014) average annual stocking of 81,207 Brown Trout. Between 21 April and 1 May, 2015, the NYSDEC stocked 37,840 yearling Brown Trout in Dunkirk Harbor, Cattaraugus Creek, Barcelona Harbor and at Point Breeze. The NYSDEC began re-emphasizing Brown Trout stocking in place of domestic Rainbow Trout in 2002 for the purposes of diversifying their tributary trout/salmon fishery and for maintaining migratory behavior of their Salmon River Steelhead strain. Between 10 April and 6 May, 24,780 adult Brown Trout were stocked by the PFBC to provide catchable trout for the opening of the 2015 Pennsylvania trout season and an additional 600 adult Brown Trout were stocked on 16 December in support of late season trout fishing. Pennsylvania NGO's also stocked 77,793 yearling Brown Trout, primarily in support of a put-grow-take Brown Trout program that was initiated in 2009. This program is currently being supported through the annual donation of 100,000 certified IPN-free eggs from the NYSDEC. Brown Trout stocking is expected to continue at the current rates for 2016 in both New York and Pennsylvania.

TABLE 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1990-2015.

	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
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**
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**
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**
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**
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**
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**
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**
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**
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**
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**
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**
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**
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, 1990-2015.

	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
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**
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**
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**
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**
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**
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**
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**
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**
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**
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**
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**
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	**233,578**	**0**	**0**	**136,479**	**1,882,614**	**2,252,671**
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	**304,819**	**0**	**0**	**141,013**	**1,789,667**	**2,235,499**

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 Geoffrey Steinhart (ODW)

Stocking

All Lake Erie jurisdictions stocked Steelhead or lake-run Rainbow Trout (hereafter Steelhead) in 2015 (Table 6.1). Based on these efforts, a total of 1,784,667 yearling Steelhead and 5,000 domestic strain Rainbow Trout were stocked in 2015, representing a 5% decrease from 2014 and a 3% decrease from the long-term (1990-2014) average. Nearly all (99%) of the Steelhead stocked in Lake Erie originated from naturalized Great Lakes strains. A Lake Erie strain accounted for 60% of the strain composition, followed by a Lake Michigan strain (31%) and a Lake Ontario strain (7%); Lake Erie strains were collected from Trout Run in Pennsylvania; Lake Michigan strains were collected from the Manistee River in Michigan, and the Lake Ontario strains were collected from the Salmon River in New York and the Ganaraska River in Ontario. New York also stocked 19,500 Magog strain Steelhead, which represented about 1% of all Steelhead stocked in Erie.

TABLE 6.1. Steelhead stocked by jurisdiction and location for 2015.

Jurisdiction	Location	Strain	Number	Life Stage	Yearling Equivalents	
Michigan	Huron River	Manistee River, L. Michigan	64,735	Yearling	64,735	
					64,735	**Sub-Total**
Ontario	Mill Creek	Ganaraska River, L. Ontario	55,000	Adult	55,000	
	Lake Erie at Wheatley Harbour	Ganaraska River, L. Ontario	1,250	Adult	1,250	
	Port Stanley Harbour	Ganaraska River, L. Ontario	14,000	Adult	14,000	
					70,250	**Sub-Total**
Pennsylvania	Bear Creek	Trout Run, L. Erie	12,000	Yearling	12,000	
	Conneaut Creek	Trout Run, L. Erie	75,100	Yearling	75,100	
	Crooked Creek	Trout Run, L. Erie	74,047	Yearling	74,047	
	Elk Creek	Trout Run, L. Erie	244,640	Yearling	244,640	
	Fourmile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Godfrey Run	Trout Run, L. Erie	18,720	Yearling	18,720	
	Presque Isle Bay	Trout Run, L. Erie	83,762	Yearling	83,762	
	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	111,000	Yearling	111,000	
	Walnut Creek	Trout Run, L. Erie	185,000	Yearling	185,000	
	Lake Erie	Trout Run, L. Erie	62,000	Yearling	62,000	
					1,079,019	**Sub-Total**
Ohio	Chagrin River	Manistee River, L. Michigan	90,085	Yearling	90,085	
	Conneaut Creek	Manistee River, L. Michigan	84,866	Yearling	84,866	
	Grand River	Manistee River, L. Michigan	89,861	Yearling	89,861	
	Rocky River	Manistee River, L. Michigan	91,779	Yearling	91,779	
	Vermilion River	Manistee River, L. Michigan	65,149	Yearling	65,149	
					421,740	**Sub-Total**
New York	Silver Creek	Washington	5,000	Yearling	5,000	
	Canadaway Creek	Washington	10,000	Yearling	10,000	
	18 Mile Creek	Magog	3,000	Yearling	3,000	
	18 Mile Creek	Magog	7,500	Yearling	7,500	
	18 Mile Creek	Magog	9,000	Yearling	9,000	
	18 Mile Creek	Washington	8,900	Yearling	8,900	
	18 Mile Creek	Washington	32,000	Spring Fingerling	320	
	Chautauqua Creek	Washington	15,226	Yearling	15,226	
	Chautauqua Creek	Washington	15,310	Yearling	15,310	
	Chautauqua Creek	Washington	15,223	Yearling	15,223	
	Chautauqua Creek	Washington	13,386	Yearling	13,386	
	Buffalo Creek	Washington	10,000	Yearling	10,000	
	Cattaraugus Creek	Trout Run, L. Erie	30,000	Fall Fingerling	1,058	
	Cattaraugus Creek	Washington	30,000	Yearling	30,000	
	Buffalo River Net Pens	Washington	5,000	Yearling	5,000	
	Bison City R&G Club	Domestic	4,000	Yearling	4,000	
	Erie Basin Marina	Domestic	1,000	Yearling	1,000	
					153,923	**Sub-Total**
					1,789,667	**Grand Total**

State fisheries management agencies are responsible for 92% of all Steelhead Trout stocking effort in Lake Erie. Approximately 8% of the Steelhead stocking is through sportsmen's organizations in Pennsylvania (74,512 yearlings) and Ontario (70,250 yearlings). Fisheries agency stocking of spring yearlings took place between 9 March and 7 May, with smolts averaging about 179 mm in length (Table 6.2).

TABLE 6.2. Stocking summaries of yearling steelhead by fisheries agency for 2015.

Agency	Range of Dates Stocked	mean length (mm)	N of yearlings stocked
Michigan Dept. of Natural Resources	21 April	193	64,735
New York Dept. of Environmental Conservation	8 April - 7 May	124	147,545
Ohio Division of Wildlife	27 April - 7 May	181	421,740
Pennsylvania Fish and Boat Commission	9 March - 4 May	185	1,004,507
		179	1,638,527

In 2015, NYSDEC staff marked several lots of juvenile Steelhead using a combination of fin clips and coded-wire tags (Table 6.3). Fin Clips included an adipose clip (15,526), a left ventral fin clip (15,310), coded-wire tag (CWT) only (15,223) and a combination adipose / CWT (13,386) marked fish. All marked fish were stocked into Chautauqua Creek on 17 April, 2015 in a continuing evaluation of smolt emigration as related to stocking size.

TABLE 6.3. Fin clips of Steelhead stocked in Lake Erie, 2000-2015.

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	-	-	-

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 2014; Markham 2015). These studies demonstrated a need to pursue a more detailed investigation to examine the effects of size of fish and choice of 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 is planned to occur in 2015 and 2016, subsequent evaluation of adult returns is planned from Fall 2015 – Spring 2018. Detailed methods and study design can be found in Markham (2016).

Results of the initial year of this expanded research effort were similar to the two-year pilot emigration project conducted in 2013 and 2014. However, the study design used in 2015 has provided additional insights on the effects of size and stocking location on post-stocking residency. It is apparent that many of the Steelhead stocked at the traditional upstream stocking location do not emigrate to the lake and remain stream residents at least through the spring through summer study period. This was especially noticeable with the upper small group. Steelhead from the upper small group were spread throughout the stream five weeks post-stocking, and their high abundance upstream from the stocking location indicated that they tended to move upstream post-stocking more so than migrating downstream. The upper large group appeared to vacate the stocking site at a higher proportion than the upper small group, and were scarce at all sample sites by the beginning of June, five weeks post-stocking. Some individuals from the upper large group exhibited the same upstream movement behavior seen in the upper small group, but to a much lesser extent.

In contrast, Steelhead stocked near the mouth of the stream appeared to vacate the stream within several weeks of stocking, especially the large group. However, sampling conducted during the end of May detected that the lower small group exhibited similar upstream migration patterns as the upper small group to the extent that some of these fish were being sampled several miles upstream of their stocking location.

It is still too early in the study to conclude which of the four groups will produce the greatest return as adults. Initial results indicate that many (33 of 35 fish) of the small (<18 in) returning fish sampled in this stream during Fall 2015 were not stocked in Chautauqua Creek. However we do not know if they originated from stocking by other Lake Erie jurisdictions such as PA or OH, or another New York stocked tributary. It will require at least two or more years of investigation to determine which combination of stocking location and size provides the best return of adult steelhead for New York's fishery.

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 sp.)*, checked for fin clips and marked and released. A total of 1,066 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; Table 6.4). Sex ratio has averaged about 52% males to 48% 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%) and 2015 (52%). In review of the last six 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 60 mm since this assessment started in 2010. Mean length has declined in both male and female adult Steelhead Trout, but has been more pronounced in males.

TABLE 6.4: Sample size (N), % males, and mean lengths on of adult fall spawning run Steelhead Trout sampled at Godfrey Run 2010-2015, 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
	1,066	52%	598	580	589

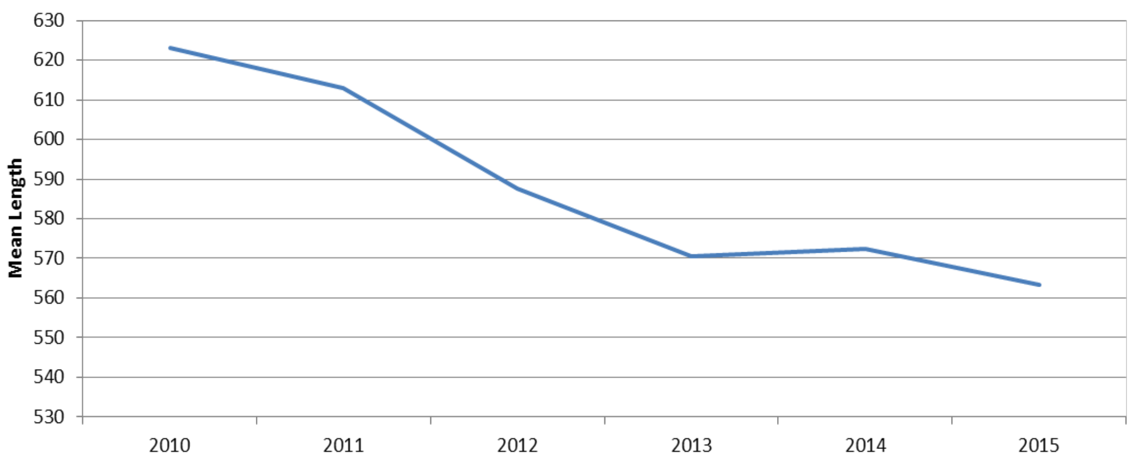

FIGURE 6.1. Mean length of adult Steelhead Trout returning to Godfrey Run, Erie County, PA, from 2010-2015.

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 3% of the Godfrey Run spawning population, but averaged about 15% of the spawning population between 2012 and 2015 (Figure 6.2). Concurrently, the relative percentage of larger fish (>650 mm) averaged about 15% between 2010 and 2012, but decreased to 5% in 2015.

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 3 years.

The reasons contributing to the decline of larger fish in recent spawning runs is less clear. Attacks from Sea Lampreys may have been a contributing factor for the large decline in the Steelhead population that occurred in 2009-10, but their effects are less evident in recent years. Sea Lamprey wounding on adult Steelhead sampled at Godfrey Run has shown a steady decline in wounding rate (# of wounds / 100 fish) since 2010 (Figure 6.3). There was a slight bump in wounding rate in 2013, but this is probably due to small sample size (N=19). Fresh wounding (A1-A3) peaked in 2011 at 6.0 wounds/100 Steelhead, but dropped to 0 wounds in 2015 ; healed wounds (A4 – B4) were highest in 2010 at 16.1 wounds/100 Steelhead but also declined to a time series low of 2.7 wounds / 100 Steelhead in 2015.

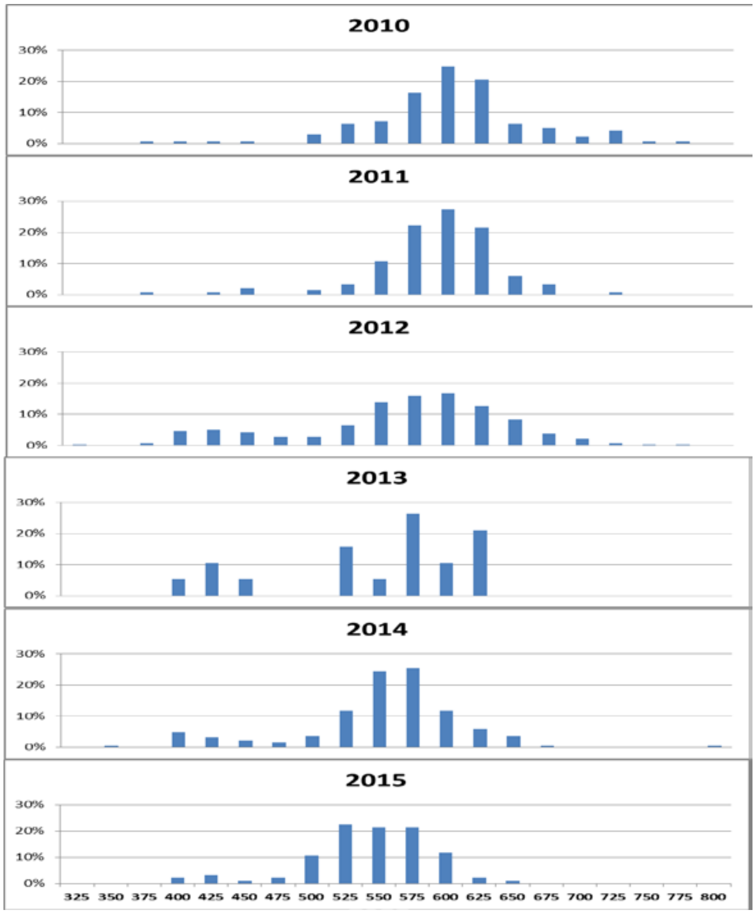

FIGURE 6.2. Length frequency (by 25mm bins) of adult Steelhead Trout returning to Godfrey Run 2010-2015, Erie County PA.

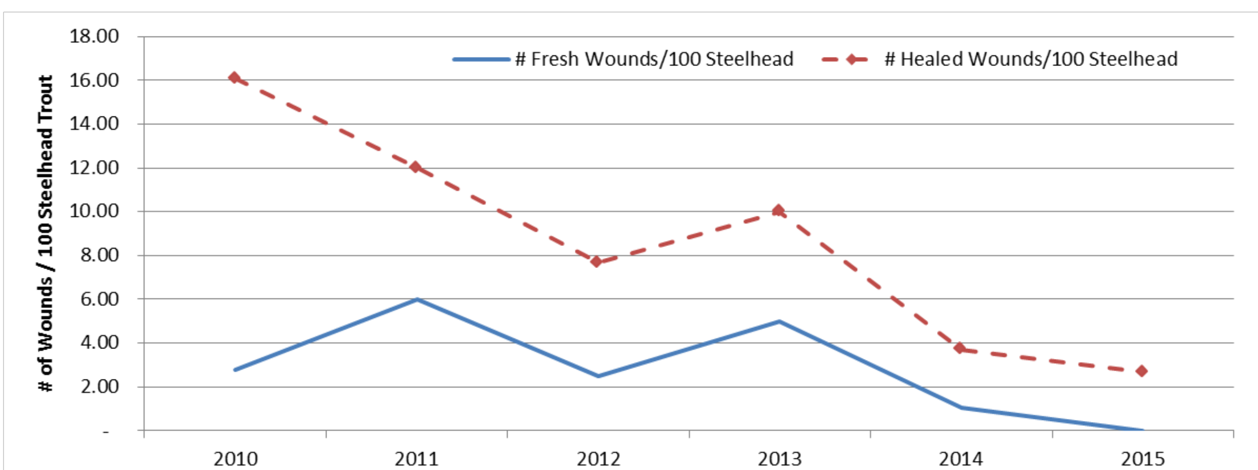

FIGURE 6.3. Sea Lamprey wounding rates on adult Steelhead Trout returning to Godfrey Run 2010-2015, Erie County PA.

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 2015 estimated Steelhead harvest from the summer open-water boat angler fishery totaled 6,460 fish across all US agencies, essentially unchanged from 2014 (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 2015. Harvest in New York and Ohio increased 61% and 31%, respectively. Pennsylvania harvest fell 54% from 2014, and Michigan did not record any harvest from open lake boat anglers in 2015. Among the US jurisdictions, over 71% of the reported harvest was concentrated in central basin waters of Ohio (66%) and Pennsylvania (5%). The west-central basin waters of Ohio accounted for 3% the harvest. The east basin accounted for 23% of the harvest, about equal for Pennsylvania (13%) and New York (10%) A small amount (2%) of harvest was seen in the western basin waters in Ohio.

TABLE 6.5. Estimated harvest by open lake boat anglers in Lake Erie, 1999-2015.

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
1999-2014 mean	13,941	3,723	654	25,736	40	28,008

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

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 2014, the 2015 Steelhead harvest rates increased significantly in Pennsylvania but declined sharply in Ohio. Steelhead boat angler harvest rates in 2015 were 0.18 Steelhead per angler hour in Pennsylvania waters, a 59% increase from 2014 and 0.04 Steelhead per angler hour in Ohio waters, a 82% decrease from 2014. The combined harvest rate for 2015 across all reporting agencies (0.11 Steelhead/angler hr) was about 15% below the long-term average of 0.13 Steelhead/angler hr. (Figure 6.4)

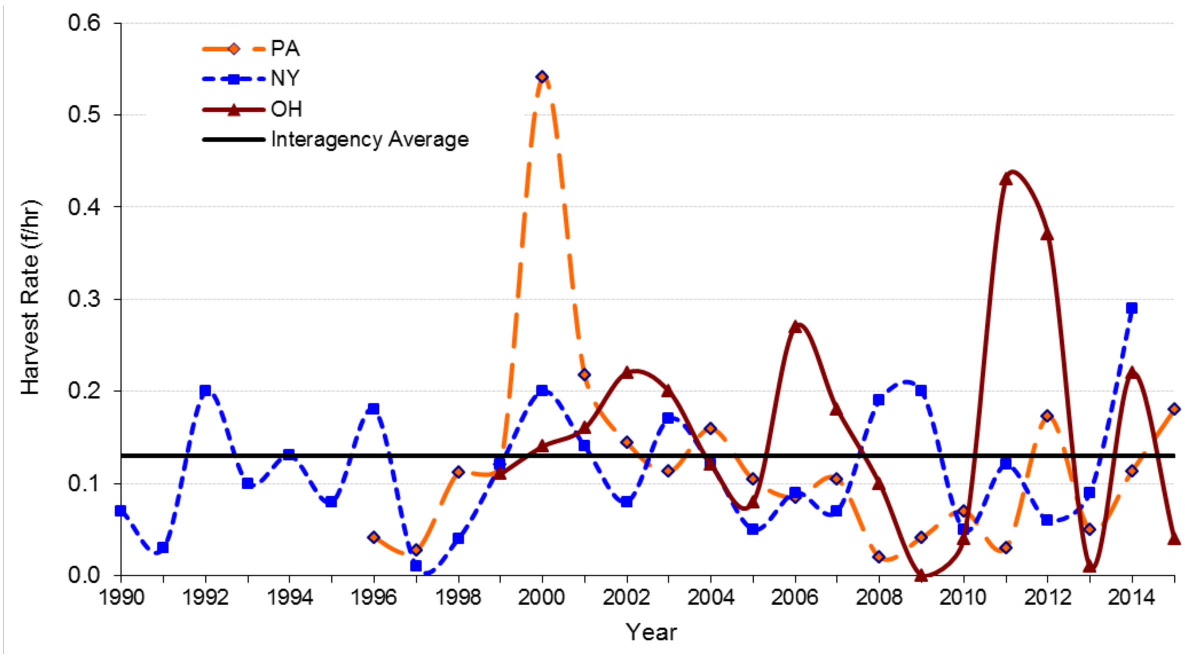

FIGURE 6.4. Targeted Steelhead harvest rates (fish/angler hr) in Lake Erie by open lake boat anglers in Ohio, Pennsylvania and New York, 1990-2015.

The OMNRF collected open water angler diary reports that can detail trends over time by area of the lake. In 2015, diarists reported 55 targeted Steelhead (Rainbow Trout) angler trips in west-central basin and 24 targeted trips in the east-central basin waters of Lake Erie. Only four trips targeting Steelhead was recorded through the diary program in the east basin for 2015.

Angler diary reports from Ontario in west-central basin waters show that rod-hours for Steelhead in 2015 increased 30% from 2014 but were 39% below the 25-year (1990-2014) mean of 2,675 hours (Figure 6.5). The 2015 Steelhead catch rates in the west central basin (0.291 fish per rod-hour) were an 870% increase from 2014, and 111% higher than the long-term average of 0.138 Steelhead/rod-hr.

The 803 rod-hours of effort recorded by anglers fishing the east-central basin for Steelhead was a slight increase from 2014 (35%) but 43% below the 25-year average of 1,407 rod-hours (Figure 6.6). The 2015 catch rate of 0.045 f/rod-hr was a 50% increase from 2014 but 38% below the long-term average of 0.072 Steelhead/rod-hr.

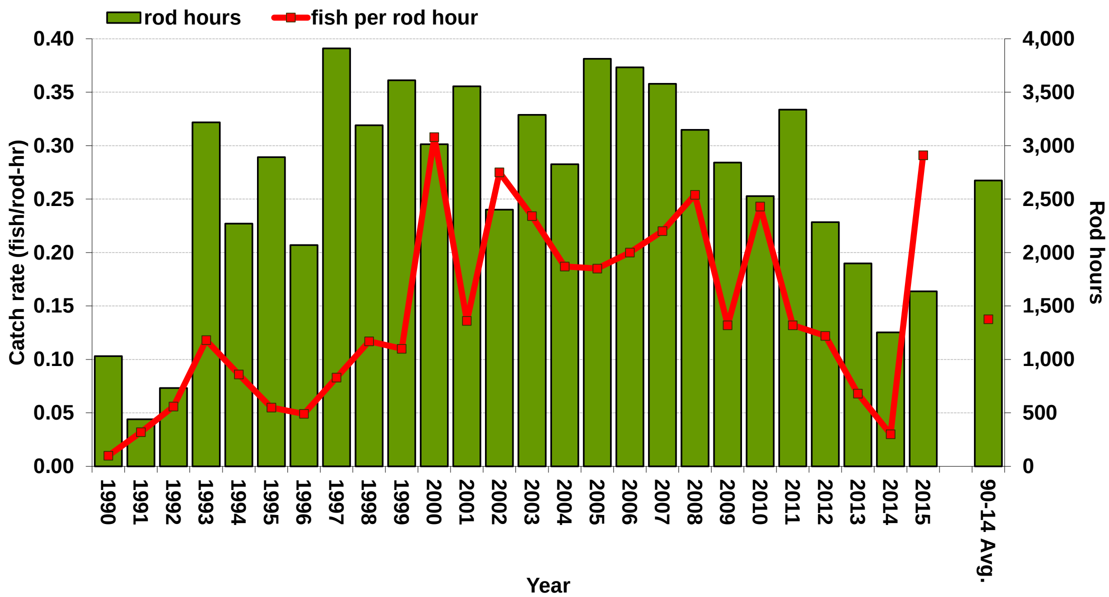

FIGURE 6.5. Targeted Steelhead effort and catch rates in Lake Erie's west-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2015.

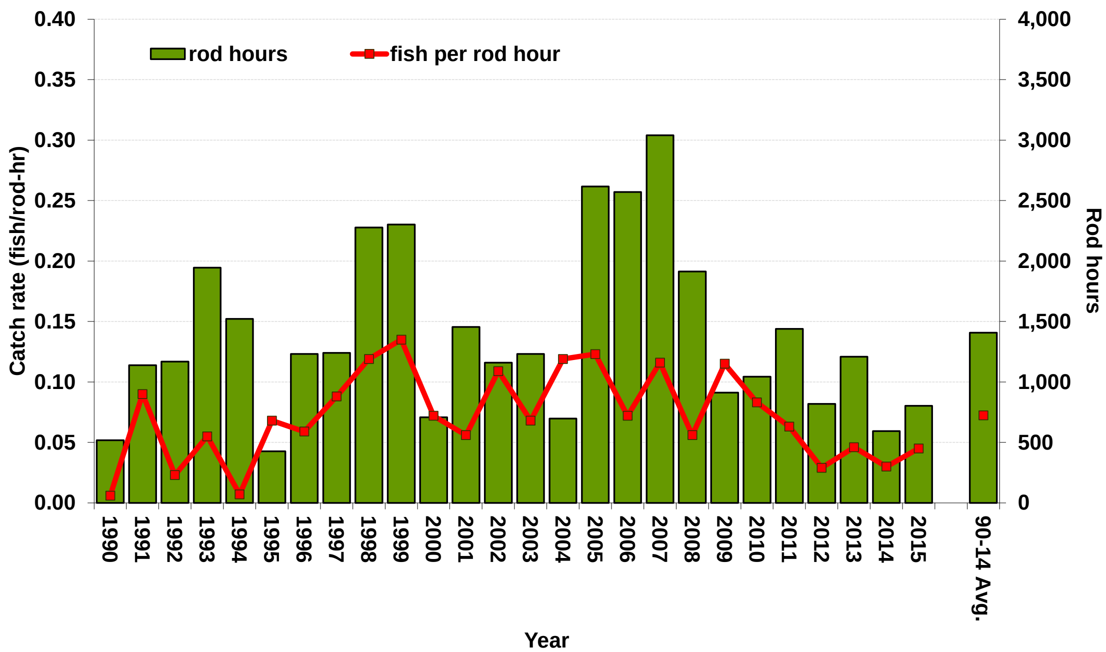

FIGURE 6.6. Targeted Steelhead effort and catch rates in Lake Erie's east-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2015.

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 steelhead catch rates of around 0.15 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 of around 0.60 fish/angler hour in the mid-2000's, but a decline 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.

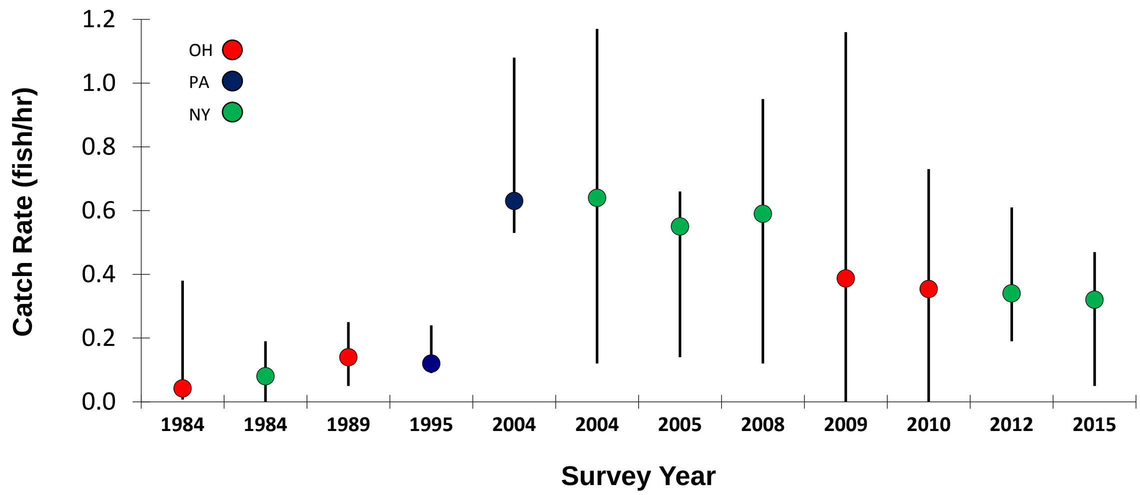

FIGURE 6.7. Targeted Steelhead catch rates (fish/angler hour) in Lake Erie tributary angler surveys by year and jurisdiction, 1984-2015.

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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), Mark Rogers (USGS), Zy Biesinger (USFWS), and Jim Markham (NYSDEC)

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 the 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. Cisco 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 2014). The most recent, acoustically derived, estimate of yearling-and-older Rainbow Smelt abundance is low (1,754/hectare; 2013) relative to a recent peak in 2009 (~12,000/hectare; Forage Task Group 2013). 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 2015).

Current Status of Cisco

Cisco observations have been documented in 18 of the last 21 years, including 2015. Of the 47 individual fish 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 Cisco 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 (30 observations combined). These captures have occurred in all months that commercial vessels operate (March through December). 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. In 2015, four Cisco were reported by the fishery; two in late June and early July (yellow perch gillnets near Port Colborne) and two in late July (rainbow smelt trawls near Long Point).

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 Cisco 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.

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. (Table 7.2).

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.

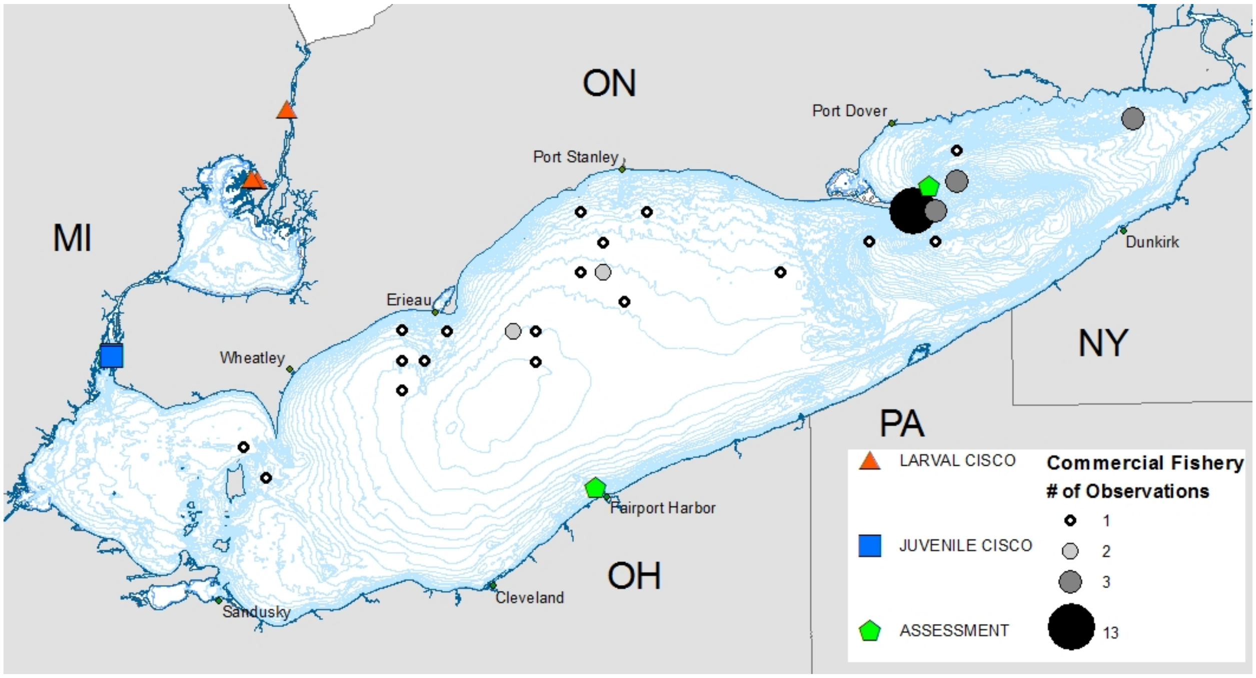

FIGURE 7.1. Cisco observations in Lake Erie and the Huron-Erie Corridor, 1995-2015. Commercial fishery observations are indicated with grey circles with size and shading indicating number of observations per 5' fishing grid. Locations of larval and juvenile Cisco observations (2010-11; USGS, USFWS) are indicated with triangles and squares, respectively. Locations of single observations from agency assessment surveys are shown with a green pentagon.

TABLE 7.1. Sampling details from Cisco captured during commercial (C) and assessment (A) fishing efforts, 1990-2015. Length = Total Length (mm); Sex = female (F); male (M) or unknown (U). Target species is shown where known.

Year	Month	Length	Sex	Gear	Source	Target Species
1990	SEP	260	F	GN	A	
1995	APR	443	F	GN	C	Whitefish
1996	APR	371	F	GN	C	Whitefish
1999	AUG	153	F	TR	C	rainbow smelt
1999	AUG	158	M	TR	C	rainbow smelt
1999	AUG	211	F	GN	C	lake whitefish
1999	MAY	323	M	U	U	
1999	SEP	140	M	TR	C	rainbow smelt
1999	SEP	U	F	TR	C	rainbow smelt
1999	SUMMER	156	F	U	A	
2000	SEP	238	UK	GN	A	
2001	OCT	173	U	TR	C	rainbow smelt
2002	SEP	315	F	TR	C	rainbow smelt
2002	SEP	170	F	TR	C	rainbow smelt
2003	AUG	278	F	GN	A	coldwater sp
2003	JUL	301	UK	GN	C	y perch
2003	JUN	341	F	GN	C	yellow perch
2003	MAY	298	M	GN	C	white bass
2003	SEP	298	M	TR	C	rainbow smelt
2003	SEP	222	M	TR	C	rainbow smelt
2004	JUN	U	U	GN	U	
2005	AUG	U	F	GN	C	walleye
2005	DEC	367	F	GN	C	yellow perch
2005	JUL	325	M	GN	C	yellow perch
2005	JUL	350	F	GN	C	yellow perch
2005	JUN	357	F	GN	C	yperch

Year	Month	Length	Sex	Gear	Source	Target Species
2006	MAR	261	M	GN	C	yellow perch
2007	MAY	333	F	GN	C	yperch; wbass
2007	MAY	389	F	GN	C	white fish
2008	MAR	464	M	GN	C	white bass
2008	MAR	413	F	GN	C	white bass
2010	APR	438	F	GN	C	wbass
2010	JUN	322	M	GN	C	yellow perch
2010	JUN	355	F	GN	C	yellow perch
2010	JUN	366	F	GN	C	yellow perch
2011	APR	319	F	TR	C	rainbow smelt
2011	AUG	250	U	TR	C	rainbow smelt
2011	JUL	262	F	TR	C	rainbow smelt
2011	MAY	308	M	GN	C	yellow perch
2012	NOV	292	F	GN	C	yellow perch
2013	JUL	277	M	TR	C	rainbow smelt
2014	APR	335	U	GN	C	yellow perch
2014	MAY	330	F	GN	C	yellow perch
2015	JUL	408	F	GN	C	yellow perch
2015	JUL	309	M	TR	C	rainbow smelt
2015	JUL	285	F	TR	C	rainbow smelt
2015	JUN	342	M	GN	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 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
- Reducing Impediments and Addressing Knowledge Gaps

Perhaps most important is the last section which will provide potential experiments and ideas for addressing uncertainties. It suggests multiple approaches to fill in knowledge gaps and inform management choices. These include approaches to: i) Determining the presence of a spawning stock; ii) Hatchery options in the absence of a spawning stock; iii) Determining available spawning habitat / habitat quality; iv) Determining fishery effects; and v) Confronting Rainbow Smelt.

This document is in currently in final 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 Great Lakes experts. Some of the document's proposed approaches to filling information gaps have been ongoing, including attempts to secure additional contemporary samples from Lake Erie. Two of these attempts - targeting Cisco in the fall at potential spawning locations and targeting Cisco in fishery bycatch - have been detailed previously (Forage Task Group 2015). Neither program resulted in any Cisco observations. In 2015, for the fourth consecutive year the USGS-Lake Erie Biological Station implemented targeted netting on west basin spawning shoals used by Lake Whitefish to determine if there was a Cisco spawning population. Again, no Ciscoes were observed despite soliciting input from Upper Great Lakes Cisco spawning assessment programs and refinements of technique based on the previous years' experiences. Considerable headway was also made in 2015 on perhaps the largest outstanding knowledge - determining the origin of the Cisco currently found in Lake Erie.

Determining the source of contemporary Lake Erie Cisco

Until recently, the best information available regarding the relationship between contemporary Lake Erie Cisco, historic Lake Erie Cisco, and contemporary Cisco from other Great Lakes, was based on a genetic analysis (using microsatellite markers) of nine contemporary Lake Erie Cisco collected in the 1990s. The results indicated that the recently caught Cisco were genetically most similar to Lake Erie specimens from 1950s and 1960s, suggesting that a remnant of the original Lake Erie stock may exist (Rocky Ward, USGS Northern Appalachian Research Laboratory, Wellsboro, PA, unpublished data). Based on this limited information, the extant surviving Cisco most similar to the Lake Erie remnant was determined to be from Lake Huron.

Preliminary work during 2012 and 2013, funded by the Great Lakes Restoration Initiative, was conducted in order to establish a database of Cisco genetic information. Historic samples from throughout the Great Lakes and contemporary samples from Lakes Huron, Ontario, and Superior were genotyped. This database was to be the comparative foundation from which questions regarding the origin of recently caught adult (Lake Erie) and larval (Huron-Erie Corridor, HEC) Cisco could be asked. Late in 2014, funding to the OMNR via the Canada Ontario Agreement was directed to the continuance of this genetic work by examining the archive of DNA from Cisco captured in recent years;

In 2015, work by Dr. Wendylee Stott (USGS Great Lakes Science Centre) on the genetic database had advanced to the point where an attempt could be made to assign contemporary Erie samples to the other Great Lake populations. Additionally, a new characterization of “historic” Erie samples from the 1920s was also available for comparison. The contemporary GL 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. These new findings were less definitive than the previous 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). These findings prompted a change in approach to the question of remnant stocks, and a refinement of methods which is ongoing (see 2016; below).

In January 2016, twenty-two available whole fish specimens from recent Lake Erie observations were made available for morphometric analysis as part of work to develop a guide to contemporary Cisco of the Great Lakes (Andrew Muir et al., in review, 2016). Based on a preliminary analysis of metrics, in particular gill raker lengths and counts, most of these 22 fish were not of the expected *Artedia* or *Albus* morphotype varieties historically described in Lake Erie. Instead, the majority (n=19) were deemed to be “swarm” Cisco (a hybridized form of deep water Cisco prevalent in Lake Huron) while others were considered a form of Cisco x Whitefish hybrid (n=2); one was deemed to be *Coregonis artedi* (Randy Eshenroder, GLFC, pers comm). This finding might start to explain the preliminary genetic analysis' failure to assign contemporary Erie to another Cisco population. Ongoing work to revisit the genetic analysis will incorporate the same morphometric analysis of fish used to bolster genetic sample sizes.

Activities for 2016

The genetic work is ongoing with a planned completion of fall 2016. The sample size of contemporary Cisco will be increased from 11 to 30, representing the full complement of currently available DNA. Previously characterized comparison populations will be enhanced. For example, contemporary Lake Huron was previously characterized using samples only from one northern location and will now include samples from Georgian Bay and more southerly locations. Work will also include the creation of additional comparison populations, for example a “new” Historic Lake Erie population using a recently discovered (M. Rogers, USGS, 2014) cache of historical scale samples. These scale samples were collected at ports during 1949-1962; the last period of intense commercial Cisco fishing in Lake Erie. It is notable that this is the same time period that produced the samples used for the initial genetic analysis (R. Ward; above) to which Erie Cisco from the 1990s were deemed to be most closely related. In addition to questions of relatedness and assignment, considerable effort will be given to explore the

possibility of hybridization. Bar-coding of all contemporary samples will help to rule out Whitefish and Bloater as sources. The database used for comparison will in fact be expanded to include all contemporary *Coregonus* sp. for the Great Lakes. This will provide a better reference for comparison for samples from both Lake Erie and the HEC, where “swarm”, Bloater, Whitefish, and hybrids may be confounding the picture. Samples from the HEC will be incorporated into the analysis to help answer questions about immigration into Erie from Huron.

Stocking is becoming 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). 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.

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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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Lake Whitefish fisheries are influenced significantly by the harvest policies of other fisheries in which they are caught. Although a formal Lake Erie harvest policy for Lake Whitefish does not exist, general status indicators have been sufficient to meet the demands of Lake Whitefish management in past decades. Declines in Lake Whitefish abundance coupled with the growing need for fishery certification prompted the Lake Erie Committee to add Charge 8 to the list of CWTG charges for 2014-2015 and beyond. In addition to general stock status metrics described in Charge 2, more quantitative metrics, biological reference points and broader indications of stock health will be addressed by Charge 8. The Coldwater Task Group will be collaborating with the Data Deficient Working Group and members of other task groups to fulfill this charge in support of revised Lake Whitefish management initiatives.

In 2015, representatives from the CWTG, the Data Deficient Working Group, and Walleye/Yellow Perch Task Group continued to address statistical catch-at-age (SCAA) model configurations for Lake Whitefish that were examined in 2014. Multiple SCAA modeling options were considered along with discussion of data gaps and model selection criteria. Methods to derive natural mortality parameter estimates for Lake Erie Whitefish SCAA were considered with concerns expressed related to uncertainty, implications for biological risk and existing methods used for assessment of other Great Lakes Lake Whitefish populations. Over the course of the year, commercial trap net data became available for SCAA and additional biological survey data were made available for estimation of growth parameters.

SCAA models were run in 2015 (Belore), with comparisons of model fit using total sums of squares, objective functions and coefficients of variation for abundance estimates. Model configurations included types of commercial gill net effort (all large mesh effort and large mesh effort with Lake Whitefish in the catch), varying length of time series, varying lambdas for data sources, varying age at full selectivity in commercial gear and catchability blocks. Population estimates and trends over time were similar among model configurations; all of which assumed natural mortality=0.28 (Figure 8.1). Model outcomes and model fit were not very sensitive to forms of commercial effort, lambdas and other fishery parameter assumptions.

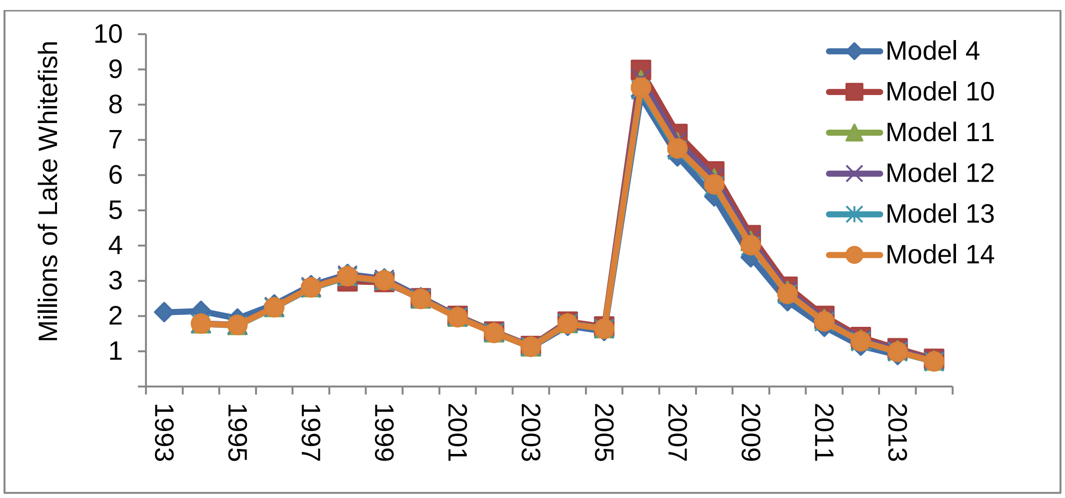

Figure 8.1. Statistical catch-at-age analysis for Lake Erie Whitefish using 6 model configurations (1993-2014).

Lower trophic level water temperature and dissolved oxygen profile data (Forage Task Group), municipal water intake temperature data, bathymetric data (Haltuch and Berkman, 1998) were used to estimate monthly mean water temperatures and dissolved oxygen levels at 1 m depth intervals to estimate average Lake Whitefish monthly habitat volume (Figure 8.2). These habitat volume estimates were combined with mean proportion of monthly commercial harvest by basin to derive the mean annual water temperature experienced by Lake Whitefish in Lake Erie (7.95 °C). This parameter was used in Pauly's equation (Pauly 1984) with Von Bertalanffy growth parameters (Figure 8.3) estimated from survey data to produce a natural mortality estimates by sex (Female 0.33, Male 0.35) and for sexes combined (M=0.35). Other methods were used to estimate natural mortality rates that ranged from 0.16 to 0.56. Further work is required to achieve consensus on the natural mortality rate assumption to run SCAA. The group agreed that a Lake Whitefish tagging program would help reduce uncertainty concerning natural mortality of Lake Whitefish. As a pilot study, Ohio DNR implanted 9 acoustic tags in Lake Whitefish that were collected from trapnets near the mouth of the Maumee River in 2015. A complete report with greater detail on topics discussed here and additional subjects relevant to Charge 8 is anticipated in 2016.

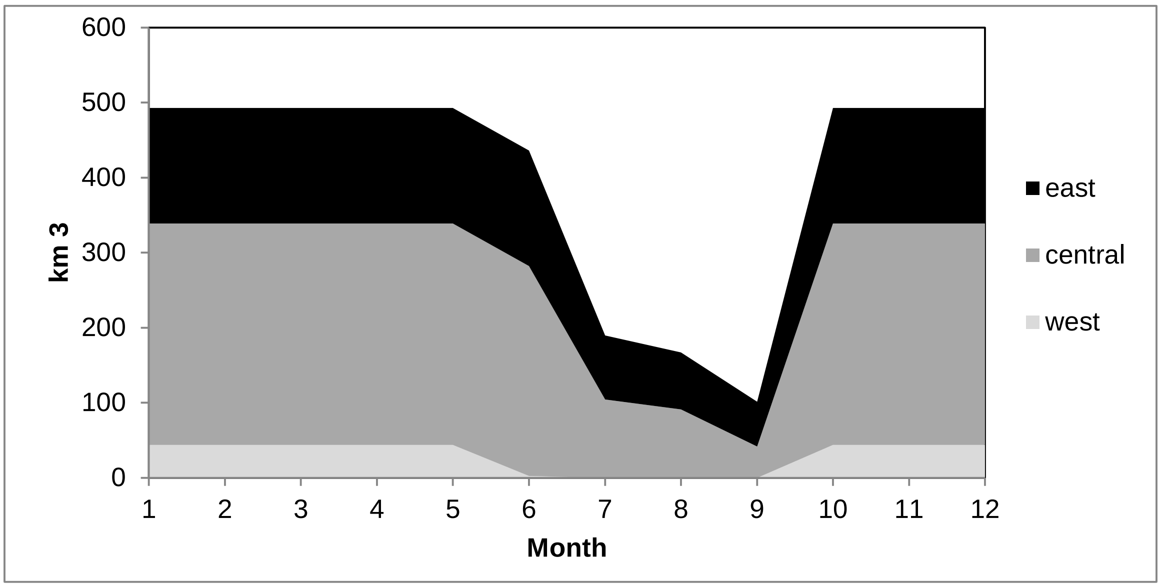

Figure 8.2. Average monthly Lake Whitefish habitat by volume (km3) in Lake Erie, based on lower trophic data (Forage Task Group), partnership index temperature and dissolved oxygen profiles and municipal water intake temperature data. Lake Whitefish habitat was defined as ≤ 18 ◦ C and ≥ 3 mg / l dissolved oxygen.

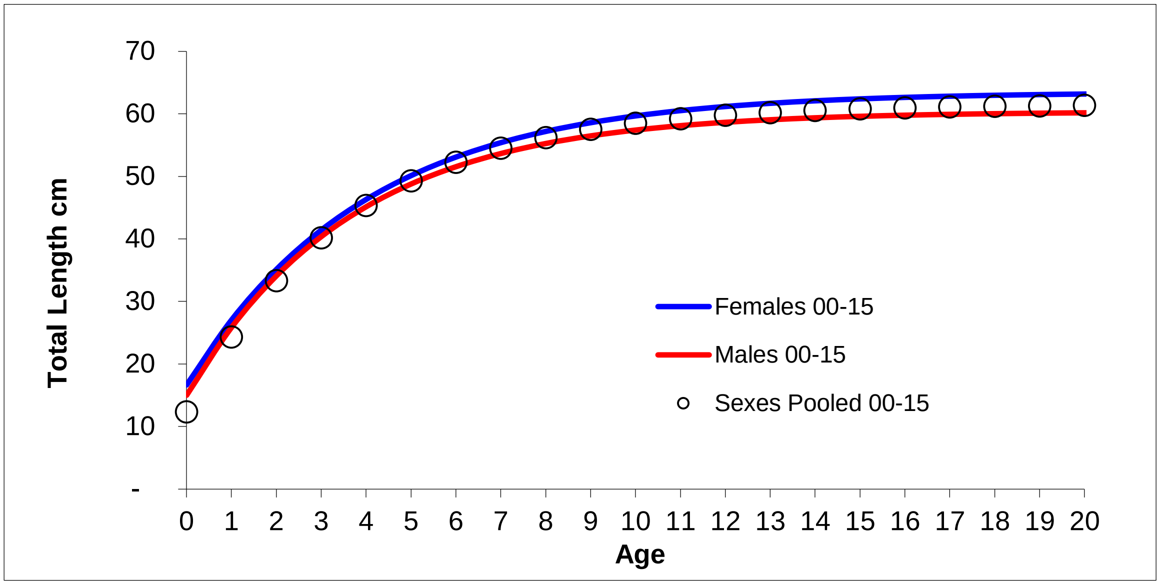

Figure 8.3. Von Bertalanffy growth curve for Lake Whitefish by sex and for sexes pooled (2000-2015). Parameter estimates for females were: L_∞ =63.5 cm K=0.25 to=-1.21 and for males: L_∞ =60.4 cm K=0.27 to= -1.05 and for sexes pooled: L_∞ =61.6 cm K=0.28 to= -0.81.

References

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