REPORT OF THE LAKE ERIE COLDWATER TASK GROUP

23 March 2015

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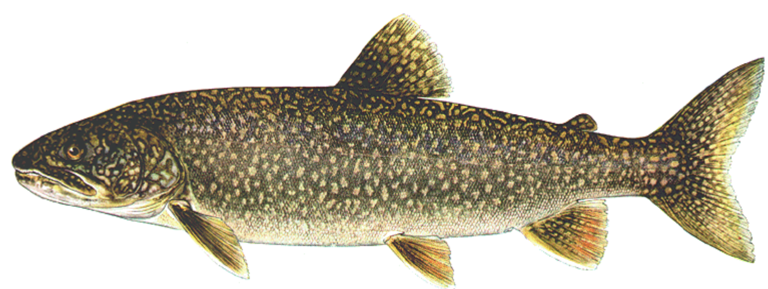
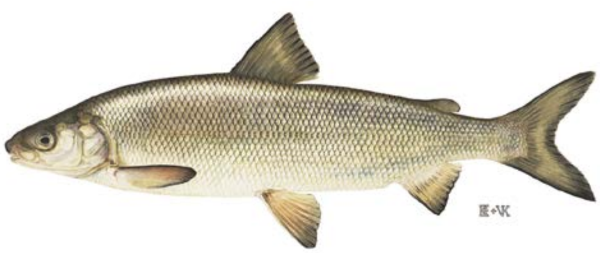
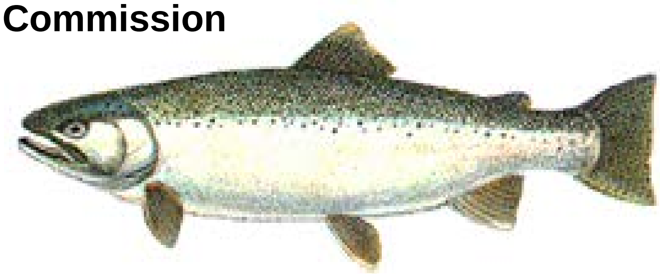




Presented to:

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. 2015. Report of the Lake Erie Coldwater Task Group, March 2015. 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 2014 – 2015 Coldwater Task Group Charges

Background

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

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

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

This report is designed to address activities undertaken by the task group members toward each charge in this past year and is presented orally to the LEC at the annual meeting, held this year on 23-24 March 2015 in Ypsilanti, Michigan USA. 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 2015

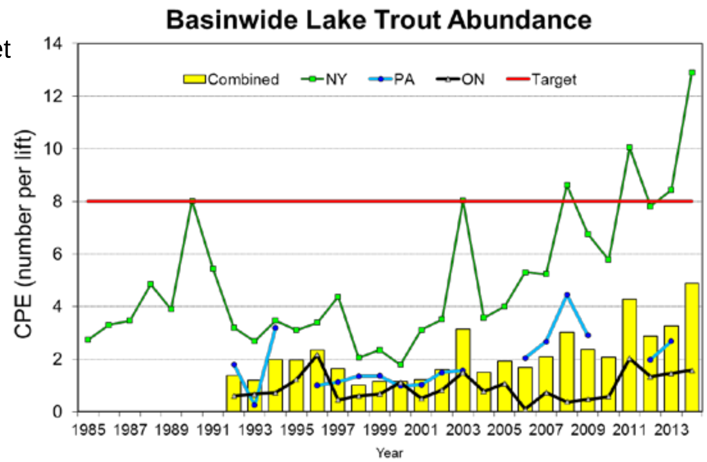
Lake Erie Committee
REPRESENTING THE FISHERY MANAGEMENT AGENCIES OF LAKE ERIE AND LAKE ST. CLAIR

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 2014-2015: (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.

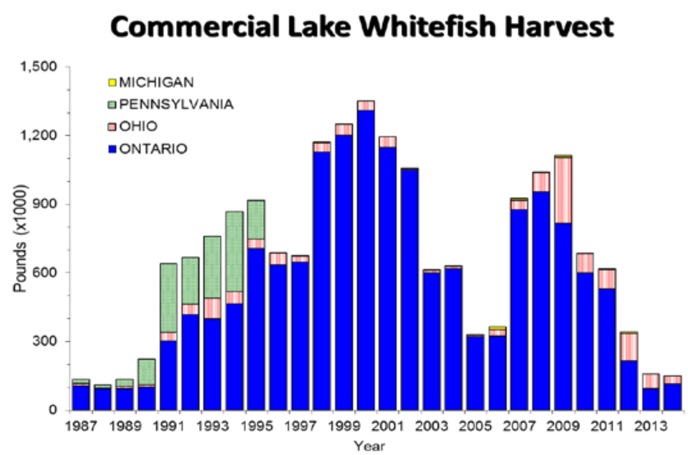
Lake Trout

A total of 727 Lake Trout were collected in 109 unbiased gill net lifts across the eastern basin of Lake Erie in 2014. High Lake Trout catches were recorded in all jurisdictions relative to the time series. Young adults (ages 4-6) 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 4.9 fish per lift, but remains below the rehabilitation target of 8.0 fish/lift. Adult (ages 5+) abundance index increased in 2014 to a time series high (3.0 fish/lift), and for the first time exceeded the target of 2.0 fish per lift. 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.



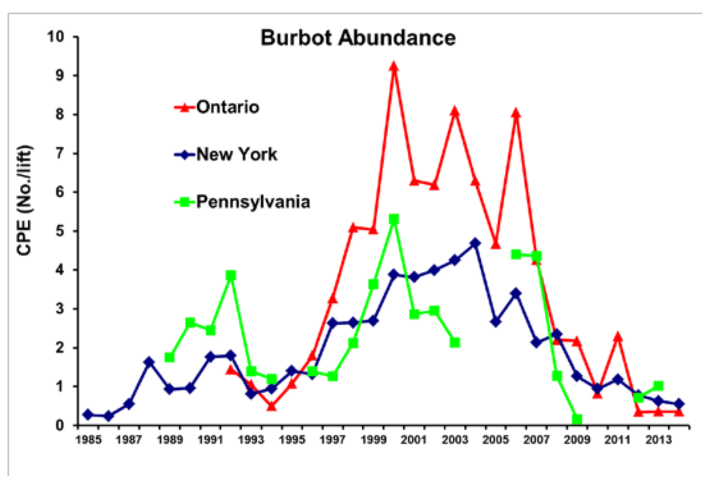
Lake Whitefish

Lake Whitefish harvest in 2014 was 149,367 pounds, distributed exclusively between Ontario (77%) and Ohio (23%). Catches of sub-adult and adult Lake Whitefish in assessment surveys is low for the time series. Catches in 2014 were comparable to low levels observed during the 1980s before recovery. The 2003 year class (age 11) comprised the largest fraction of Lake Whitefish observed in fisheries and assessment surveys in 2013. Lake Whitefish sampled in fisheries and surveys ranged in age from 4 to 26. Few juvenile Lake Whitefish were observed in assessment surveys. Continued poor recruitment elevates the need for reduced fishing mortality and habitat improvement. Mean condition factors of adult male and female Lake Whitefish remain near historic averages.



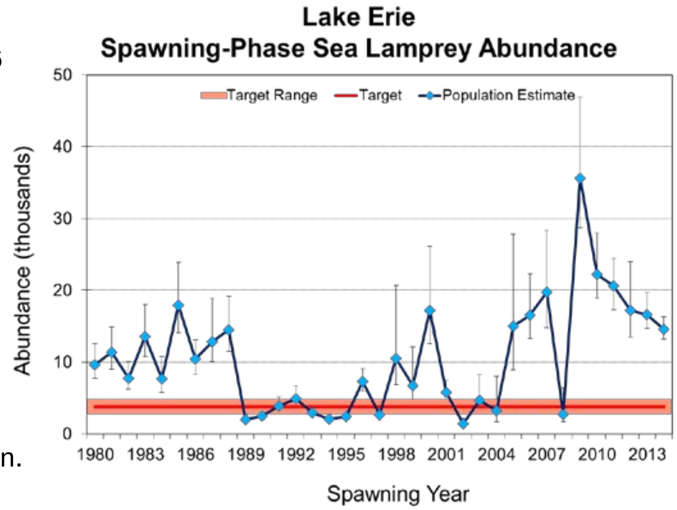
Burbot

Total commercial harvest of Burbot in Lake Erie during 2014 was 2,695 pounds (1,222 kg) of which 70% came in New York by two fishers. Burbot abundance and biomass indices from annual coldwater gillnet assessments decreased (NY) or remained at a low level (ON) in 2014 continuing a downward trend since the early-2000s across east basin areas. Agency catch rates during 2014 averaged 0.37 (Ontario) to 0.55 (New York) Burbot per lift, which are about 20 to 8 times lower than mean catch rates observed during 2000-2004, respectively. Burbot catch ranged in age from 1 to 21 years in 2014. Ongoing low catch rates of Burbot in assessment surveys, the majority (55%) of the population being age-13+, 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.



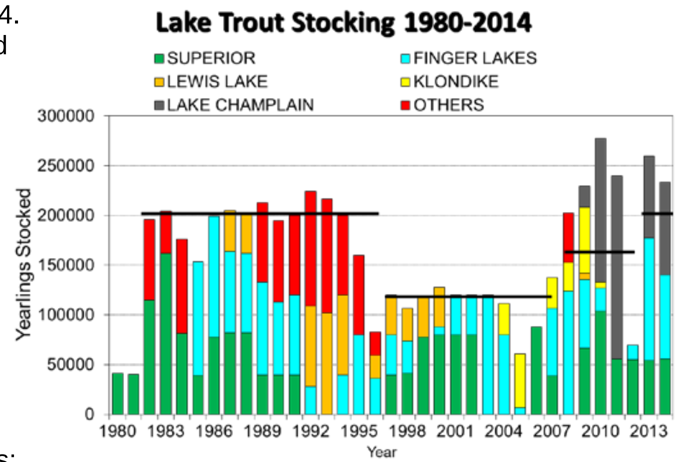
Sea Lamprey

The A1-A3 wounding rate on Lake Trout over 532 mm was 16.6 wounds per 100 fish in 2014. This was a 16% increase from the 2013 wounding rate and is approximately double what was observed in 2011. The 2014 wounding rate is just over three times the target rate of five wounds per 100 fish; wounding rates have been above target for 19 of the past 20 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 (126 wounds per 100 fish). The estimated number of spawning adult Sea Lamprey (14,577) was lower than 2014 and the fifth consecutive annual decline; however, it is still well above the target population of 3,800. Comprehensive stream evaluations continued in 2014, including extensive surveys of Lake St. Clair and the Detroit River, to determine the source of the Lake Erie population.



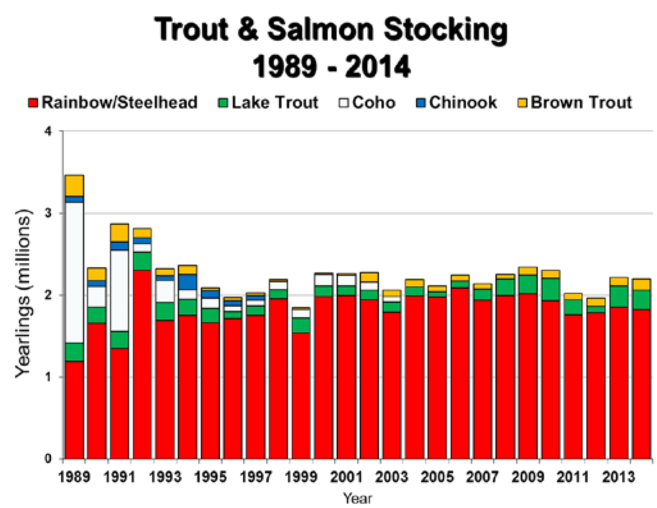
Lake Erie Salmonid Stocking

A total of 2,252,671 salmonids were stocked in Lake Erie in 2014. This was a 2% increase in the number of yearling salmonids stocked compared to 2013, and was 1% above the long-term average since 1990. Minor increases in stocking numbers were observed for Steelhead and moderate decreases of Lake Trout were seen between 2013 and 2014. Although Brown Trout make up only 6% of all trout stockings, the numbers stocked increased 31% from 2013. By species, there were 233,578 yearling Lake Trout stocked in all three basins of Lake Erie; 136,479 Brown Trout stocked in New York and Pennsylvania waters, 3,950 domestic Rainbow Trout stocked in New York, and 1,878,664 Steelhead stocked across all five jurisdictional waters.



Steelhead

All agencies stocked yearling Steelhead in 2014. The summary of Steelhead stocking in Lake Erie by jurisdictional waters for 2014 is: Pennsylvania (1,070,554; 57%), Ohio (428,610; 23%), New York (258,950; 14%), Michigan (67,800; 4%) and Ontario (56,700; 3%). Steelhead stocking in 2014 (1.883 million) represented a 2% increase from 2013 and slightly above long-term average. Annual stocking numbers have been consistently in the 1.7-2.0 million fish range since 1993. The summer open lake fishery for Steelhead was again evaluated by all U.S. agencies and also in Ontario for 2014. Open lake harvest was estimated at 10,652 Steelhead: Ontario, 4,165; Ohio, 3,516; Pennsylvania, 2,552; New York, 419; and Michigan, 0. Overall, this harvest was almost twice that recorded for 2013, but Ontario data was not available for 2013. Overall open lake catch rates are near the long-term average, but effort remains minimal. Based upon creel surveys, the majority (>90%) of the fishery effort targeting Steelhead occurs in the tributaries from fall through spring.



Cisco

Cisco, considered extirpated in Lake Erie, have been reported in small numbers (1-7) in 16 of the past 20 years. Of the 37 observations since 1995, all but two were surrendered by commercial fishermen operating in Ontario waters including two surrendered in 2014. None were captured in 2014 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 9 samples determined those sample fish were most likely from a remnant stock. Efforts are underway to increase this sample size to supplement this research; 27 additional Cisco samples were made available in 2014 to be genetically analyzed in 2015. A technical document entitled "Impediments to the Rehabilitation of Cisco (*Coregonus artedi*) in Lake Erie" was drafted by the CWTG in 2014 with the purpose of describing 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. A completed document is to be given to the LEC 2015.

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

James Markham (NYSDEC), Larry Witzel (OMNRF), Chuck Murray (PFBC), and Mark Rogers (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.

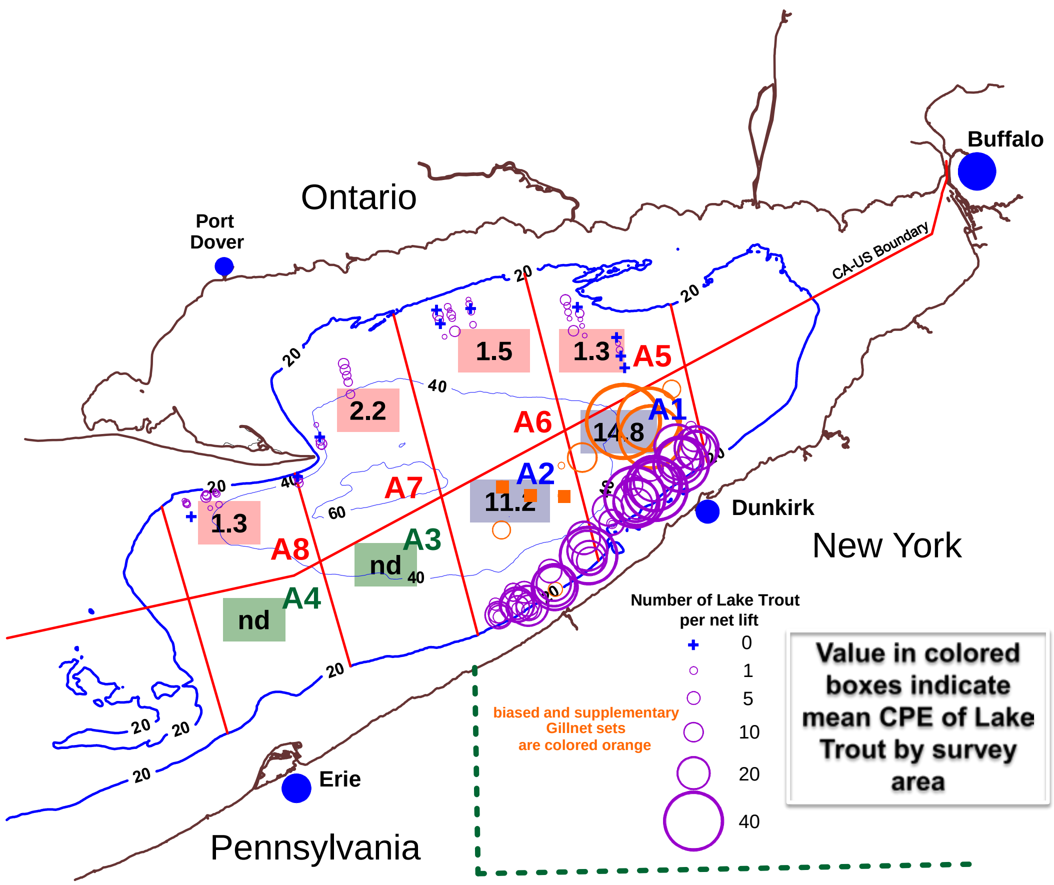


FIGURE 1.1. Standard sampling areas (A1-A8) used for assessment of Lake Trout in the eastern basin of Lake Erie, 2014, and catch per effort of Lake Trout in each area. Circles represent the number of Lake Trout per net lift.

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.

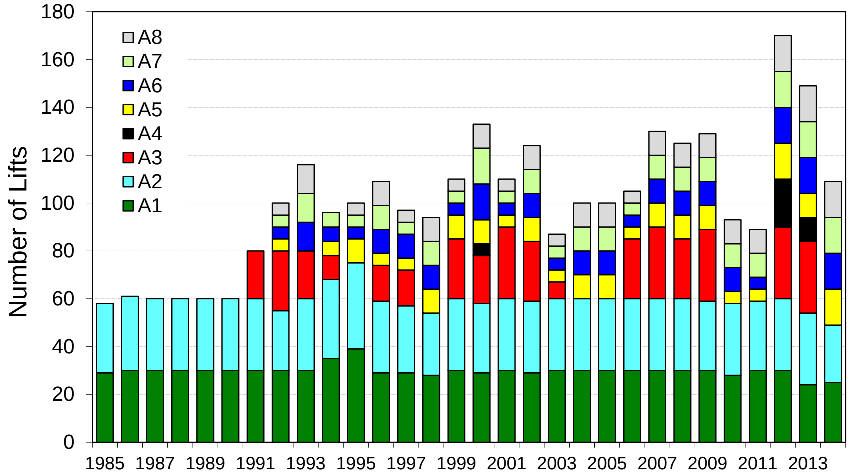


FIGURE 1.2. Number of unbiased coldwater assessment gill net lifts by area in the eastern basin of Lake Erie, 1985-2014.

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 2014 by the combined agencies was 109 unbiased standard Lake Trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 49 lifts by the NYSDEC and 60 by USGS/OMNRF. No sampling was conducted by the PFBC in 2014. NYSDEC moved 10 of their standard 60 lifts to new locations in 2014 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 2015).

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 six of the eight standard areas in 2014 (Figure 1.1), collecting a total of 727 Lake Trout in 109 unbiased lifts. Areas A1 and A2 again produced the highest catch per unit effort (CPE) values (Figure 1.1), coinciding with areas of yearling Lake Trout stocking. 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 survey areas in the east basin indicates a lack of movement away from the stocking area.

Lake Trout ranging from ages 2 to 24 were captured in 2014 and represented sixteen age-classes (Table 1.1). Unlike the past twelve years, young adult cohorts (ages 4-6) were the most abundant and represented 82% of the total catch in standard assessment nets (Figure 1.3). Cohort abundance continues to decline rapidly after age-5, and relatively low numbers of Lake Trout age-7+ were caught. Lake Trout cohorts ages 10 and older comprised less than 5% of the overall catch in 2014.

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 2014.

A) Lean Strain

AGE	SEX	NUMBER	MEAN LENGTH (inches TL)	MEAN WEIGHT (pounds)	PERCENT MATURE
2	Male	13	413.0	784.0	0.0
	Female	9	408.0	747.0	0
3	Male	6	520.0	1612.0	100.0
	Female	1	497.0	1225.0	0
4	Male	162	636.0	3202.0	99
	Female	67	646.0	3468.0	52
5	Male	134	682.0	3891.0	100
	Female	125	696.0	4258.0	99
6	Male	71	707.0	4492.0	100
	Female	45	718.0	4860.0	100
7	Male	34	727.0	4783.0	100
	Female	30	743.0	5584.0	100
8	Male	17	753.0	5558.0	100
	Female	15	779.0	5828.0	100
9	Male	1	768	5530	100
	Female	0	---	---	100
11	Male	8	812	7495	100
	Female	8	804.0	6089.0	100
12	Male	3	841	7928	100
	Female	6	801.0	6340.0	100
13	Male	2	812.0	---	100
	Female	4	834	7638	100
14	Male	3	828.0	8205	100
	Female	1	823.0	7845	100
15	Male	2	779.0	---	100
	Female	1	862	7470	---
19	Male	0	---	---	100
	Female	1	862	9330	---
24	Male	0	---	---	100
	Female	1	857	8001	---

B) Klondike Strain

AGE	SEX	NUMBER	MEAN LENGTH (inches TL)	MEAN WEIGHT (pounds)	PERCENT MATURE
4	Male	1	557	2000.0	0
	Female	1	545	---	0
6	Male	33	635	3208.0	100
	Female	30	651	3607.0	100
7	Male	6	651	3441.0	83
	Female	0	---	---	100
8	Male	0	---	---	100
	Female	1	698	4775.0	100
10	Male	2	672	3860.0	100
	Female	0	---	---	-----

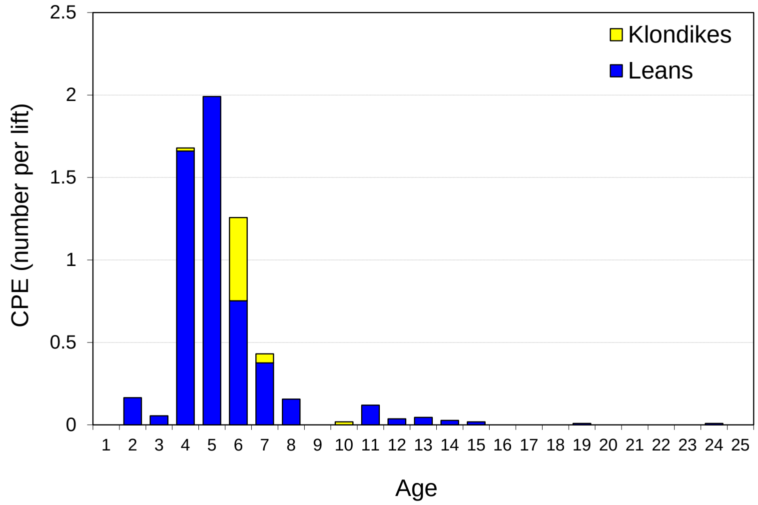


FIGURE 1.3. Relative abundance (number per lift) at age of Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie 2014.

The overall trend in area-weighted mean CPE of Lake Trout caught in standard nets in the eastern basin increased in 2014 to 4.9 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 NY and ON waters in 2014. Abundance estimates were the highest in the series in NY waters. Basin-wide abundance still remains well below the rehabilitation target of 8.0 fish/lift (Markham et al. 2008).

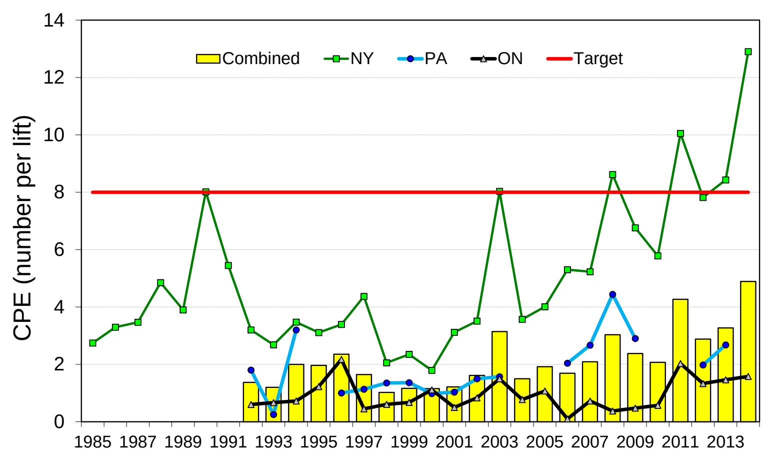


FIGURE 1.4. Mean CPE (number per lift) by jurisdiction and combined (weighted by area) for Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1985-2014.

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 25 Lake Trout were caught in the east basin during the OMNRF Partnership Index Fishing Program in 2014. Lake Trout were caught in the East-Central (1), Pennsylvania Ridge (6) and East (18) basin surveys. The Lake Trout index in the east basin (0.30 fish/lift) was slightly below the time series mean (0.39 fish/lift) while catch rates in Pennsylvania Ridge (0.33 fish/lift) were above average (0.21 fish/lift; Figure 1.5). Coded-wire tags were retrieved from 21 Lake Trout, revealing the following strains: Lake Champlain (10), Slate Island (8) and Finger Lakes (3). Variability of abundance estimates in this survey is high due to lower sample sizes in hypolimnetic waters, especially in the Pennsylvania Ridge area.

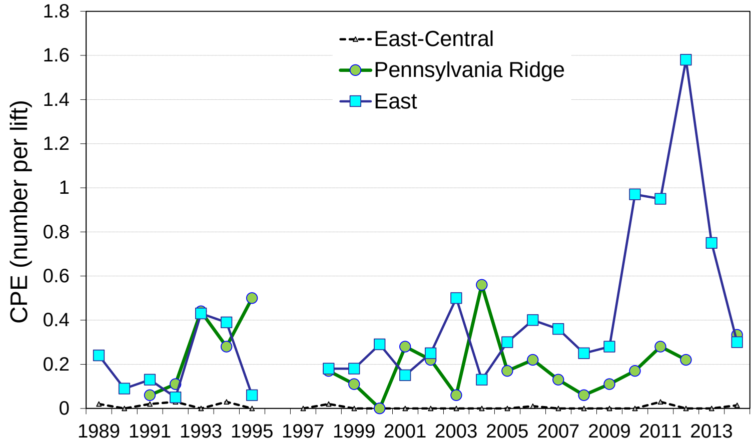


FIGURE 1.5. Lake Trout CPE (number per lift) by basin from the OMNRF Partnership Index Fishing Program, 1989-2014. Includes canned (suspended) and bottom gill net sets, excluding thermocline sets.

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 3.0 fish per lift in 2014 (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 (Markham et al. 2008). The increase in adult abundance was mainly due to a relatively high abundance of age-5 and age-6 Lake Trout (see Figure 1.3).

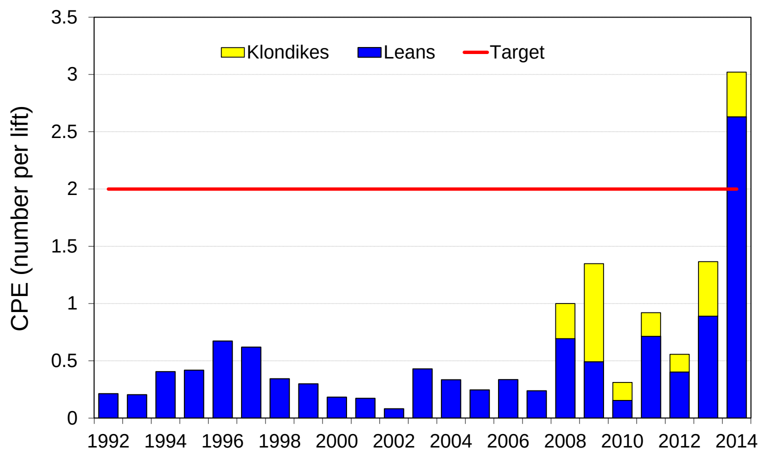


FIGURE 1.6. Relative abundance (number per lift) weighted by area of age-5-and-older Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2014.

The relative abundance of mature females ≥age-6, an index of repeat-spawning females ages six and older, also increased in 2014 to 0.79 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 (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).

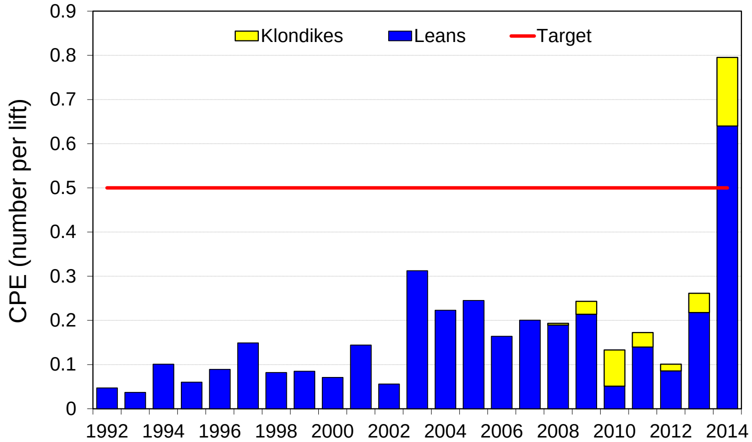


FIGURE 1.7. Relative abundance (all strains combined; number per lift weighted by area) of mature female Lean strain and Klondike strain Lake Trout age-6-and-older in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2014.

Stocking Performance

The proportion of stocked Lake Trout surviving to age 2 provides an index of stocking success. The CWTG performs a stocking performance (SP) index for Lake Trout, calculated by dividing age-2 CPE in standardized gill net catches by the number of fish stocked in that year-class. The quotient is multiplied by 10^5 to rescale the index to the number of age-2 Lake Trout caught per lift per 100,000 yearling Lake Trout stocked. Because the index is scaled to a standard, it can be used to compare survival of stocked fish to age-2 between years with any confounding effects from stocking amounts.

The SP index shows declining survival of stocked Lake Trout from 1992 through 1998 with very few of the yearlings stocked from 1994 through 1997 surviving to age-2 in 1995 through 1998 (Figure 1.8). The index increases beginning in 1999, likely due to a combination of different stocking methods: increased Lake Trout size at stocking, stocking strains, and a decreased adult Lake Trout population. Of interest was the 2006 spike in survival index to 1.11, which was the highest value in the time-series and can be attributed entirely to returns from Klondike-strain Lake Trout stocked in 2005. The 2014 SP index was 0.06, which was below average for the time series (Figure 1.8). Age-2 CPE increased slightly in 2014 but remained below average as well. The low SP index and age-2 CPE values may be attributed, at least in part, to a change in stocking practices that occurred in 2013. Lake Trout stocking was expanded in 2013 to Ohio and Pennsylvania waters instead of just New York waters, and the distribution of returns of age-2 Lake Trout to the east basin may be different compared to previous years.

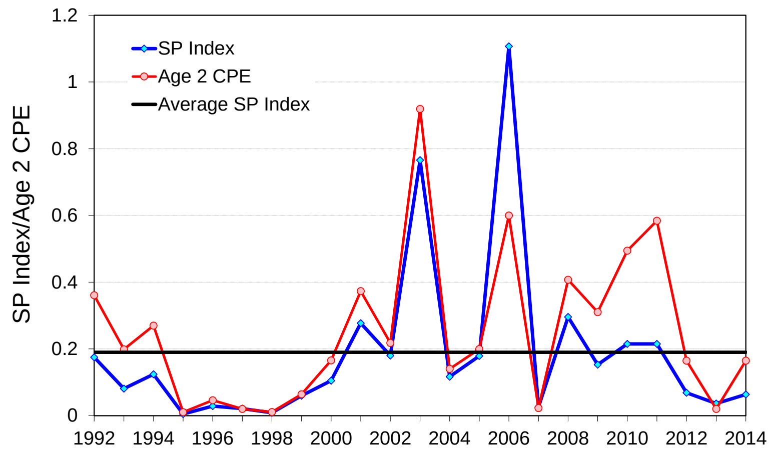


FIGURE 1.8. Stocking Performance (SP) index and age-2 CPE (number per lift) for Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2014. The SP index is equal to the number of age-2 fish caught per lift for every 100,000 yearling Lake Trout stocked.

Strains

Seven different Lake Trout strains were found in the 825 fish caught with either hatchery-implanted coded-wire tags (CWTs) or fin-clips in 2014 (Table 1.2). Similar to last year, the majority of the trout (97%) were comprised of three strains: Lake Champlain (LC; 61%), Finger Lakes (FL; 27%) and Klondike (KL; 9%). These have been the most stocked strains in Lake Erie over the past ten years. Slate Island (SI; 2%), Apostle Island (AI; >1%), Traverse Island (TI; >1%), and Lewis Lake (LL; >1%) strains were the only other strains sampled in 2014. The FL strain continues to show the most consistent returns at older ages; 93% (N=146) of Lake Trout age-7 and older were FL strain fish.

TABLE 1.2. Number of Lake Trout by stocking strain and age collected in gill nets from the eastern basin of Lake Erie, August 2014. Stocking strain codes are: FL = Finger Lakes, LL = Lewis Lake, KL = Klondike, SI = Slate Island, TI = Traverse Island, AI = Apostle Island, LC = Lake Champlain. Shaded cells indicate cohorts with a stocking history.

AGE	FL	KL	LL	SI	TI	AI	LC
1							
2	9						14
3				6			
4		2		4			225
5				4			240
6	79	63	2	2		4	25
7	64	6					
8	31	1			1		
9	1						
10		2					
11	16						
12	9						
13	6						
14	4						
15	3						
16							
17							
18							
19	1						
20							
21							
22							
23							
24	1						
TOTAL	**224**	**74**	**2**	**16**	**1**	**4**	**504**

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).

Recent survival estimates indicate a decline to well below target levels, 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 of the FL strain from 1996 through 2006 are above the target survival rate but are below the ranges previously observed for these strains during the period of successful lamprey control.

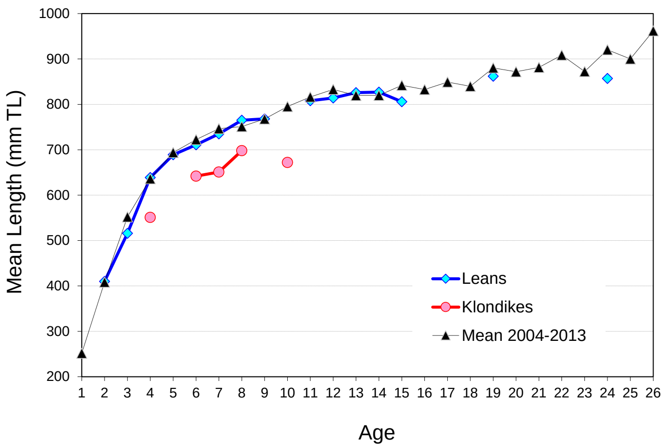
Estimates of the 2003, 2004, 2006, and 2007 year classes of Klondike (KL) strain fish indicate very low survival rates at adult ages that are comparable to survival rates of SUP strain Lake Trout from the 1997-2001 year classes (Table 1.3). Mean overall survival estimates were 60% or higher (Lake Trout Task Group 1985; Markham et al. 2008) for the FL strain but below the target level (60%) for the Lewis Lake (LL), SUP, and KL strains. The Finger Lakes strain, the most consistently stocked Lake Trout strain in Lake Erie, had an overall mean survival estimate of 0.73. Mean overall survival for all strains combined was at target levels.

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

	STRAIN				
Year Class	**LL**	**SUP**	**FL**	**KL**	**ALL**
1983		0.687			0.454
1984		0.619	0.502		0.533
1985		0.543	0.594		0.578
1986		0.678			0.634
1987		0.712	0.928		0.655
1988		0.726	0.818		0.679
1989		0.914	0.945		0.766
1990		0.789	0.634		0.709
1991	0.616				0.615
1992	0.568				0.599
1993			0.850		0.646
1994					0.649
1995					0.489
1996			0.780		0.667
1997		0.404	0.850		0.549
1998		0.414			0.364
1999		0.323	0.76		0.431
2000		0.438	0.769		0.655
2001		0.225	0.696		0.522
2002			0.693		0.633
2003			0.667	0.242	0.585
2004*				0.417	0.420
2005*			0.409		0.682
2006*			0.726	0.143	0.715
2007*			0.737	0.481	0.851
MEAN	**0.592**	**0.575**	**0.727**	**0.321**	**0.603**

Growth and Condition

Mean length-at-age and mean weight-at-age of eastern basin Lean strain Lake Trout remains consistent with averages from the previous ten years (2004-2013) through age 7 (Figures 1.9 and 1.10). Variations in both mean length and weight compared to the 10-year average occur at older ages and seem to be an artifact of low sample sizes. Consistent with past results, mean length and weight of Klondike strain Lake Trout were significantly lower than Lean strain Lake Trout at ages 5-and-older (two sample t-test; P<0.01). In general, Klondike strain Lake Trout are smaller in both length- and weight-at-age-3+ compared to Lean strain Lake Trout. By age 8, Klondike strain Lake Trout average 127 mm (5 inches) smaller and nearly 2.7 kg (six pounds) lighter than Lean strain fish.



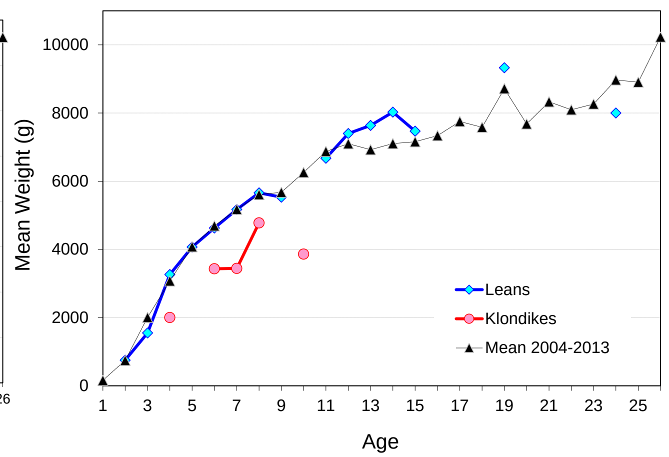


FIGURE 1.9. Mean length-at-age of Lean strain and Klondike strain Lake Trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2014. The previous 10-year average (2004-2013) from New York waters is shown for current growth rate comparison.

FIGURE 1.10. Mean weight-at-age of Lean strain and Klondike strain Lake Trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2014. The previous 10-year average (2004-2013) from New York waters is shown for current growth rate comparison.

Mean coefficients of condition (Everhart and Youngs 1981) were calculated for age-5 Lake Trout by sex to determine time-series changes in body condition. Overall condition coefficients for age-5 Lake Trout remain well above 1.0, indicating that Lake Erie Lake Trout are, on average, heavy for their length (Figure 1.11). Condition coefficients for age-5 male and female Lean strain Lake Trout show an increasing trend from 1993-2000, and have remained high and relatively steady since. The condition coefficients of Klondike strain Lake Trout show a similar pattern to Lean strain Lake Trout for both males and females since 2008, but are generally lower.

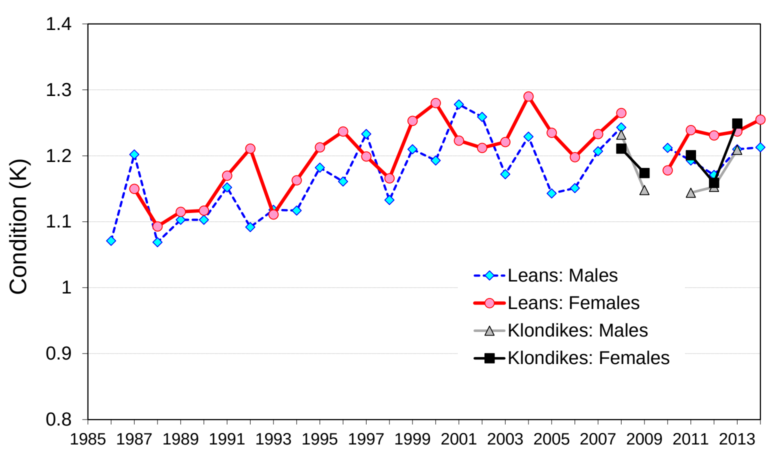


FIGURE 1.11. Mean coefficients of condition for age-5 Lean strain and Klondike strain Lake Trout, by sex, collected in eastern basin assessment gill nets in Lake Erie, August 1985-2014.

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 653 Lake Trout were harvested in New York waters out of an estimated catch of 2,148 in 2014 (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 200 Lake Trout occurred in Pennsylvania waters in 2014 (Figure 1.12). This was above the series average of 83 fish per year and only the third year harvest was detected since 2006. Lake Trout catch in Pennsylvania waters was estimated at 3,282 fish, which was the highest on record.

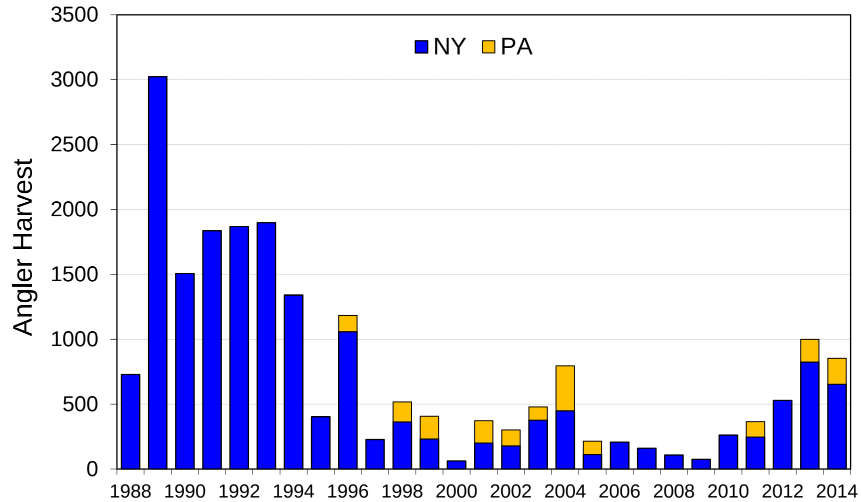


FIGURE 1.12. Estimated Lake Trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2014.

Natural Reproduction

Despite more than 30 years of Lake Trout stocking in Lake Erie, no naturally reproduced Lake Trout have been documented. Two potentially wild fish (no fin clips; no CWT's) were caught in eastern basin coldwater gill net surveys in 2014, making a total of 61 potentially wild Lake Trout recorded over the past 14 years. Otoliths are collected from Lake Trout found without CWTs or fin-clips and will be used in future stock discrimination studies. A November gill net survey initiated by NYSDEC in 2008 to detect presence of spawning condition Lake Trout in local shoals was not conducted in 2014 due to poor weather conditions. A similar spawning survey conducted by OMNRF were also curtailed in 2014 due to weather.

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 2014 Lake Trout model estimated the Lake Erie population at 287,848 fish and the age-5 and older population at 76,215 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.

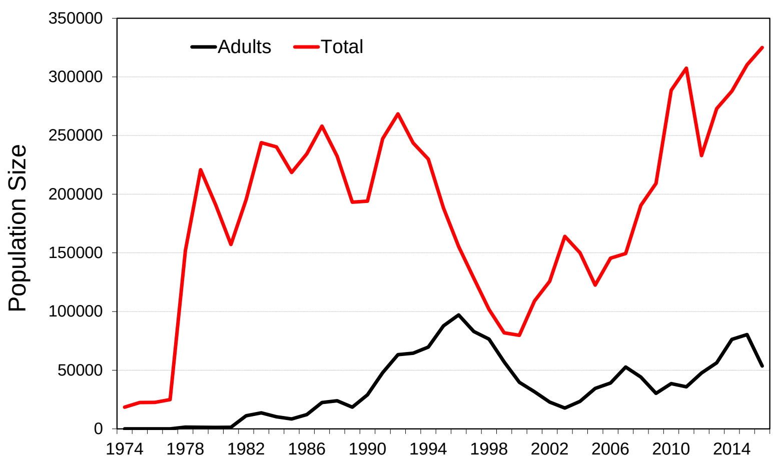


FIGURE 1.16. Projections of the Lake Erie total and adult (ages 5+) Lake Trout population using the CWTG Lake Trout model. Projections for 2014-2016 were made using low rates of Sea Lamprey mortality with proposed stocking rates. The model estimated the lakewide Lake Trout population in 2014 at 287,848 and the adult population at 76,215.

Diet

Seasonal diet information for Lake Trout is not available based on current sampling protocols. Diet information was limited to fish caught during August 2014 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 and Round Goby were most prevalent diet items, occurring in 73% and 34% of Lean strain and 57% and 64% of Klondike strain Lake Trout stomachs, respectively (Table 1.4). Similar to past years, Smelt remain the preferred prey item for Lean strain Lake Trout when they are abundant. However, in years of lower adult Smelt abundance, Lake Trout appear to prey more on Round Goby. Klondike strain Lake Trout have consistently had higher percentages of Round Goby in their diets compared to Lean strain Lake Trout (Coldwater Task Group 2011). Yellow Perch and Emerald Shiner were the only other identifiable prey item found in Lake Trout stomachs in 2014.

TABLE 1.4. Frequency of occurrence of diet items from non-empty stomachs of Lean (N=466) and Klondike (N=28) strain Lake Trout collected in gill nets from eastern basin waters of Lake Erie, August 2014.

PREY SPECIES	Lean Lake Trout (N=466)	Klondike Lake Trout (N=28)
Smelt	340 (73%)	16 (57%)
Round Goby	160 (34%)	18 (64%)
Yellow Perch	4 (>1%)	
Emerald Shiner	1 (>1%)	
Unknown Fish	24 (5%)	
Number of Empty Stomachs	365	39

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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 Kevin Kayle (ODW)

Commercial Harvest

The total harvest of Lake Whitefish in Lake Erie during 2014 was 149,367 pounds (Figure 2.1). Ontario accounted for 77% of the lake-wide total, harvesting 114,636 pounds, followed by Ohio (23%; 34,731 lbs.), with no commercial harvest in Michigan, Pennsylvania or New York (Figure 2.2). Total harvest in 2014 was 6% lower than the total harvest in 2013. Lake Whitefish harvest increased in Ontario by 21%, but decreased 46% in Ohio.

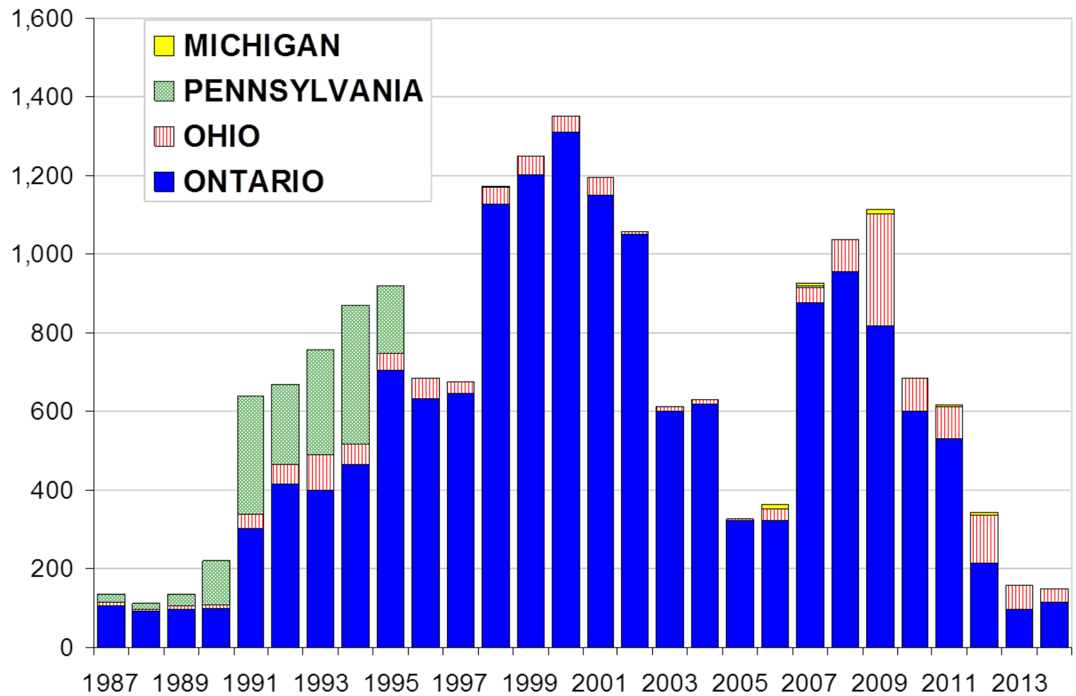

FIGURE 2.1. Total Lake Erie commercial Lake Whitefish harvest from 1987-2014 by jurisdiction. Pennsylvania ceased gill netting in 1996, and Michigan resumed commercial fishing using trap nets in 2006, excluding 2008.

Ontario's 2014 harvest represented 96% of their 2014 quota (120,000 pounds), which was set at the lowest level since 1986 (36,600 pounds). The reported Lake Whitefish harvest includes 1,316 pounds of Lake Whitefish surrendered from individual quotas that were attained. The majority (99.8%) of Ontario's 2014 Lake Whitefish harvest was taken in gill nets. The remainder (234 pounds) was caught in smelt trawls. The largest fraction of Ontario's whitefish harvest (90%) was caught in the west basin (Ontario-Erie Unit OE1) followed by OE2 (9%), with the remaining harvest distributed eastward among units OE3 (0.5%), OE4 (0.2%) and OE5 (0.1%). Harvest in OE1 from October to December represented 87% of Ontario's Lake Whitefish harvest. In OE 1, harvest peaked in November (42,888 lbs), whereas OE2 and OE3 harvests peaked during October (4,697 lbs). The minimal Lake Whitefish harvest from OE4 was taken during spring and summer, whereas OE5 harvest occurred primarily from April to June (133 lbs), with minimal harvest from November to December (21 lbs). There was no effort targeting Lake Whitefish in 2014; the harvest was mainly caught in fisheries targeting walleye (85%) and white bass (15%), with only trace amounts caught in White Perch, Yellow Perch and Rainbow Smelt fisheries. During the late fall-early winter spawning season, Lake Whitefish harvest during November and December (78,440 pounds) accounted for 69% of Ontario's annual harvest.

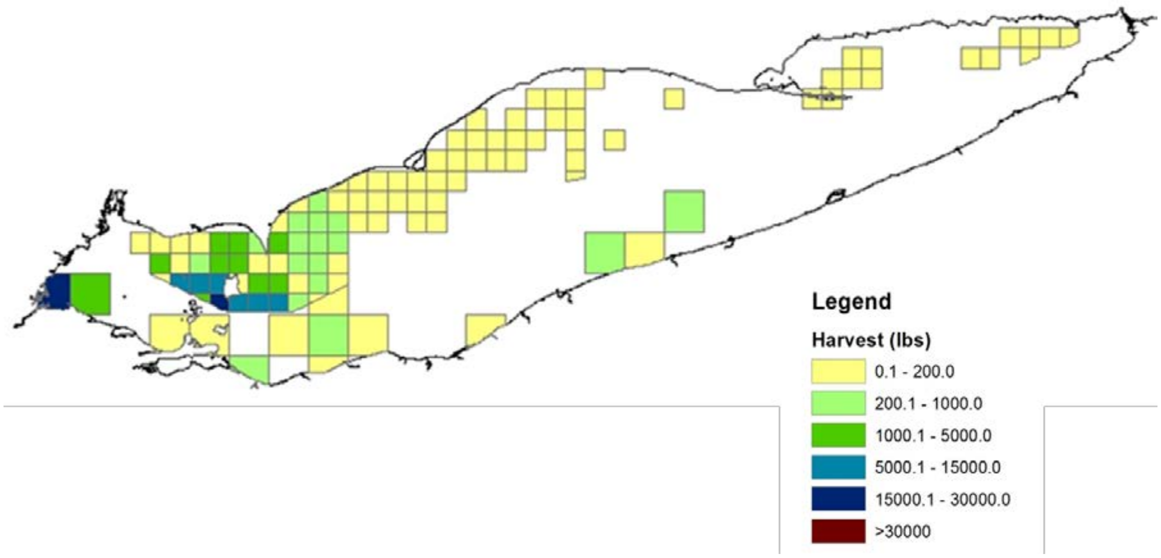

FIGURE 2.2. Lake Erie commercial harvest of Lake Whitefish in 2014 by 5-minute (Ontario) and 10-minute (Ohio) grids. No Lake Whitefish harvest was reported in Pennsylvania, New York or Michigan.

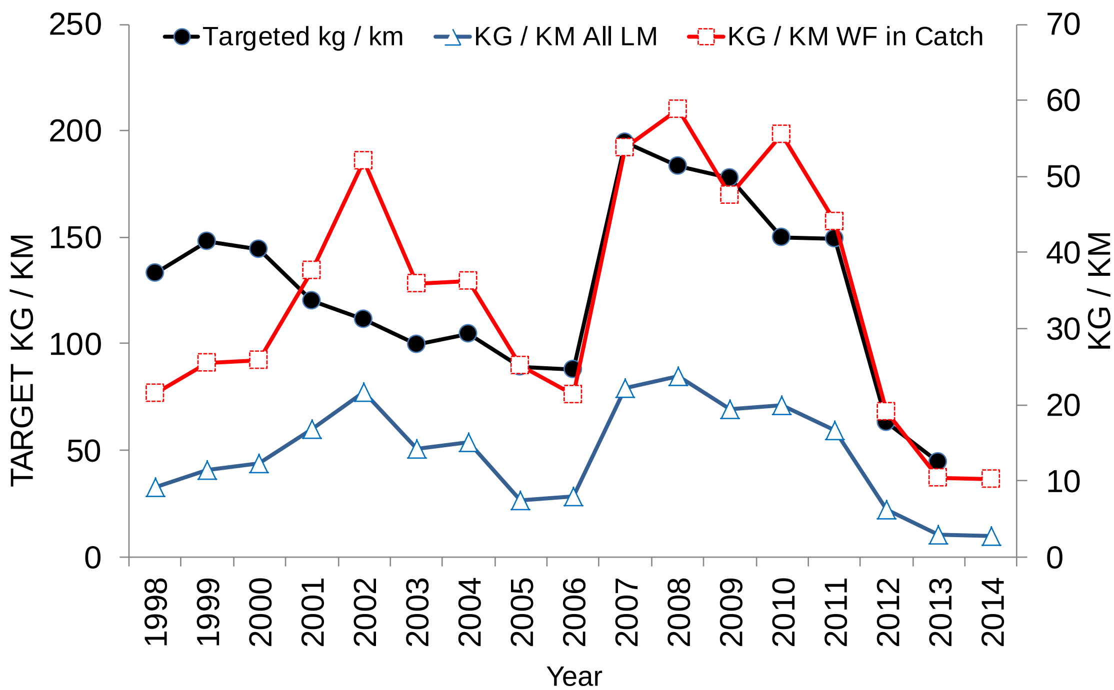

FIGURE 2.3. Lake-wide Ontario annual commercial large mesh gill net catch rates according to three forms of effort 1998-2014. Targeted Lake Whitefish catch rate (kg/km), catch rate relative to all large mesh gillnet fished (kg/km), and catch rates from large mesh effort with Lake Whitefish in the catch.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

As there was no reported targeted gill net harvest or effort in 2014, 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 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 10% from 2013, whereas catch rates based on effort with Lake Whitefish in the catch declined 1%. In both cases, 2014 catch rates were the lowest in their respective 1998-2014 time series.

In Ohio waters during 2014, 94.3% of the Lake Whitefish trap net harvest occurred in the west basin, with the remaining harvest divided between central basin districts D2 (2.4%) and D3 (3.3%). Lake Whitefish were harvested from 1,330 Ohio trap net lifts in 2014, with lifts distributed among District 1 (39%), District 2 (50%) and District 3 (11%), respectively. The majority of Ohio's Lake Whitefish harvest occurred during November (93%), followed by October (1%), in the western basin. Ohio's remaining Lake Whitefish harvest occurred in the central basin (6%), mainly during May and June. Lake Whitefish yield in 2014 from Ohio trap nets was greatest near the mouth of the Maumee River (28,435 pounds, Figure 2.2). Ohio trap net catch rates in 2014 declined further from 2013, are the lowest since 2006-2007, yet still exceed the time period from 1996-2005 (Figure 2.4).

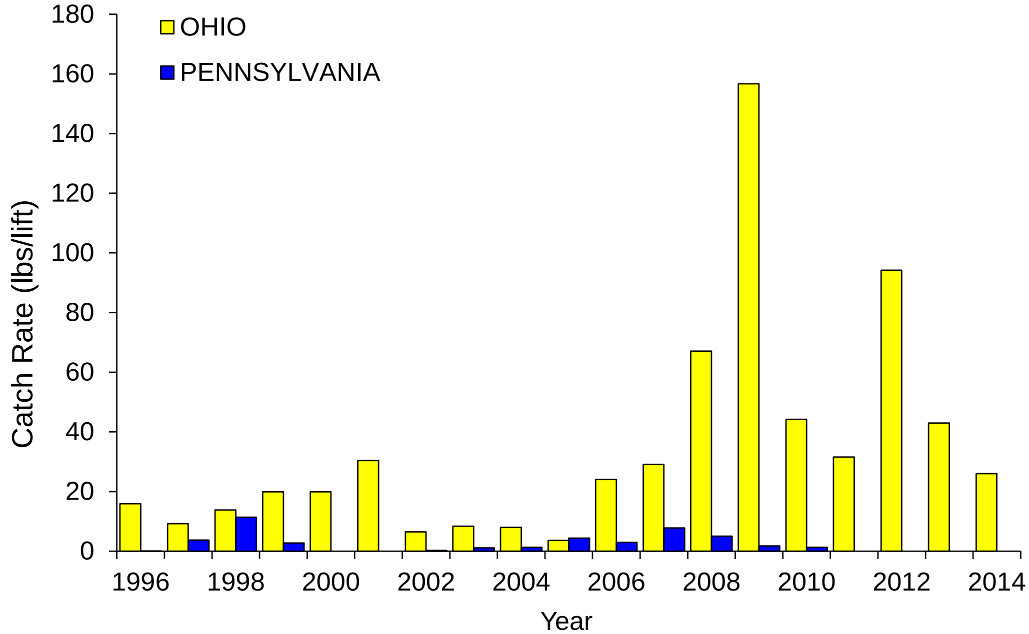

FIGURE 2.4. Lake Whitefish commercial trap net catch rates in Ohio and Pennsylvania (pounds per lift), 1996-2014. Zero harvest for Pennsylvania in 2011-2014.

Part of the reason for variable catch rates in Ohio Lake Whitefish fisheries is the concentration of the fisheries effort late in the season (November and December) in the western basin of Ohio waters of Lake Erie (see Figure 2.2 and Figure 2.5). Catch rates were highest in Ohio grids 801 and 802, adjacent to Maumee Bay. Lake Whitefish aggregate there and move to spawning locations, but in 2014 catch rates in these grids declined and may be related to reduced abundance or storms that damaged nets and ended the fishing season (Figure 2.6). The Ohio Lake Whitefish trap net fishery has changed in the last two decades to capitalize on these spawning aggregations of fish. Depending on the amount of fishing effort during the whole year in all Ohio waters and during this late time period, localized in the west basin, significant differences in overall catch rates can be realized. The current trend is for the majority of Lake Whitefish harvest and high catch rates with effort expended in a few select grids during the late season. This concentration of effort and spawning fish will have to be monitored into the future to insure that spawning stock of Lake Whitefish is not fished down to critical levels that could affect future recruitment.

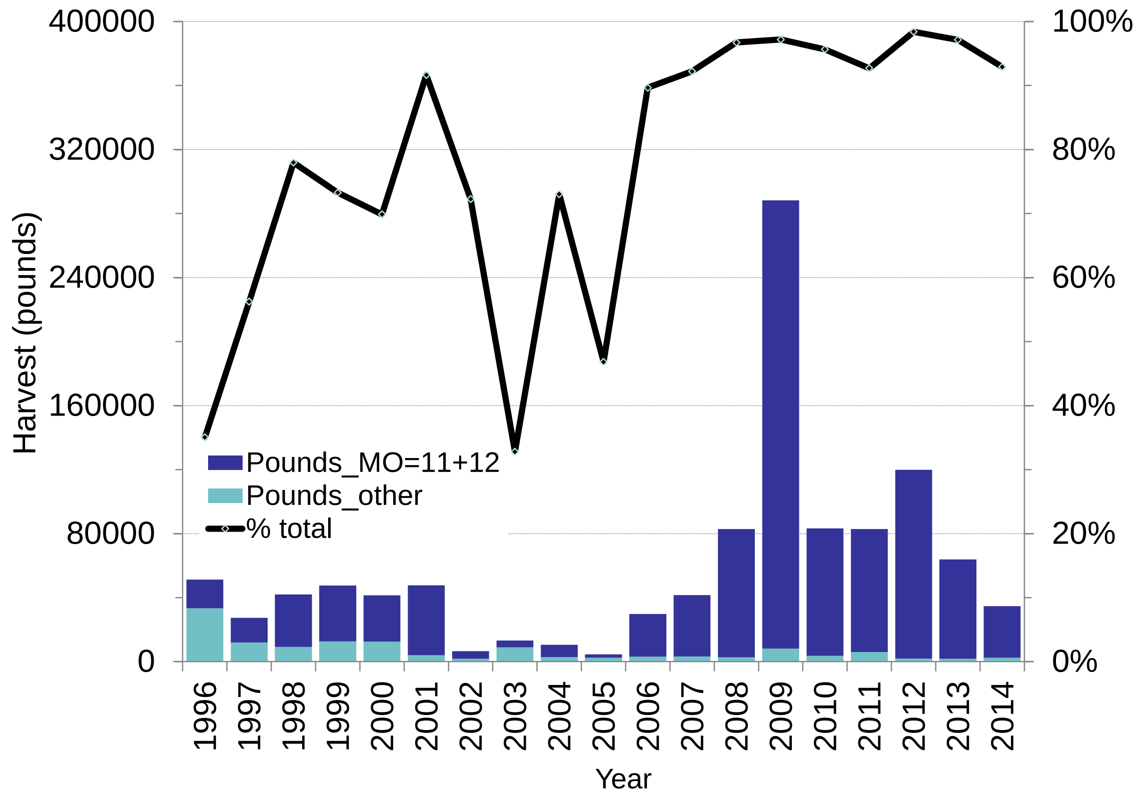

FIGURE 2.5. November and December harvest (MO=11+12) of Lake Whitefish in Ohio waters of Lake Erie, 1996-2014.

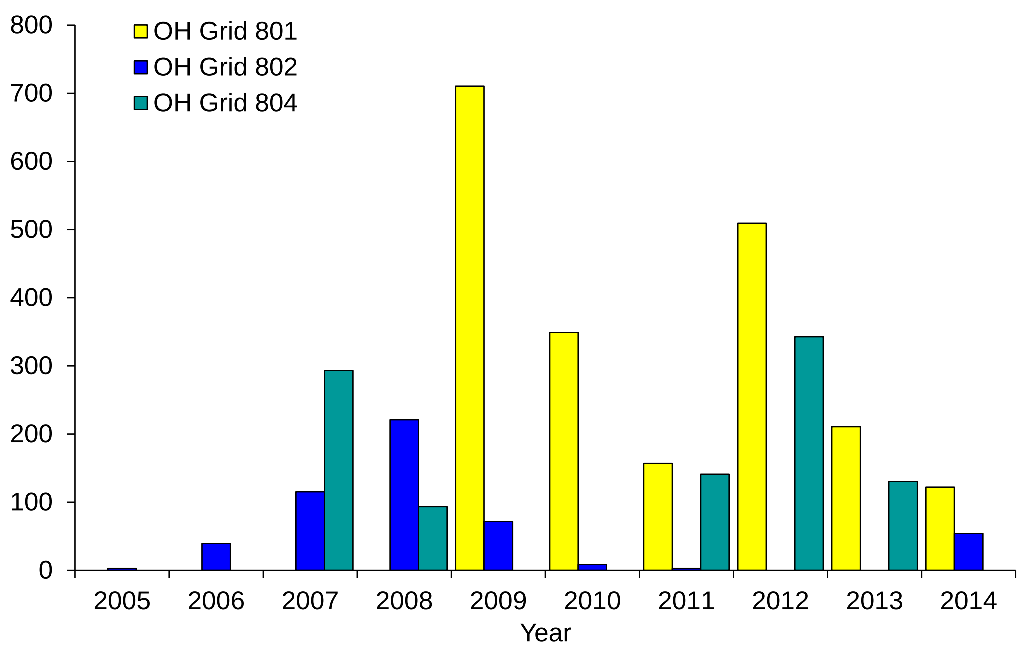

FIGURE 2.6. Ohio Lake Whitefish commercial trap net catch rates (pounds per lift) by grid in western Lake Erie. There was no harvest from grid 804 in 2014.

Ontario's west basin fall Lake Whitefish fishery in 2014 was dominated by older fish (Figures 2.7 and 2.8). The age composition of Lake Whitefish harvest from Ontario is presented for Walleye and White Bass fishery standard harvest monitoring using otoliths (N=411; Figure 2.8). For comparison, results are presented from OMNR supplementary 2014 fall Lake Whitefish harvest assessment in processing plants using scales for aging (N=99; Figure 2.8). Based on standard harvest monitoring, Ontario's whitefish harvest in 2014 consisted of Lake Whitefish from ages 4 to 26. The strong 2003 cohort (age 11) was most abundant, representing 64% of the Lake Whitefish sampled harvest in 2014 (Figure 2.8). Walleye and White Bass fishery Lake Whitefish harvests consisted of similar age compositions, while supplementary plant processing showed a younger distribution of ages (Figure 2.8). Some of the difference may be attributed to using different ageing structures in processing plants. Two (2) of the 411 harvested Lake Whitefish examined in 2014 suffered Sea Lamprey attacks (one type A3 wound and one type A or B).

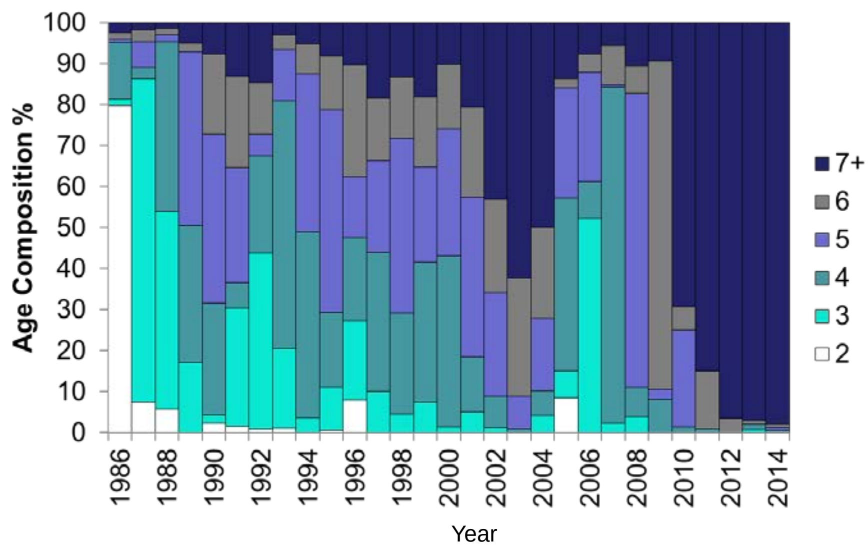

FIGURE 2.7. Ontario fall commercial Lake Whitefish harvest age composition in statistical district 1, 1986-2014, from effort with gill nets ≥3 inches, October to December.

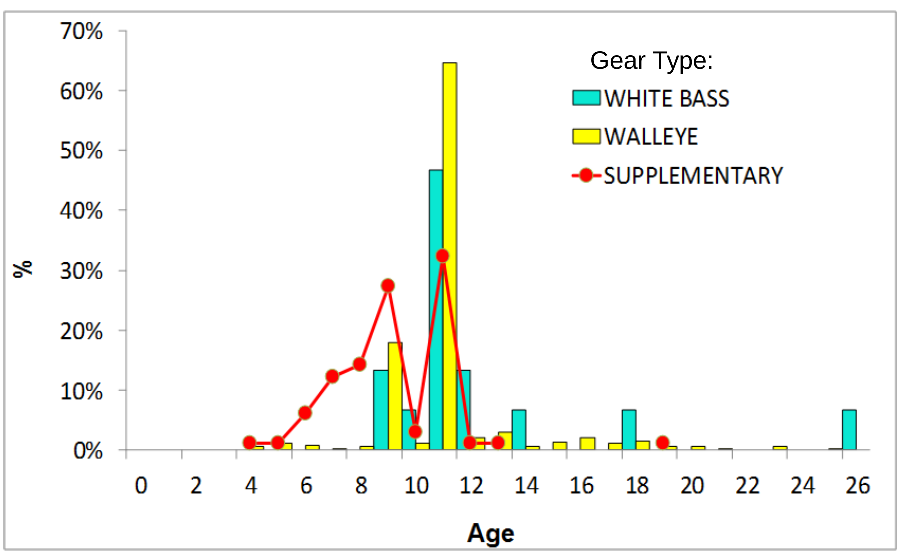

FIGURE 2.8. Age composition (otoliths, scales) of Lake Whitefish caught commercially in Ontario waters of Lake Erie in 2014 by target species fisheries (White Bass and Walleye – bars; N=411). Sex Composition: Male 77%, Female 23%, N=385. Supplementary fall commercial assessment in west and central Lake Erie (red line) N=99.

The age composition of the 2014 lake whitefish commercial fishery in Ohio was not assessed in 2014, as no lengths and ageing samples were collected. Ohio Trap netters pulled their fishing gear early, or had their gear destroyed, as a result of November 2014 storms and were forced to abandon the rest of the fishing season before biological samples were taken.

The landed weight of roe from Ontario's 2014 Lake Whitefish fishery was 2,455 pounds, most of which came from OE1 during November (70%) and October (27%). The remaining fraction of roe was collected from OE2 (3%) during October, with minimal amounts collected in November in OE 2 (4 lbs) and during October in OE 3 (1 lb). The approximate landed value of the roe was CDN$ 7,014.

Assessment Surveys

Lake Whitefish gill net indices presented include east basin coldwater 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.

Lake Whitefish catch rates in CWA nets during 2014 were similar (-1%) to 2013 and was in the 31st percentile for the time series of 1985-2014 (Figure 2.9). Catch rates in NY CWA nets during 2014 were seven times greater than in ON waters. There were no CWA samples in PA waters during 2014. Fifty-nine (59) Lake Whitefish were caught in standard CWA nets during 2014. When including Lake Whitefish captured in deep set assessment nets and a biased CWA net, of the 63 Lake Whitefish caught, there was one fish with an A1 wound, one with an A2 wound, and three with A4 wounds. The standardized A1-A3 wounding rate was 3.2 per 100 fish, while the A4 wounding rate was 4.8 wounds per 100 fish.

Partnership catch rates of Lake Whitefish ages 0 to 2 was zero in 2014, a trend which began in 2010 (Figure 2.9). Catch rates for ages 3 and older Lake Whitefish caught in Partnership surveys increased from 0.01 to 0.04 in 2014. Aside from the nine Lake Whitefish caught in Partnership Index gear in 2014, one additional Lake Whitefish was caught in auxiliary 121-mm nets in the west-central basin. The age composition of Lake Whitefish caught in Partnership Index gear ranged from ages 4 to 14, with age-11 (2003 year class) the most abundant (Figure 2.10). The one Lake Whitefish caught in auxiliary gear was age 17. None of the 10 Lake Whitefish sampled had Sea Lamprey wounds or scars.

Adult Lake Whitefish were not captured in any Ohio DNR assessment surveys in 2014. USGS late-season gillnet assessment surveys (4 lifts) performed around the Ohio islands targeting Coregonids (Cisco and Lake Whitefish) resulted in the capture of 29 Lake Whitefish. These fish ranged in age from 10 to 23 years; the majority were age-11 with a mean of 13.5 years (Figure 2.11). All fish sampled were males.

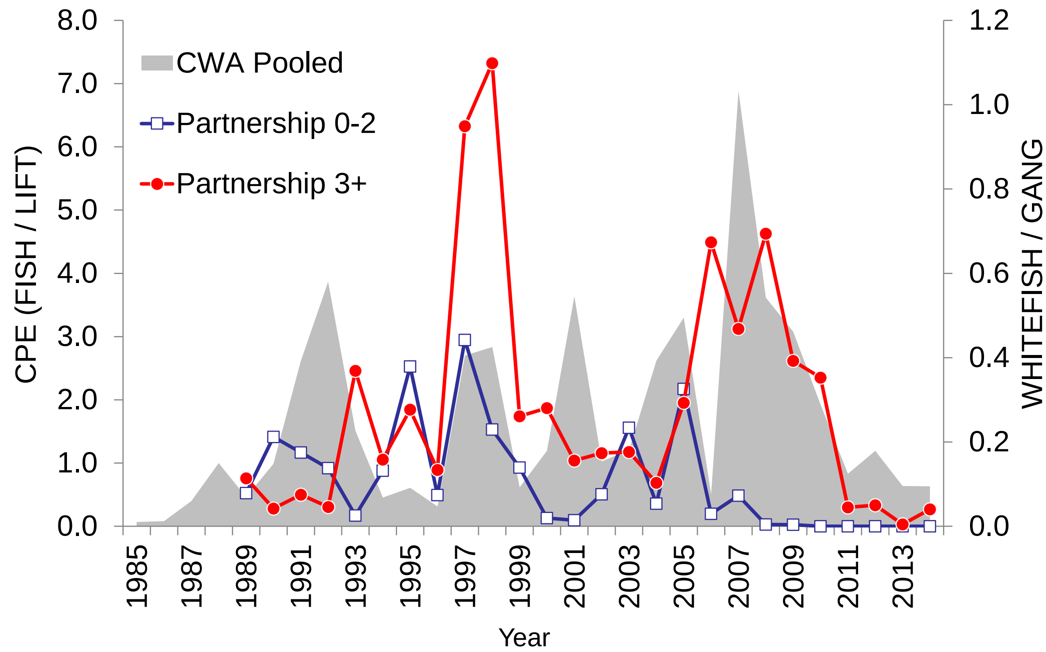

FIGURE 2.9. Catch per effort (number fish/lift) of Lake Whitefish caught in standard coldwater assessment gill nets (CWA) in New York, Ontario and Pennsylvania waters, weighted by number of lifts (grey area). Partnership central-east combined index catch rates (WF/gang) for ages 0-2 (dots) and ages 3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

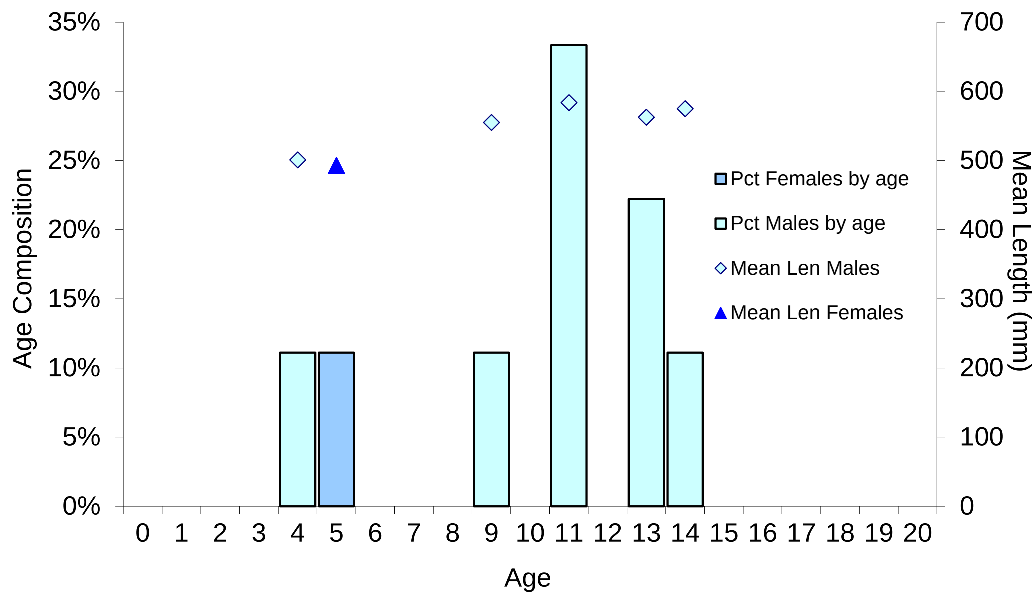

FIGURE 2.10. Age frequency distributions and mean length by sex of Lake Whitefish collected during Ontario Partnership index fishing, 2014 (N=9). Standardized to equal effort among mesh sizes and includes all index gear.

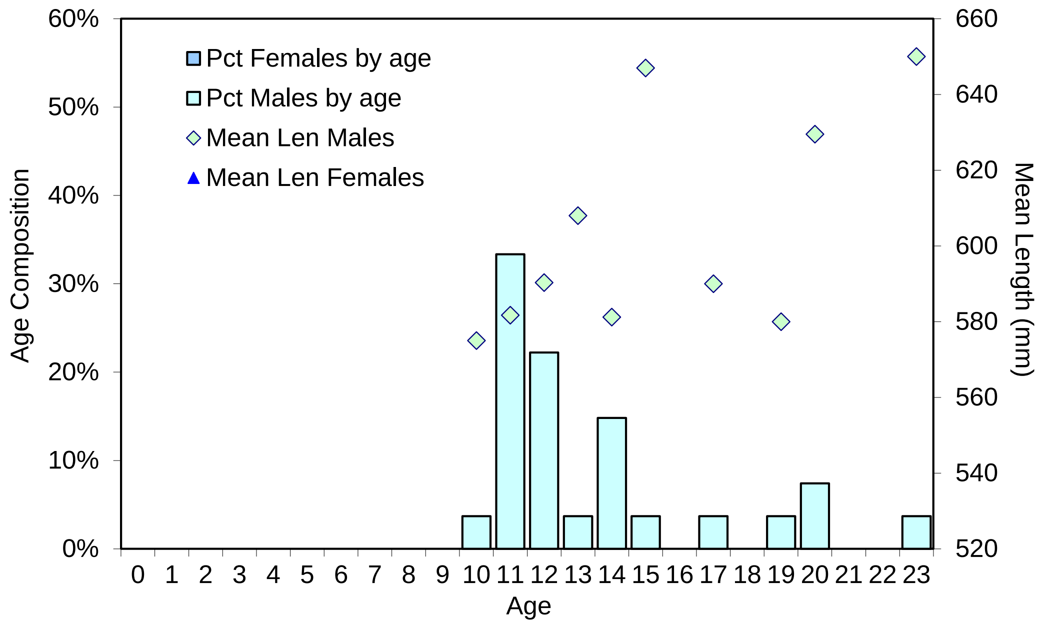

FIGURE 2.11. Age distribution and mean length-at-age of Lake Whitefish collected during late fall gill net assessment surveys in Ohio waters of Lake Erie by USGS during 2014 (N=27).

Ohio trawl surveys in the central basin of Lake Erie can encounter juvenile Lake Whitefish and assess the general magnitude of year classes. These surveys capture migrating Lake Whitefish during the spring and fall. Since the strong 2003 year class, Ohio central basin (Statistical District 2 and District 3) bottom trawl surveys conducted in August and October captured young-of-the-year (YOY) from the 2004, 2005 and 2007 year classes. In 2014, one (1) YOY Lake Whitefish was caught during the August 2014 bottom trawl assessments in Ohio District 3 (east-central basin). Yearlings were present in Ohio bottom trawl surveys in central Lake Erie during 2005 and 2006, but have been absent since then.

Ontario assessed incidental harvest of species caught in commercial Rainbow Smelt trawls in Lake Erie during September, 2014. Lake Whitefish were not observed in any of the five commercial smelt trawls.

Growth and Diet

Trends in condition are presented for Lake Whitefish collected by USGS in Ohio waters (Figure 2.12) and Ontario MNR (Figure 2.13). In Ohio waters, condition of males (mean K= 1.03) was above Van Oosten and Hile's (1947) historic condition reference value (1.015; Figure 2.12), whereas no females were sampled to determine female condition compared to the historic value. Lake Whitefish ages 4 and older collected during the fall from Ontario waters had mean condition (K) values of 1.14 for females and 1.05 for males, both of which were slightly above historic average conditions of each sex: 1.131 for females and 1.015 for males, 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, Partnership auxiliary gear, and a comparison gill netting project.

No diet analyses are presented this year; agency catches were too low to make significant statements about dietary composition or no diet samples were taken for analysis.

The decline in Lake Erie's Lake Whitefish population is evident from both fishery and survey indicators. We expect this decline will continue until recruitment increases. Total harvest in 2014 (149 thousand pounds) was the lowest observed since 1989 (135 thousand pounds). Ontario's incidental harvest attained 96% of Lake Whitefish quota (120 thousand pounds) with no targeted harvest of Lake Whitefish in 2014. With an assumed

mean weight in the harvest of 2,045 g (N=385), the total estimated harvest in 2014 was 33,130 Lake Whitefish. Preliminary population assessments suggest that the exploitation rate in 2014 may be less than 15%. A Lake Erie Lake Whitefish synopsis is in preparation that will report population estimates and biological reference points to support management of this native coldwater species.

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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.

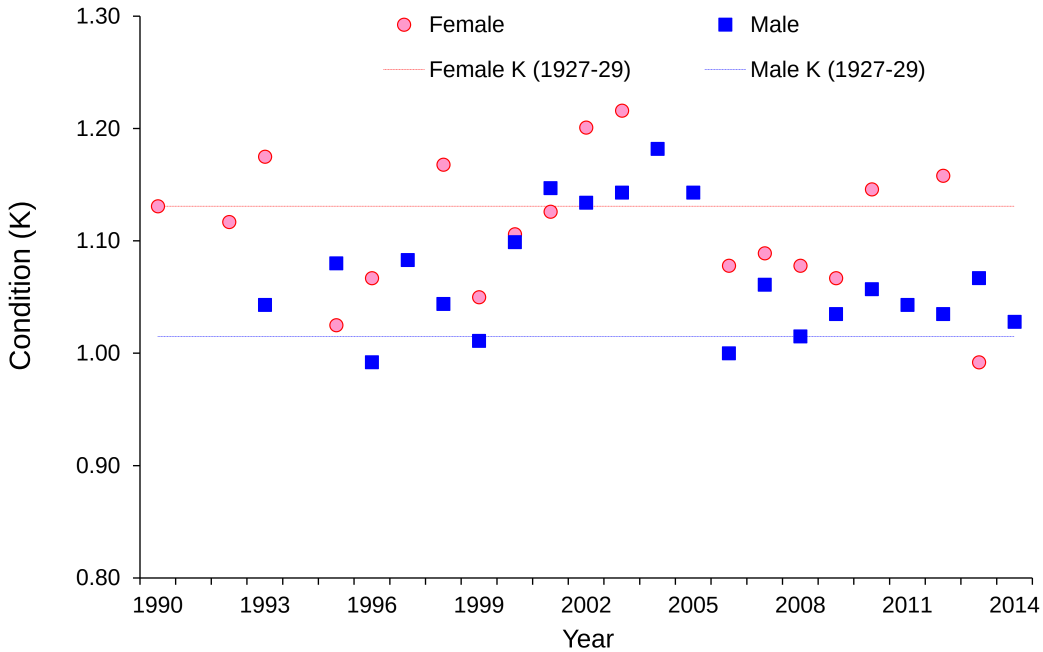

FIGURE 2.12. Mean condition (K) factor values of age 4 and older Lake Whitefish obtained from Ohio and USGS fall survey data by sex from 1990-2014. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

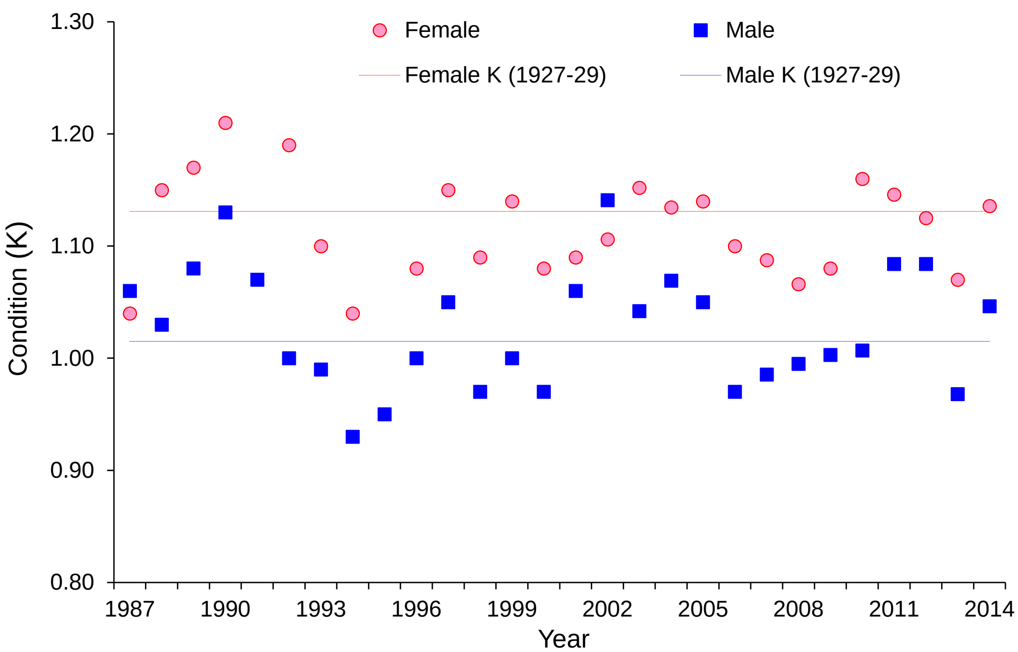

FIGURE 2.13. Mean condition (K) factor values of age 4 and older Lake Whitefish obtained from Ontario commercial and survey data (Oct-Dec) by sex from 1987-2014. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

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

Larry Witzel (OMNRF), Mark Rogers (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. Most Burbot commercial harvest occurs in the eastern end of the lake, with minimal harvest occurring in Ohio waters and the western and central basins of Ontario waters.

The total commercial harvest for Lake Erie in 2014 was 2,695 pounds (1,222 kg) of which 70% came from New York by two fishers (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 2014 was by-catch in trawls from the Rainbow Smelt fishery (83%), followed by the Yellow Perch fishery (17%).

Harvest decreased in Pennsylvania waters after 1995 following a shift from a gill net to a trap net commercial fishery, resulting in a substantial decrease of commercial effort (CWTG 1997). In 1999, a market was developed for Burbot in Ontario, leading the industry to actively target this species. 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.

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 in the Pennsylvania Ridge area and in the eastern basin, reaching a peak of about 4 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 in 2005-2006. Catch rates in the eastern basin since 1998 have been variable but exhibited an overall decreasing trend. In 2014, only three Burbot were captured in the central basin and abundance in the eastern basin (5 Burbot caught) and Pennsylvania Ridge (1 Burbot caught) remained at record low numbers (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 2014, both abundance measures were at their respective time-series minima (Figure 3.3).

Numeric abundance of Burbot as determined from coldwater assessment gill netting 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 similarly low at 0.6 or less Burbot/lift across all jurisdictions in 2014 (Figure 3.4).

TABLE 3.1. Total Burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2014.

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

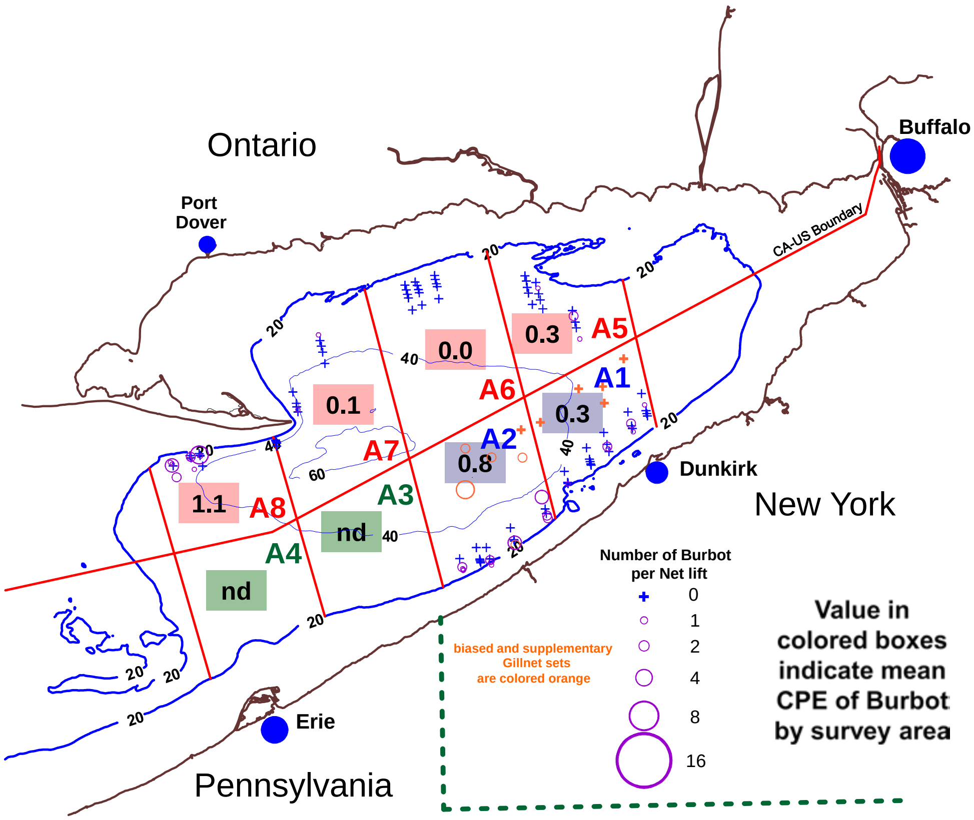

FIGURE 3.1 Distribution of eastern basin Burbot catches (Number per lift) in Ontario Partnership gill nets during August surveys of eastern Lake Erie, 1989 - 2014.

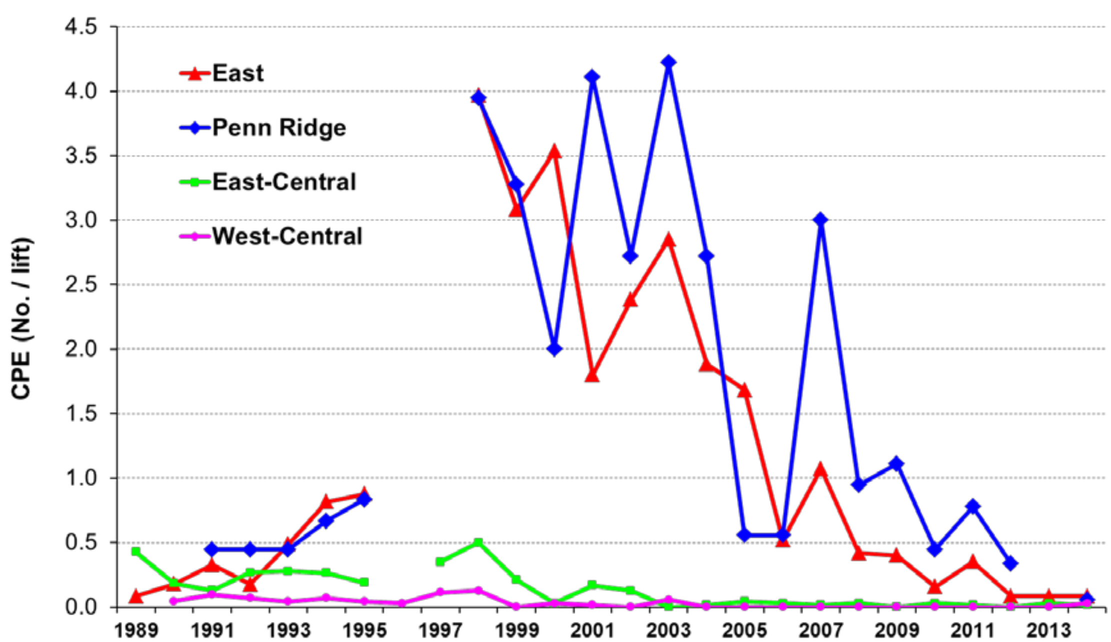

FIGURE 3.2 Burbot CPE (number per lift) by basin from the Ontario Partnership surveys 1989–2014 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets). Pennsylvania Ridge was not sampled in 2014.

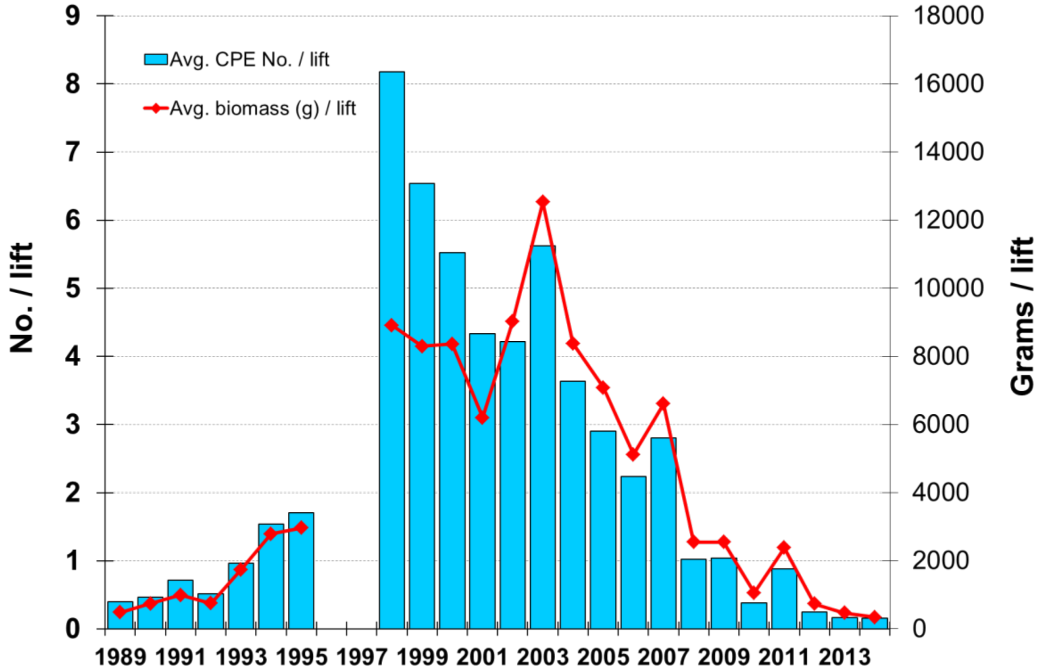

FIGURE 3.3. Average catch rate (CPE as number per lift) and biomass (grams per lift) of Burbot in Ontario waters of eastern Lake Erie, Ontario Partnership gill net survey 1989–2014 (includes only bottom sets, all mesh sizes; PA-ridge and eastern basin sample sites). Pennsylvania Ridge was not sampled in 2013.

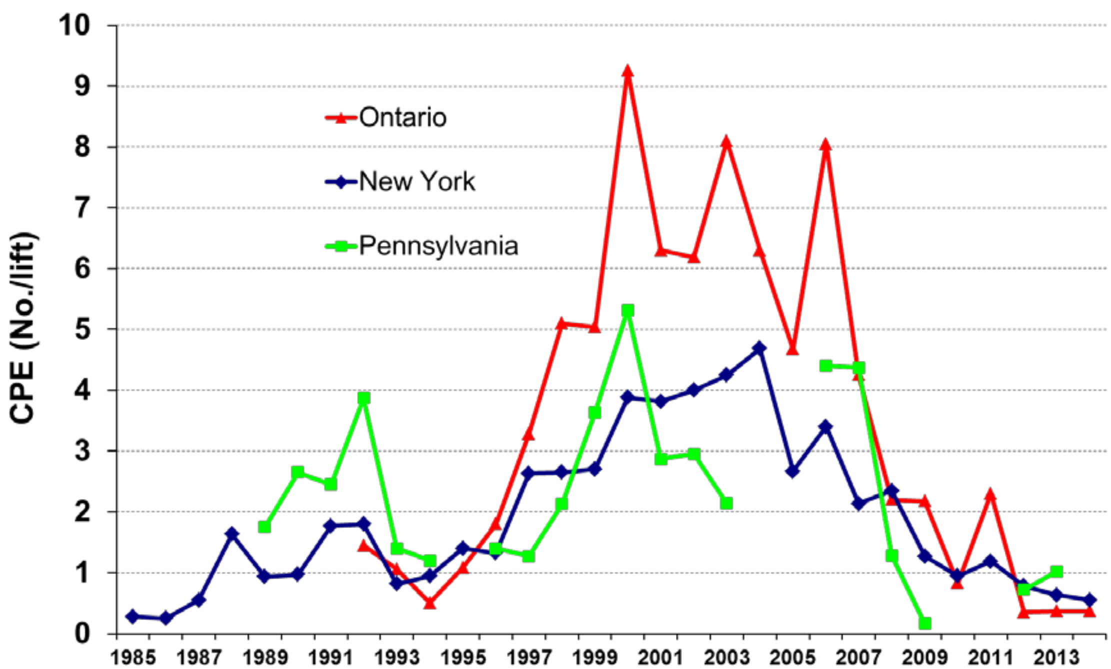

FIGURE 3.4 Average Burbot catch rate (number of fish/lift) from multi-agency summer Coldwater Assessment gill nets by jurisdiction in eastern Lake Erie, 1985-2014.

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 into the sub-6th percentile range of the respective time series (Figure 3.5). In Pennsylvania, the 2009 Burbot biomass estimate was the lowest in their time series; following two years of no assessment effort (in 2010, 2011), Burbot biomass decreased slightly to 2.4 and 3.0 kg/lift in 2012 and 2013, respectively. Pennsylvania was not surveyed in 2014.

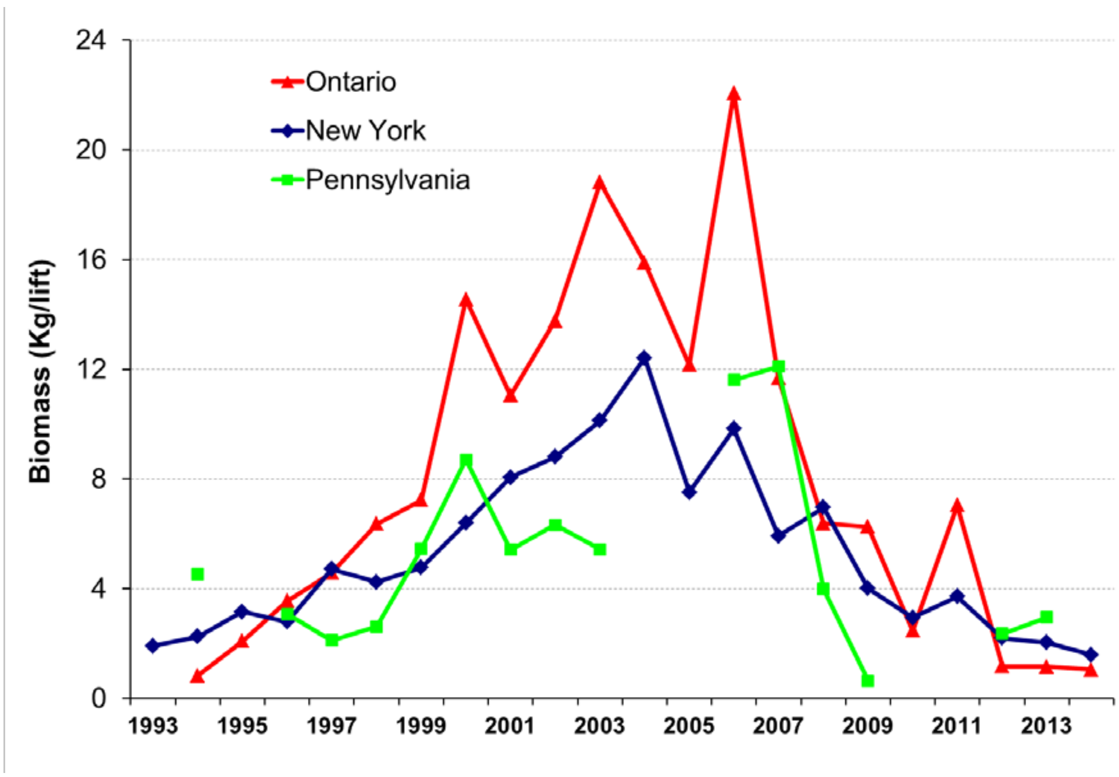

FIGURE 3.5 Average Burbot biomass (kg/lift) from summer multi-agency summer coldwater gill net assessment by jurisdiction, 1993-2014.

In a recent analysis applying GIS techniques to Burbot catches in the Ontario Partnership survey of eastern Lake Erie, Stapanian et al. (2013) found adult male Burbot were captured in greater numbers and over a greater area than adult females. The area of capture contracted by more than 60% for both sexes from 1994-2001 to 2007-2011, a period of documented Burbot population decrease. Median depth of Burbot distribution remained the same (at about 30 m) between sexes and across analysis periods. The overlap in capture areas of adult male and female Burbot decreased some 36% and 74% from 1994-2001 to 2002-2006 to 2007-2011, respectively.

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 Burbot catch ranged in age from 3 to 20 years in 2011, from 4 to 22 years in 2012, from 3 to 23 years in 2013, and from 1 to 21 years in 2014 (Figure 3.6). Burbot older than 12 years represented 74%, 54%, 61%, and 55% of the 2011, 2012, 2013, and 2014 aged fish. Mean age of Burbot (in Ontario) has increased since 1998; this trend reversed in 2014 with a 3-year decrease in mean age from 15.4 to 12.3 years (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 2014 (Figure 3.7). No age-4 Burbot were captured in 2014. A single yearling collected in New York and one two-year-old in Ontario provide the only evidence of recent-year recruitment by Burbot during

the 2014 coldwater index netting (Figure 3.6). OMNR also captured one age-0 Burbot at a nearshore index trawl station in Long Point Bay during September 2014 (L. D. Witzel, OMNRF-LEMU, pers. comm.). 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.

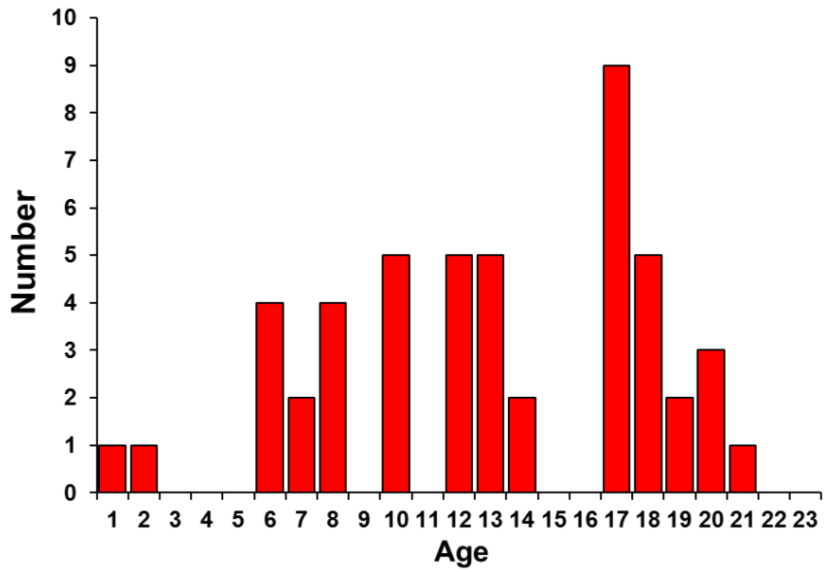

FIGURE 3.6. Age distribution of Burbot caught in multi-agency summer coldwater gill net assessment in eastern Lake Erie, 2014 (N=49).

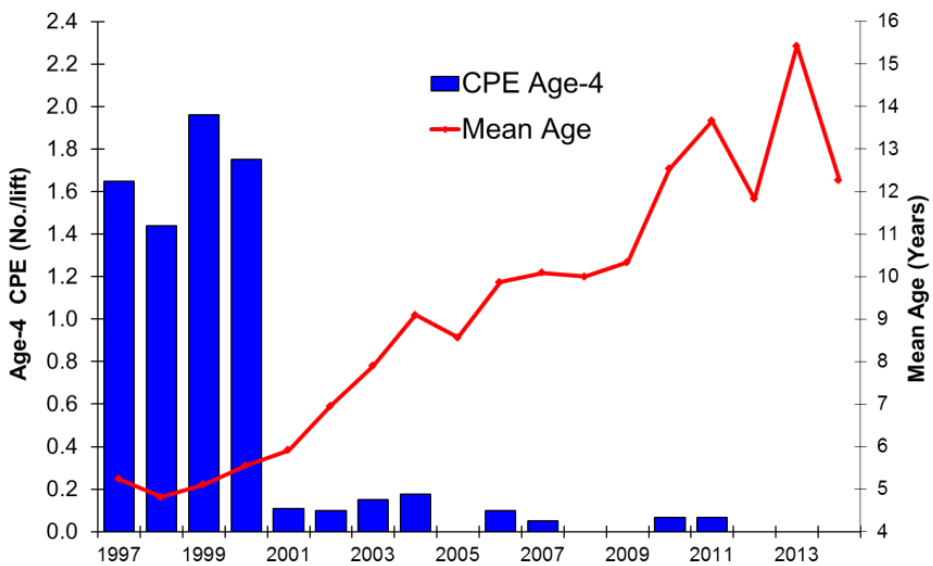

FIGURE 3.7. Mean age and average CPE of age-4 Burbot caught in multi-agency summer coldwater gill net assessment in Ontario waters of eastern Lake Erie during 1997-2014.

Growth

Mean total length of Burbot decreased in Ontario and New York in 2014, 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 second 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.

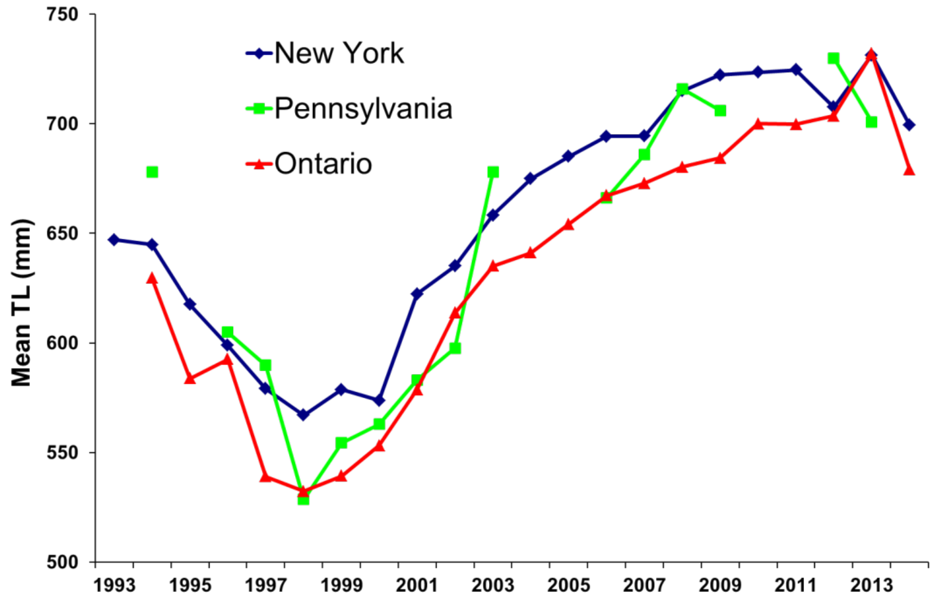

FIGURE 3.8 Average total length (TL, mm) of Burbot caught in multi-agency summer gill net assessments by jurisdiction in eastern Lake Erie during 1993-2014.

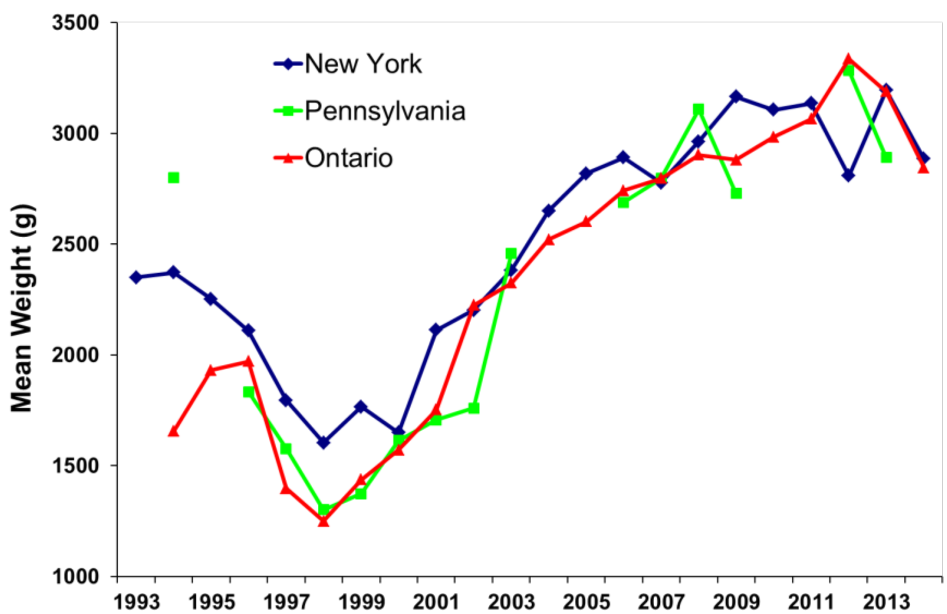

FIGURE 3.9 Average weight (g) of Burbot caught in multi-agency summer gill net assessments by jurisdiction in eastern Lake Erie during 1993-2014.

Diet

Diet information was limited to fish caught during August 2014 multi-agency coldwater assessment gill nets in the eastern basin of Lake Erie; no diet data were collected from the Ontario Partnership Index Fishing Program. Analysis of stomach contents revealed a diet made up mostly of fish, but with large unknown species content (Figure 3.10). Burbot diets continued to be diverse, with four different identifiable fish species found in stomach samples. Round Goby were the dominant prey item, occurring in 52% of the Burbot stomachs, followed by Rainbow Smelt (34% occurrence). Yellow perch and Trout-perch were found in 3.4% of non-empty Burbot stomachs, all from New York collections.

Round Gobies have increased in the diet of Burbot since they first appeared in the eastern basin in 1999 (Figure 3.11). They were the main diet item for Burbot in nine of the last 12 years. Smelt were the dominant prey in 2005, 2009 and again in 2012.

Preliminary analyses indicated that Burbot exhibited predatory control of Round Goby in deep water ($\geq$ 20 m) areas of the eastern basin (Madenjian et al. 2011). Further, 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.

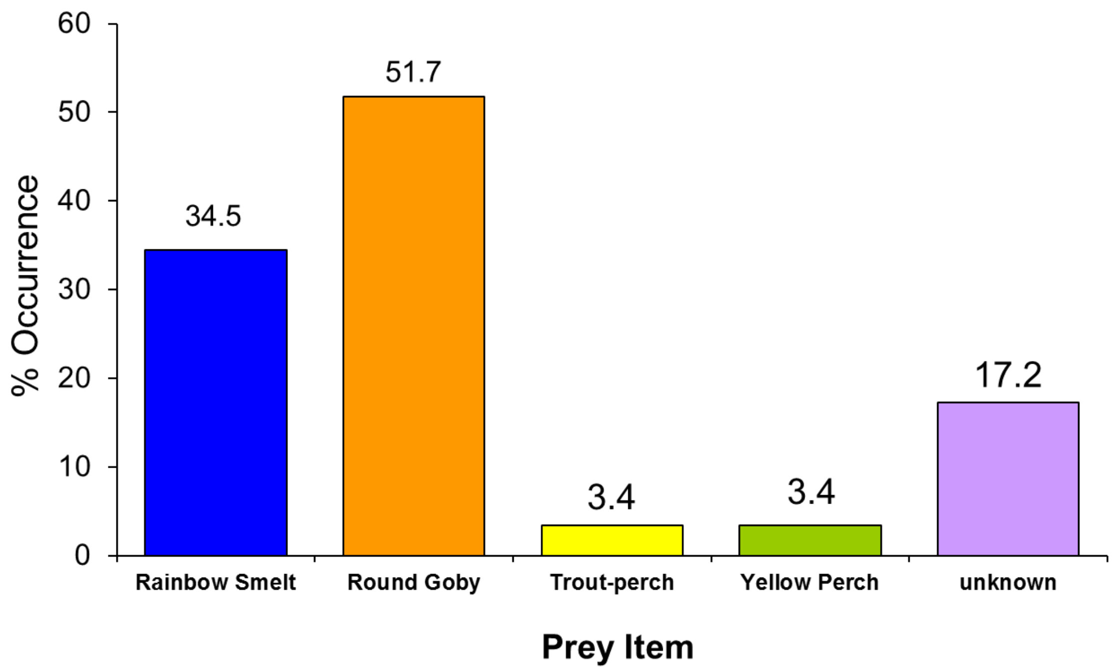

FIGURE 3.10. Frequency of occurrence of diet items from non-empty stomachs of Burbot sampled in multi-agency coldwater assessment gill nets from the eastern basin of Lake Erie, August 2014. Unknown includes fish remains that could not be identified to species (N=29).

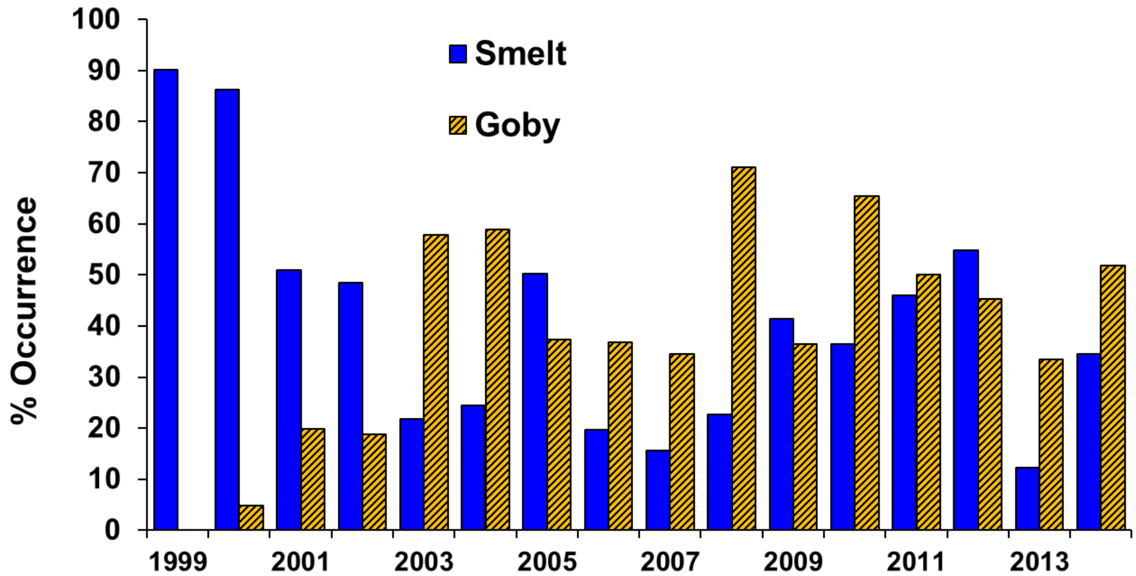

FIGURE 3.11. Frequency of occurrence of Rainbow Smelt and Round Goby in the diet of Burbot caught in summer multi-agency coldwater assessment gill nets in the eastern basin of Lake Erie, 1999-2014.

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

Tim Sullivan (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 152 A1-A3 wounds were found on 916 Lake Trout greater than 532 mm (21 inches) total length in 2014, equaling a wounding rate of 16.6 wounds per 100 fish (Table 4.1; Figure 4.1). This was a 16% increase from the 2013 wounding rate of 14.3 wounds per 100 fish and a 102% increase over the past three years. The current wounding rate is over three times the target rate of 5.0 wounds per 100 fish (Lake Trout Task Group 1985; Markham et al. 2008). Wounding rates have remained above target for 19 of the past 20 years. Large Lake Trout continue to be the preferred targets for Sea Lamprey; Lake Trout between 635 and 736 mm TL (25-29 inches) had the highest A1-A3 wounding rate (18.5 wounds/100 fish) and fish greater than 736 mm (29 inches) total length (TL) had the second highest wounding rate (15.1 wounds/100 fish; Table 4.1). Conversely, the 16 Lake Trout in the 432-532 mm (17-21 inch) size category did not have any wounds in 2014.

A1-A3 Wounding Rate on Lake Trout >532 mm

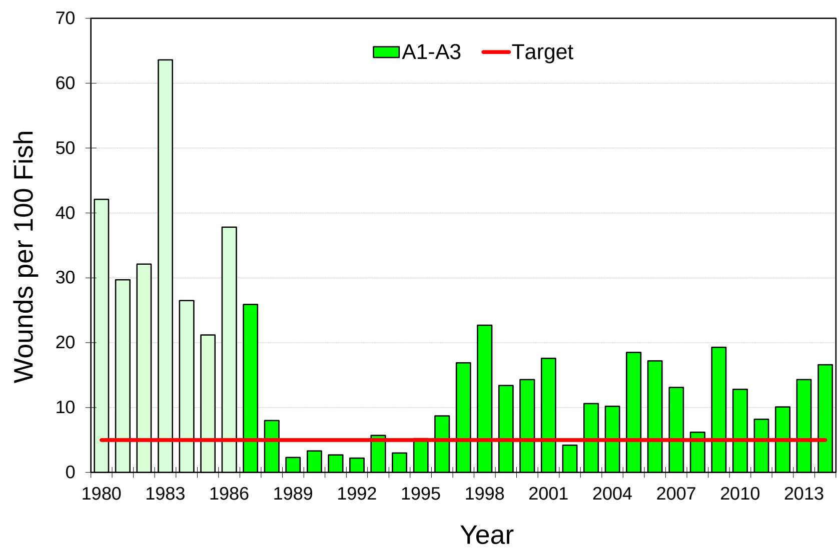

FIGURE 4.1. Number of fresh (A1-A3) Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2014. The target rate is 5 wounds per 100 fish. Lighter shading indicates pre-treatment years.

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 2014.

Size Class Total Length (mm)	Sample Size	Wound Classification A1	A2	A3	A4	No. A1-A3 Wounds Per 100 Fish	No. A4 Wounds Per 100 Fish
432-532	16	0	0	0	0	0.0	0.0
533-634	152	1	2	13	27	10.5	17.8
635-736	612	7	38	68	323	18.5	52.8
>736	152	1	6	16	192	15.1	126.3
>532	916	9	46	97	542	16.6	59.2

Fresh A1 wounds are considered indicators of the attack rate for the current year at the time of sampling (August). The A1 wounding rate in 2014 was 1.0 wounds per adult Lake Trout greater than 532 mm, which was the lowest A1 wounding rate since 2002 and below the series average of 2.0 wounds per 100 fish (Table 4.1; Figure 4.2). A total of 9 A1 wounds were spread across all size categories greater than 532 mm.

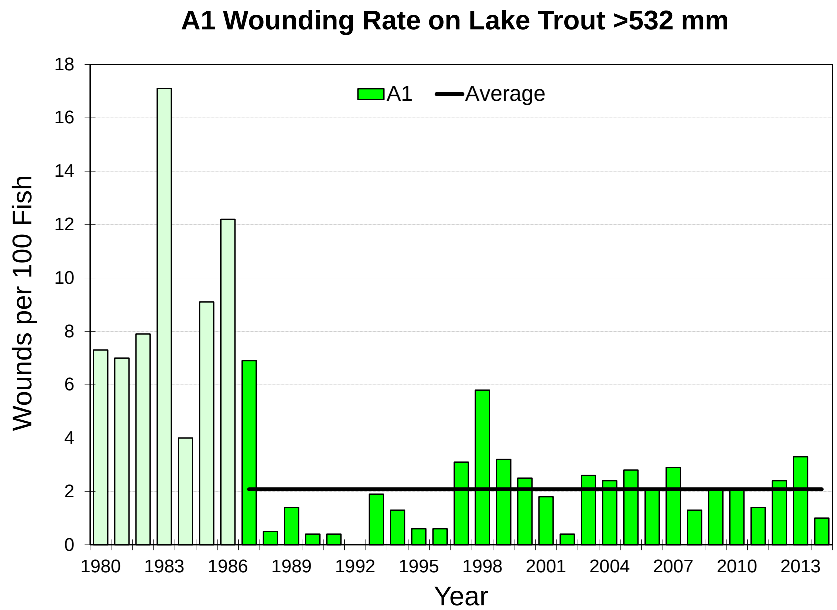

FIGURE 4.2. Number of A1 Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2014. The post-treatment average includes 1987-2013. Lighter shading indicates pre-treatment years.

The past year's cumulative attacks are indicated by A4 wounds. A4 wounding rates increased in 2014 to 59.2 wounds per 100 fish (Figure 4.3). This was second highest A4 wounding rate in the time series and well above average (26.8 wounds per 100 fish). Similar to previous years, A4 wounding rates increased with Lake Trout size; Lake Trout larger than 736 mm (29 inches) averaged more than one A4 wound per fish with many fish possessing multiple wounds (Table 4.1).

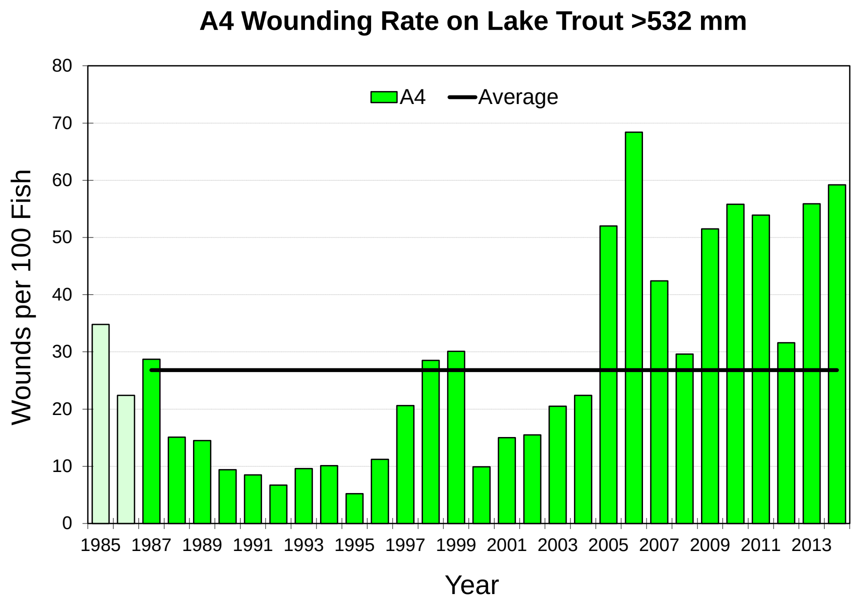

FIGURE 4.3. Number of A4 Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1985-2014. The post-treatment average includes 1987-2013. Lighter shading indicates pre-treatment years.

Finger Lakes (FL), Klondike (KL), and Lake Champlain (LC) strain Lake Trout were the most sampled strains, 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 three times as high on KL strain Lake Trout compared to FL strain Lake Trout, and nearly twice as high compared to LC strain Lake Trout. A4 wounds were the highest on FL strain fish. However, almost all Lake Trout >736 mm TL, which are the preferred prey size of Sea Lamprey, were FL strain fish. Lake Superior Lake Trout strains (Klondike (KL), Traverse Island (TI), Apostle Island (AI), Superior (SUP), Michipicoten (MIC)) 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 six 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 but are more susceptible to attacks than FL strain Lake Trout.

TABLE 4.2. Frequency of Sea Lamprey wounds observed on Lake Trout greater than 532 mm (21 inches), by strain, collected from assessment gill nets in the eastern basin of Lake Erie, August 2014. AI=Apostle Island, FL=Finger Lakes, KL=Klondike, LC=Lake Champlain, LL=Lewis Lake, SI = Slate Island, TI=Traverse 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	4	0	1	3	6	100.0	150.0
FL	215	1	11	10	198	10.2	92.1
KL	74	2	11	13	54	35.1	73.0
LC	493	6	21	56	216	16.8	43.8
LL	2	0	0	0	2	0.0	100.0
SI	13	0	0	0	2	0.0	15.4
TI	1	0	0	0	0	0.0	0.0

Burbot Wounding Rates

The Burbot population, once the most prevalent coldwater predator in the eastern basin of Lake Erie, has declined over 85% (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 4.4). Both A1-A3 and A4 wounding rates on Burbot were 3.6 wounds per 100 fish in 2014. This represented an increase in A1-A3 but a decrease in A4 wounding rates compared to 2013.

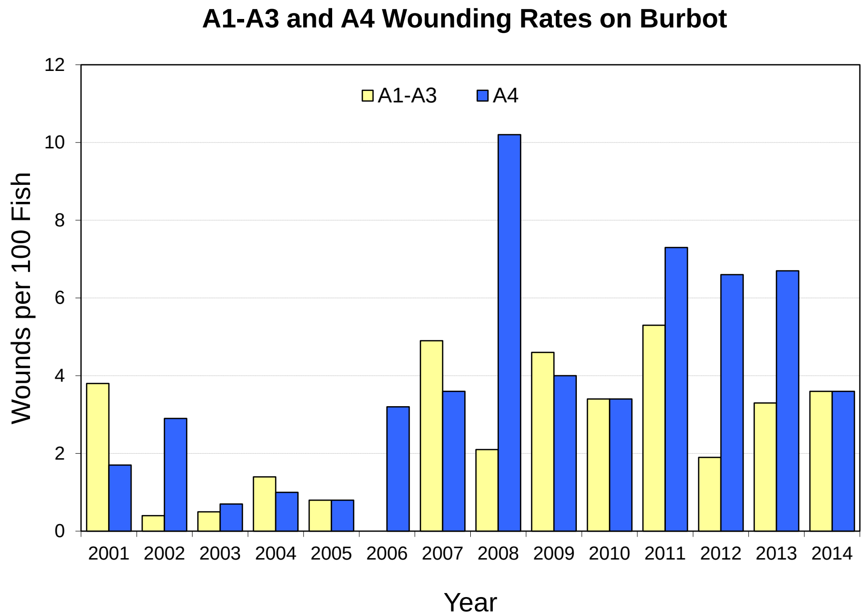

FIGURE 4.4. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Burbot (all sizes) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2014.

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). A total of 2 fresh (A1-A3) and 3 healed (A4) wounds were observed on 64 Lake Whitefish in 2014 assessment netting in New York, producing an A1-A3 wounding rate of 3.1 wounds/100 Whitefish and an A4 wounding rate of 4.7 wounds/100 fish (Figure 4.5). This was the highest A1-A3 wounding rate observed on Lake Whitefish in the series. A total of 411 commercially caught Lake Whitefish from the west basin were sampled in 2014, and only two wounds were found on these fish.

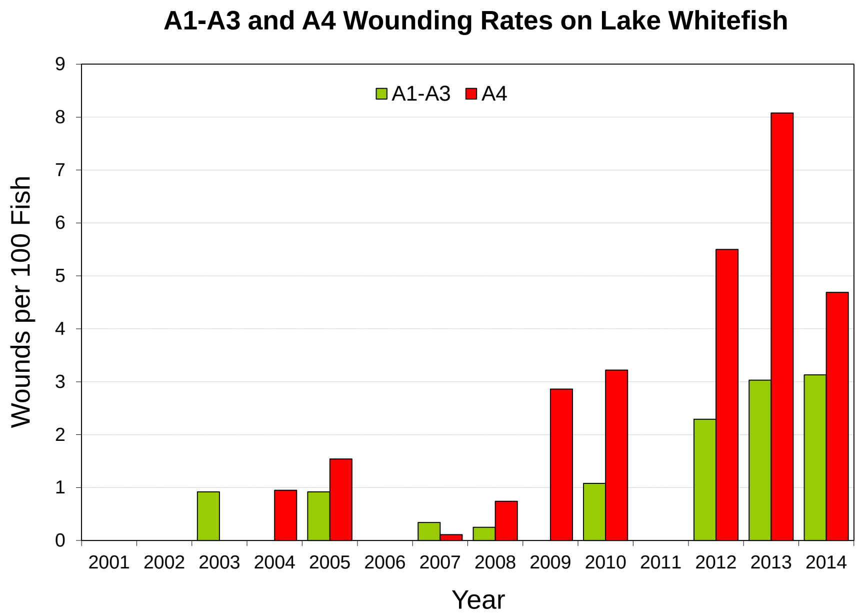

FIGURE 4.5. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Lake Whitefish (all sizes) sampled in assessment gill nets in the New York waters of Lake Erie, August, 2001-2013.

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.

TABLE 4.3. Frequency of Sea Lamprey wounds observed on Steelhead from various Lake Erie tributary surveys, 2003-2012.

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

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. Although Sea Lamprey wounds have been recorded on fish species since the survey began in 1989, detailed information on type and category of wound were not recorded until 2011.

A total of 25 Lake Trout were examined for wounds in 2015. The wounding rate (number of wounds on Lake Trout per 100 examined) of type A1-A3 was 9 for adult Lake Trout examined with total lengths greater than or equal to 532 mm (Figure 4.6). Slate Island strain Lake Trout had 13 A1-A3 wounds per 100 fish; and 38 scars per 100 fish. Of the 10 Lake Champlain strain Lake Trout caught, the A1-A3 wounding rate was10%, while the A4 wounding rate was 20%, and the scarring rate was 30%. One scar was observed on 3 Finger Lakes strain Lake Trout examined (33%), but none had wounds. One of the four Lake Trout lacking a coded wire tag had an A4 wound (25%). The majority (18) of the Lake Trout were found in eastern basin waters, with 6 in the Pennsylvania Ridge and 1 in the east-central basin. Sea Lamprey wounds were also recorded on other fish species including Smallmouth Bass, Walleye, Steelhead and Yellow Perch (Figure 4.6). Scars were also observed on Smallmouth Bass, Walleye and Channel Catfish.

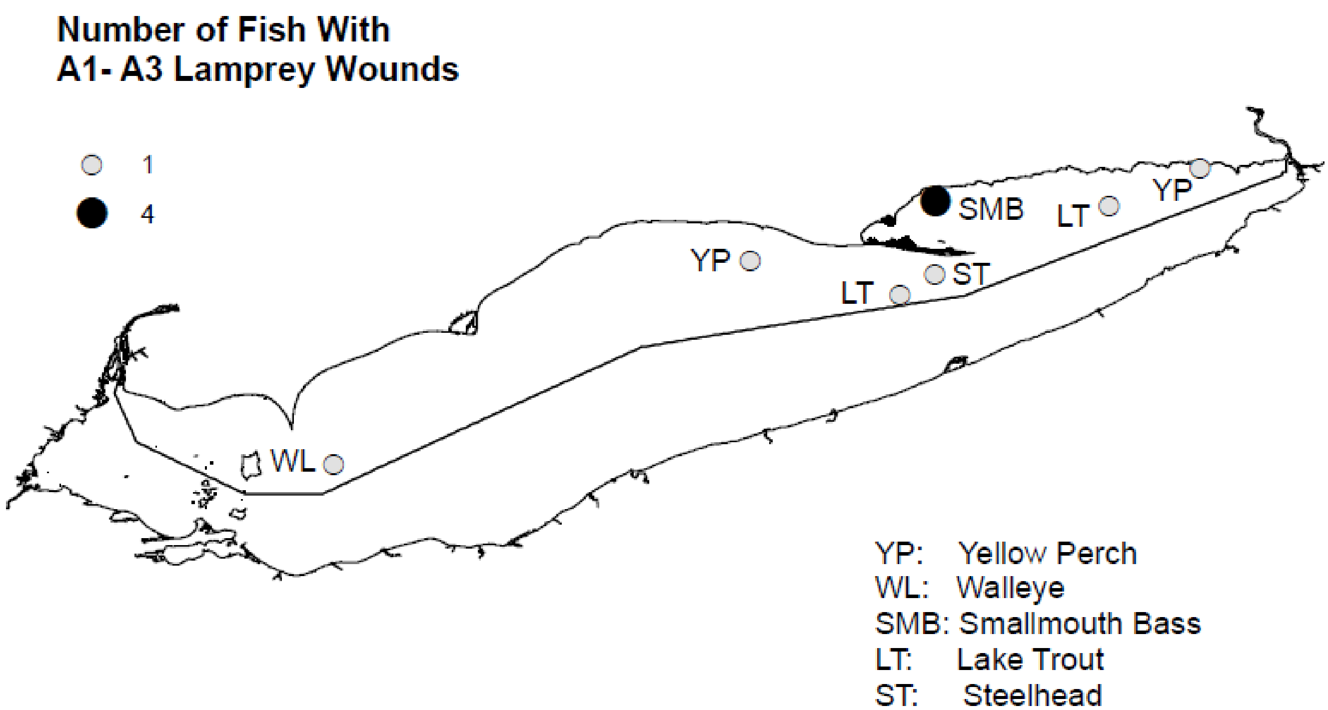

FIGURE 4.6. Number of fish with A1-A3 Sea Lamprey wounds during Partnership Index gillnetting, 2014. Includes all index and auxiliary gear.

2014 Sea Lamprey Control Actions

Lampricide Control

Lampricide applications were conducted in two Ontario streams (Table 4.4). North and South creeks; tributaries to Big Creek, were re-treated upstream of Lehman dam in 2014. Low flow conditions in 2013 resulted in an ineffective treatment. The upper portion of Spittler Creek; a tributary to Big Otter Creek, was treated in 2014. This section of stream was deferred to 2014 as insufficient discharge prevented treatment in 2013. Although it ranked for treatment based on presence of large Sea Lamprey larvae (≥100mm), the infested portion of upper Conneaut Creek was not treated in spring 2014 due to concerns over Hornyhead Chub (*Nocomis biguttatus*), a candidate species in the State of Pennsylvania. Approval has now been granted, and treatment is planned for 2015.

Assessment

Assessments were conducted to search for new populations of Sea Lamprey larvae or to monitor existing populations in 36 tributaries (21 U.S., 15 Canada) and one offshore lentic area (Appendix 4.1). A new population of large larval Sea Lamprey ammocoetes was found in Big Sister Creek, New York and is planned for treatment in 2015. Also, a total of 1.7 ha of the Niagara River was surveyed with granular Bayluscide (gB). Four larval Sea Lamprey were collected.

During the 2014 field season, 67 gB surveys covering 50,000m² were conducted in the upper and lower portions of the St. Clair River to supplement previous data and to fill spatial gaps where needed. Fifty five Sea Lamprey larvae were collected during these gB surveys. In addition, negotiation between the Great Lakes Fishery Commission secretariat and Walpole Island First Nation (WIFN) enabled intensive deep-water electrofishing (DWEF) to be completed at 733 sites in WIFN territorial waters to provide quantitative information on Sea Lamprey habitat availability and larval densities. Although the latter was the first of a two year assessment, favorable conditions and the availability of WIFN assistants resulted in a comprehensive look at production potential for most of the area. Seven Sea Lamprey larvae were collected during DWEF sampling. By combining the 2014 gB and DWEF surveys with previous results, the river-wide estimate of larval Sea Lamprey abundance is now 919,509.

A production potential study was completed on one tributary to Lake Erie; the Grand River, in Ontario. The investigation evaluated the production potential for Sea Lamprey upstream from a critical barrier by sampling habitat and native lamprey populations as a surrogate for Sea Lamprey. Results of the study are pending.

TABLE 4.4. Lake Erie lampricide treatments during 2014.

Tributary	Date	Distance Treated (km)
Canada		
Big Otter Creek (Spittler Creek)	May 30	13.5
Big Creek (North/South Creek)	June 1	6.5

Electrofishing and habitat surveys were conducted in the Grand River (Ohio) above Harpersfield Dam. These data were used to construct population and cost-estimate models for lampricide treatment of the upper river in the event that the Harpersfield Dam becomes ineffective at blocking adult Sea Lamprey migration.

A total of 5,816 adult Sea Lamprey were captured at 6 sites in 5 tributaries (2 U.S., 3 Canada); compared to 6,015 caught during 2013. The estimated number of adult sea lampreys in Lake Erie during 2014 was 14,577 (13,184-16,342; Figure 4.7), which was greater than the target range of 3,800 ± 1,200. The five-year average of adult sea lampreys is 19,054, which is greater than the target and demonstrates a positive slope.

All Sea Lamprey caught in adult assessment traps in Lake Erie tributaries were scanned for coded wire tags. Tags were collected from 10 lampreys (3 released in the St. Clair River, 7 released in Lake Erie tributaries). This work was part of the 2012 mark-recapture study that was conducted to 1) determine whether juveniles released in the St. Clair River can migrate successfully through the Huron-Erie Corridor (HEC) and survive to be recaptured in the eastern basin in Lake Erie and 2) compare recovery rates for juveniles released in the HEC and eastern Lake Erie tributaries. Analysis will occur during winter 2015.

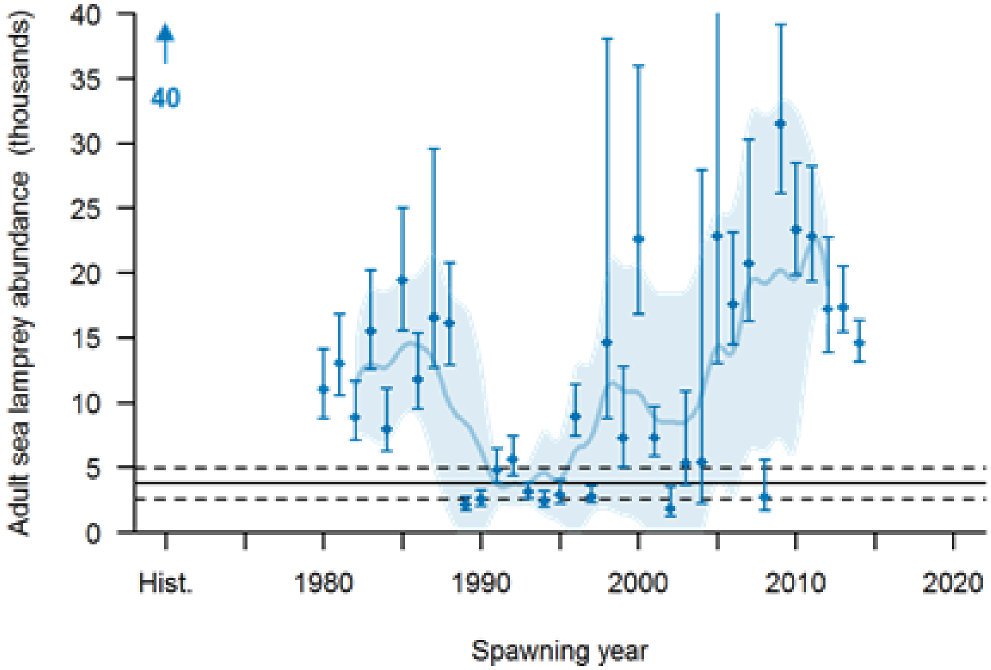

FIGURE 4.7. Abundance estimates with 95% CIs (vertical bars) of adult Sea Lamprey in Lake Erie, including historic pre-control abundance and the five-year moving average (line) with 95% CIs (shaded area). Target abundance and 95% CI range were estimated from abundances during a period with acceptable marking rates (horizontal solid and dashed lines).

Barriers

During 2014, field crews visited 116 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. Routine maintenance, spring start-up, and safety inspections were performed on all U.S. and Canadian barriers. Also, repairs were conducted on 2 barriers; Little Otter Creek and Youngs Creek.

Fish Community Assessment surveys were conducted on three tributaries to Lake Erie: Forestville, Normandale and Young's creeks. The purpose of this work was to evaluate the condition of fish communities within streams where purpose built Sea Lamprey barriers exist. Analysis of the results is pending.

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 the Grand River, Ohio. Project partners include the Great

Lakes Fishery Commission (GLFC), U.S. Fish and Wildlife Service (Service), Ohio Department of Natural Resources (ODNR), and Ashtabula County. The USACE developed several alternatives, including: status quo, rebuild onsite, or rebuild further downstream. The Corps selected an onsite rebuild as the preferred alternative and completed the Detailed Project Report, which was sent to the Corps District Headquarters for approval. A consultation to ensure blockage at a barrier was conducted with a partner agency for one site in one tributary (Table 4.5).

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

Mainstream	Tributary	Agency	Project	Sea Lamprey Control Position	Comments
Raisin R.		USFWS[1]	Sterling State Park Wetland Dike	Concur	Wetland improvement

[1]U.S. Fish and Wildlife Service, Fish and Wildlife Conservation Office (Alpena).

Risk Management

The Risk Management Team, USGS and Upper Midwest Environmental Sciences Center conducted field tests to determine the concentration of niclosamide (2', 5-dichloro-4'-nitrosalicylanilide) in sediment (sand and silt) and in the water column following the application of Bayluscide 3.2% granular Sea Lamprey larvicide to five 518 m^2 plots off the mouth of Hog Island Creek (Mackinaw County, Michigan) and one 518 m^2 plot off the mouth of the Peshtigo River (Marinette County, Wisconsin). Sample analysis is ongoing.

Toxicity tests were conducted on Conneaut Creek to determine the toxicity of TFM to the Hornyhead Chub (HHC; *Nocomis biguttatus*). The HHC is listed as endangered in the State of Pennsylvania and has only been found in the upper section of Conneaut Creek (Fish Creek Road to Porter Road) and a small tributary, Fish Creek. The tests show that HHC's are not sensitive to TFM at concentrations used to kill larval Sea Lamprey in streams. There was 100% survival (n=10) in Test 1 at concentrations up to 2.37x MLC (minimum lethal concentration) and 90% survival (n=10) in Test 2 at concentrations up to 2.46 X MLC. One HHC died in Test 2 in the tank with the highest TFM concentration (avg = 2.16x MLC). There was 100% survival in both tests at concentrations that would be used to kill larval Sea Lamprey.

2015 Sea Lamprey Control Plans

Lampricide Control

Lampricide applications are planned for 7 streams (6 U.S., 1 Canada), including; Canadaway, Conneaut, and Raccoon Creeks, and Paint (Clinton River), Cayuga (Buffalo River), and Big Sister creeks. The latter three of which will be first-time treatments (all U.S). Komoka Creek, a tributary to the Thames River and located near London, ON, is ranked to be treated in 2015 and will also be a first time treatment.

Assessment

Larval assessments are planned on 65 streams (36 U.S., 29 Canada)., and 2.4 hectares of gB assessment is planned on the St. Clair River, continuing to outline hotspot distributions, detect and to monitor abundance. DFO will continue to work in cooperation with WIFN to complete the second of a two-year assessment effort using DWEF and RoxAnn to quantify habitats and estimate the larval sea lamprey production in waters adjacent to WIFN. Additionally, 1.2 hectares of gB assessment is planned on the Detroit River to ensure the continuation of no larval Sea Lamprey production.

Adult assessments are planned on Big Otter, Big, Youngs, and Cattaraugus creeks and the Grand River (2 U.S., 3 Canada). Clear Creek will also be monitored with the assistance from the Seneca Nation.

Barriers

The Corps expects to begin the design phase of the Grand River (Ohio) barrier once the Detailed Project Report is approved and the Project Partnership Agreement is signed by all parties. Construction is targeted for 2016. Field crews plan to visit barrier sites on U.S. tributaries to perform barrier inspections and to ground truth the current barrier inventory data within the Barrier Inventory and Project Selection System (BIPSS) database, and the routine operation and maintenance of all Canadian barriers is planned. The retrofit of an existing railroad crossing bridge (Black Water Dam in Tillsonburg, Ontario) is a potential option to create a Sea Lamprey barrier for Big Otter Creek. The owner of the structure has been identified and discussions will be initiated in 2015.

Risk Management

Toxicity tests will be conducted in a portable bioassay trailer on the Grand River (Ohio) to determine the toxicity of TFM to Logperch (*Percina caprodes*). Logperch are the primary host of the federally endangered Snuffbox Mussel (*Epioblasma triquetra*). This work was scheduled for 2014, but high water levels in the Grand River precluded Logperch collection.

The Risk Management Team, USGS and Upper Midwest Environmental Sciences Center will conduct tests to determine the concentration of niclosamide (2', 5-dichloro-4'-nitrosalicylanilide) in sediment (sand and silt) and in the water column following the application of Bayluscide 3.2% granular Sea Lamprey larvicide in a lotic system (sites to be determined).

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 2014 and plans for 2015.

Stream	History	Surveyed in 2014	Survey Type[1]	Results	Plans for 2015
Canada					
St. Clair R.	Positive	Yes	Evaluation	Positive	Evaluation
Talford Cr.	Negative	Yes	Detection	Negative	
Thames R.	Positive	Yes	Evaluation	Positive	Evaluation
Belle R.	Negative	Yes	Detection	Negative	
Puce R.	Negative	Yes	Detection	Negative	
Pike R.	Negative	Yes	Detection	Negative	
Turkey R.	Negative	Yes	Detection	Negative	
Canard R.	Negative	Yes	Detection	Negative	
Detroit R.	Negative	Yes	Detection	Negative	
Cedar Cr.	Negative	Yes	Detection	Negative	
Detroit R.	Negative	No			Detection
Mill Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Sturgeon R.	Negative	No			Detection
East Two Cr.	Negative	No			Detection
Morden Drain	Negative	No			Detection
Sixteenmile Cr.	Negative	No			Detection
Ox Cr.	Negative	No			Detection
Brock Cr.	Negative	No			Detection
McKay Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Tyrconnell Cr.	Negative	No			Detection
Talbot Cr.	Negative	No			Detection
Kettle Cr.	Negative	No			Detection
East Cr.	Positive	No			Evaluation
Catfish Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Silver Cr.	Positive	Yes	Evaluation	Negative	
Big Otter Cr.	Positive	Yes	Treat-Eval	Negative	Evaluation
South Otter Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Clear Cr.	Positive	Yes	Evaluation	Negative	
Big Cr.	Positive	Yes	Treat-Eval	Positive	Distribution
Fishers Cr.	Positive	No			Evaluation
Forestville Cr.	Positive	Yes	Evaluation	Negative	
Normandale Cr.	Positive	Yes	Evaluation	Negative	
Youngs Cr.	Positive	Yes	Treat-Eval	Negative	Evaluation

Appendix 4.1. *continued*

Stream Canada *continued*	History	Surveyed In 2014	Survey Type[1]	Results	Plans for 2015
Hay Cr.	Negative	Yes	Detection	Negative	Detection
Nanticoke Cr.	Negative	Yes	Detection	Negative	
Sandusk Cr.	Negative	Yes	Detection	Negative	
Stoney Cr.	Negative	No			Detection
Evans Cr.	Negative	No			Detection
Grand R.	Negative	Yes	Detection	Negative	
Unnamed Cr.	Negative	No			Detection
Unnamed Cr.	Negative	No			Detection
Black Cr.	Negative	No			Detection
Welland R.	Negative	No			Detection
Stream United States	**History**	**Surveyed** **In 2014**	**Survey Type[1]**	**Results**	**Plans for 2015**
Niagara R.	Positive	Yes		Positive	
Buffalo R.	Positive	Yes	Eval/Treat-Eval	Positive	Treat-Eval
Rush Cr.	Negative	No			Detection
Eighteenmile Cr.	Negative	No			Detection
Big Sister Cr.	Negative	Yes	Detection/Dist	Positive	Treat-Eval
Delaware Cr.	Positive	Yes	Evaluation	Negative	Evaluation
Muddy Cr.	Negative	Yes	Detection	Negative	
Cattaraugus Cr.	Positive	Yes	Evaluation/Dist	Positive	Evaluation/Dist
Cattaraugus Cr. (estuary)	Positive	Yes	Evaluation	Negative	Evaluation
Silver Cr.	Negative	No			Detection
Halfway Br.	Positive	Yes	Evaluation	Negative	
Beaver Cr.	Negative	No			Detection
Canadaway Cr.	Positive	Yes	Evaluation/Dist	Positive	Evaluation
Walker Cr.	Negative	No			Detection
Chatauqua Cr.	Positive	No			Evaluation
Eightmile Cr.	Negative	No			Detection
Gannondale Academy Cr.	Negative	No			Detection
Crooked Cr.	Positive	Yes	Evaluation/Barrier	Positive	Evaluation
Racoon Cr. (PA)	Positive	Yes	Evaluation/Dist	Positive	Treat-Eval
Conneaut Cr.	Positive	Yes	Evaluation/Dist	Positive	Treat-Eval
Camp Luther Cr. #1	Unknown	Yes	Detection	Negative	
Camp Luther Cr. #2	Unknown	Yes	Detection	Negative	
Wheeler Cr.	Positive	No			Evaluation
Arcola Cr.	Negative	No			Detection
Township Park Cr.	Unknown	Yes	Detection	Negative	
Grand R. (OH)	Positive	Yes	Evaluation/Dist	Negative	Evaluation/Dist

Appendix 4.1. *continued*

Stream United States *continued*	History	Surveyed in 2014	Survey Type[1]	Results	Plans for 2015
Grand R. (OH)	Positive	Yes	Evaluation/Dist	Negative	Evaluation/Dist
Grand R. (OH) lentic	Negative	No			Evaluation
Chagrin R.	Positive	Yes	Evaluation/Dist	Negative	Evaluation/Dist
Euclid Cr.	Negative	No			Detection
Doan Br.	Unknown	Yes	Detection	Negative	
Beluah Beach Cr. #2	Negative	Yes			
Beluah Beach Cr. #3	Negative	Yes			
Cranberry Cr.	Negative	Yes			Detection
Anderson Cr. (Erie Co. OH)	Unknown	No			Detection
Huron R. (East & West Br.)	Negative	No			Detection
Sandusky R.	Negative	No			Detection
Sandusky R. (lentic)	Negative	No			Detection
Muddy Cr.	Negative	No			Detection
Portage R.	Negative	No			Detection
La Carpe Cr.	Unknown	No			Detection
Huron R. (Barrier)	Negative	No			Detection
Black R. (MI)	Positive	No			Evaluation/Dist
Mill Cr. (Black R.)	Positive	No			Evaluation/Dist
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	Eval/Dist/Barrier	Positive	Treat-Eval
St. Clair R.	Positive	Yes	Evaluation	Positive	Evaluation
Detroit R.	Negative	Yes	Detection	Negative	Detection

[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 instream 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, 230,080 yearling Lake Trout were stocked in Lake Erie in 2014, the fourth highest annual stocking effort since directed stocking efforts began in 1982, and that exceeds the current Lake Trout stocking goal of 200,000 yearlings (Figure 5.1). For the second consecutive year, Lake Trout stocking occurred in each of the Lake Erie basins: yearling Lake Trout were stocked in Ohio at both Catawba (40,894) and Fairport Harbor (40,148), in Pennsylvania at Northeast (52,715), and in New York offshore of Dunkirk (40,691). In addition, the Ontario Ministry of Natural Resources and Forestry stocked 55,632 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 99,100 fall fingerling Lake Trout (Finger Lakes strain) were stocked at Catawba (40,364), Fairport (40,179), and Northeast (18,557) in October 2014 as part of study to determine the best time to stock Lake Trout in the west basin of Lake Erie.

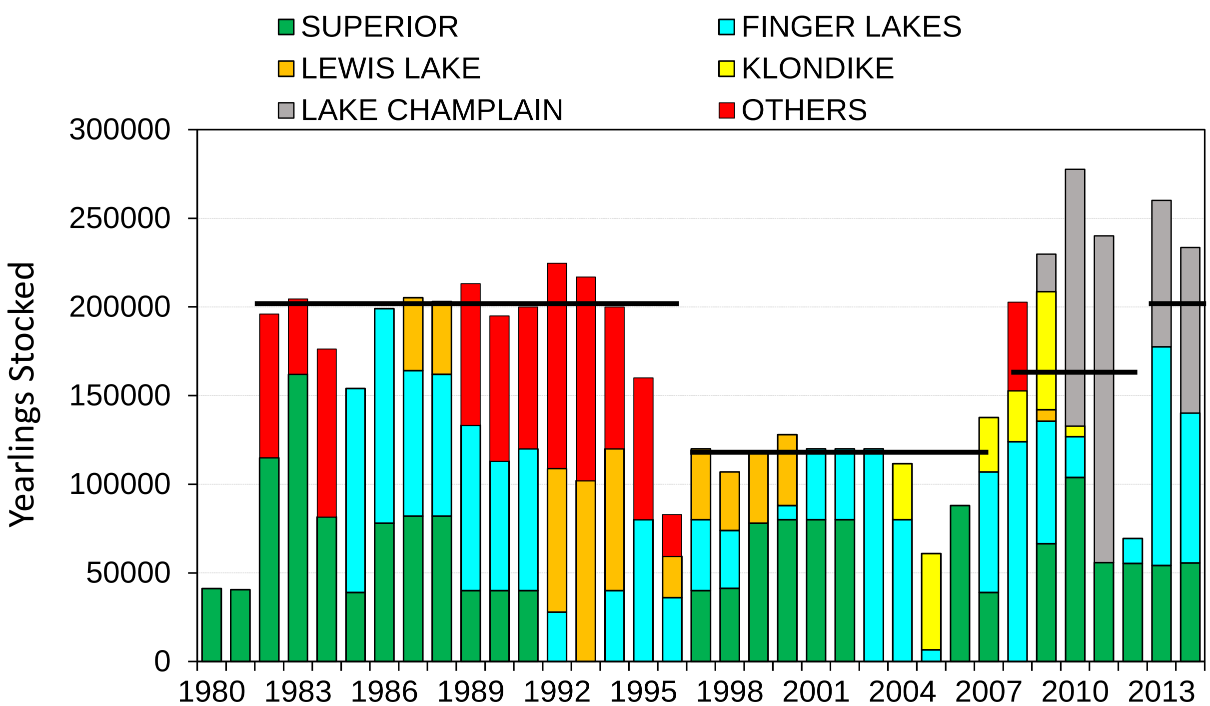

FIGURE 5.1. Lake Trout (in yearling equivalents) stocked by all jurisdictions in Lake Erie, 1980-2014, by strain. Stocking goals through time are shown by black lines dark lines; the current stocking goal is 200,000 yearlings per year. Superior includes Superior, Apostle Island, Traverse Island, Slate Island, and Michipocten strains; Others include Clearwater Lake, Lake Ontario, Lake Erie, and Lake Manitou strains.

Stocking of Other Salmonids

In 2014, over 2.2 million yearling trout were stocked in Lake Erie, including Rainbow/Steelhead Trout, Brown Trout and Lake Trout (Figure 5.2). Total salmonid stocking increased 2% from 2013, and 1% above the long-term average (1990-2013). 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 1,882,614 yearling

Rainbow/Steelhead Trout were stocked in 2014, accounting for 84% of all salmonids stocked. This was a 2% increase in Steelhead stocking from 2013 and 2% higher than the long-term (1990-2013) average of 1,850,204 yearling Steelhead. About 57% of all Steelhead stocking occurred in Pennsylvania waters, followed by 23% in Ohio waters and 14% in New York waters, 4% in Michigan waters and 3% in Ontario waters. Steelhead stocking increased significantly in Ontario, increasing from 2,000 yearling Rainbow Trout in 2013 to 56,700 in 2014, the highest since 2002. Steelhead stocking also increased 9% in Michigan waters. Steelhead stocking numbers remained stable in New York and Pennsylvania and declined about 9% in Ohio waters relative to 2013. A full account of Rainbow/Steelhead Trout stocked in Lake Erie by jurisdiction for 2014 can be found under Charge 6 of this report, which also provides details about the locations and strains of Steelhead/Rainbow Trout stocked across Lake Erie.

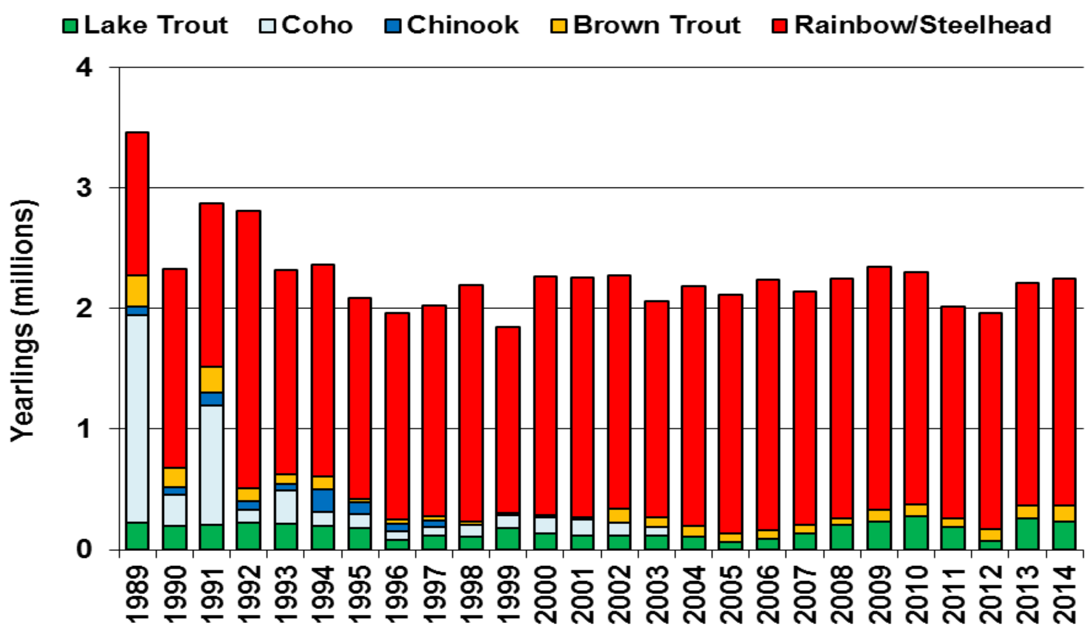

FIGURE 5.2. Annual stocking of all salmonid species (in yearling equivalents) in Lake Erie by all agencies, 1990-2014.

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 (~30% 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 136,479 yearlings in 2014. This was a 31% increase from 2013 and a 73% increase over the long-term (1990-2013) average annual stocking of 78,905 Brown Trout. Between 17 April and 1 May, 2014, the NYSDEC stocked 38,530 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 4 April and 5 May, 24,628 adult Brown Trout were stocked by the PFBC to provide catchable trout for the opening of the 2014 Pennsylvania trout season. Pennsylvania NGO's also stocked 68,988 yearling Brown Trout 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 NYDEC. Brown Trout stocking is expected to continue at the current rates for 2015 in both New York and Pennsylvania.

TABLE 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1990-2014.

	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**

TABLE 5.1. (Continued) Summary of salmonid stockings in number of yearling equivalents, 1990-2014.

	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
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**
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**

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), Kevin Kayle (ODW), and James Markham (NYSDEC)

Stocking

All Lake Erie jurisdictions stocked Steelhead or lake-run Rainbow Trout (hereafter Steelhead) in 2014 (Table 6.1). Based on these efforts, a total of 1,878,664 yearling Steelhead and 3,950 domestic strain Rainbow Trout were stocked in 2014, representing a 2% increase from 2013 and a 2% increase from the long-term (1990-2013) average. Nearly all of the Steelhead stocked in Lake Erie originated from naturalized Great Lakes strains. A Lake Erie strain accounted for 57% of the strain composition, followed by a Lake Michigan strain (26%) and a Lake Ontario strain (17%); 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.

TABLE 6.1. Steelhead stocked by jurisdiction and location for 2014.

Jurisdiction	Location	Strain	Number	Life Stage	Yearling Equivalents	
Michigan	Huron River	Manistee River, L. Michigan		Yearling	**67,800**	**Sub-Total**
Ontario	Mill Creek	Ganaraska River, L. Ontario		Adult	55,200	
	Lake Erie at Wheatley Harbour	Ganaraska River, L. Ontario		Adult	1,500	
					56,700	**Sub-Total**
Pennsylvania	Bear Creek	Trout Run, L. Erie		Yearling	18,000	
	Conneaut Creek	Trout Run, L. Erie		Yearling	75,333	
	Crooked Creek	Trout Run, L. Erie		Yearling	74,000	
	Elk Creek	Trout Run, L. Erie		Yearling	240,500	
	Fourmile Creek	Trout Run, L. Erie		Yearling	37,000	
	Godfrey Run	Trout Run, L. Erie		Yearling	18,500	
	Presque Isle Bay	Trout Run, L. Erie		Yearling	83,482	
	Raccoon Creek	Trout Run, L. Erie		Yearling	37,000	
	Sevenmile Creek	Trout Run, L. Erie		Yearling	37,000	
	Sixteenmile Creek	Trout Run, L. Erie		Yearling	18,500	
	Trout Run	Trout Run, L. Erie		Yearling	55,239	
	Twelvemile Creek	Trout Run, L. Erie		Yearling	37,000	
	Twentymile Creek	Trout Run, L. Erie		Yearling	111,000	
	Walnut Creek	Trout Run, L. Erie		Yearling	185,000	
	Lake Erie	Trout Run, L. Erie		Yearling	43,000	
					1,070,554	**Sub-Total**
Ohio	Chagrin River	Manistee River, L. Michigan		Yearling	90,063	
	Conneaut Creek	Manistee River, L. Michigan		Yearling	75,040	
	Grand River	Manistee River, L. Michigan		Yearling	108,316	
	Rocky River	Manistee River, L. Michigan		Yearling	100,074	
	Vermilion River	Manistee River, L. Michigan		Yearling	55,117	
					428,610	**Sub-Total**
New York	Bison City R&G Club	Domestics		Yearling	3,160	
	Erie Basin Marina	Domestics		Yearling	790	
	Eighteen Mile Creek	Washington		Yearling	20,000	
	Eighteen Mile Creek (South Branch)	Washington		Yearling	20,000	
	Buffalo Creek	Washington		Yearling	15,000	
	Buffalo River Net Pens	Washington		Yearling	10,000	
	Canadaway Creek	Washington		Yearling	20,000	
	Cattaraugus Creek	Washington		Yearling	90,000	
	Cayuga Creek	Washington		Yearling	10,000	
	Cazenovia Creek	Washington		Yearling	10,000	
	Chautauqua Creek	Washington		Yearling	40,000	
	Silver Creek	Washington		Yearling	10,000	
	Walnut Creek	Washington		Yearling	10,000	
					258,950	**Sub-Total**
					1,882,614	**Grand Total**

State fisheries management agencies are responsible for 94% of all Steelhead Trout stocking effort in Lake Erie. Approximately 6% of the Steelhead stocking is through sportsmen's organizations in Pennsylvania (61,232 yearlings) and Ontario (56,700 yearlings). Fisheries agency stocking of spring yearlings took place between 20 February and 8 May, with smolts averaging about 168 mm in length (Table 6.2). There were no fin clipped Steelhead stocked in 2014 (Table 6.3).

TABLE 6.2. Yearling Steelhead stocking summaries for 2014 by fisheries agency.

Agency	Range of Dates Stocked	mean length (mm)	N of yearlings stocked
Michigan Dept. of Natural Resources	21 April	193	67,800
New York Dept. of Environmental Conservation	17 April - 8 May	118	258,950
Ohio Division of Wildlife	7 April - 1 May	171	428,610
Pennsylvania Fish and Boat Commission	20 February - 22 April	177	1,070,554
			1,825,914

TABLE 6.3. Fin clips of Steelhead stocked in Lake Erie, 2000-2014.

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	-	-	-	-	-

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

NYSDEC Stocked Steelhead Emigration Study

A pilot study was conducted in Spring 2013 by the NYSDEC Lake Erie Unit to determine post-stocking emigration pattern of Steelhead and assess whether predation on newlystocked Steelhead was detectable in predator diets. The emigration portion of this study was continued in 2014. The study was conducted on two streams, Canadaway and Chautauqua Creeks. Electrofishing sites were established near the stocking location (upper) and near the creek mouth (lower) to monitor out-migration. A third (middle) sampling site was added in each stream in 2014. These sites were sampled once prior to stocking in April, and then at least once a week post-stocking through the end of May. Additional sampling occurred periodically thereafter until 1 August.

Our study indicates that a high percentage of the Steelhead smolts stocked into these two streams by the NYSDEC do not smolt and fail to emigrate from the stream to Lake Erie. Both survey years found many stocked steelhead remain in the streams through the end of May (5-6 weeks after stocking), and some fish remained present two months subsequent to the stocking date. Initial results from our survey also indicate that the threshold length for smolting may be closer to 140 mm than the 153 mm commonly mentioned in the literature for

minimum smolting size (Chrisp and Bjornn 1978; Bjornn et al. 1979; Seelbach 1987). Measures of individual fish lengths over the sampling period indicate that the majority of the steelhead larger than 140 mm emigrated from the upper sampling sites by 20 May 2014. In some instances, larger fish were observed at later sampling dates at either middle or lower sites prior to becoming absent from the samples entirely. Almost all the steelhead sampled at the upper sites in both streams after May 20, 2014, were less than 140 mm (Canadaway: 94% N=50; Chautauqua: 97% N=185).

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

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 2014 estimated Steelhead harvest from the summer open-water boat angler fishery totaled 10,652 fish across all agencies (Table 6.4) In US waters, Steelhead harvest totaled 6,487 Steelhead; a 25% decrease from the 2013 estimated harvest. The Ontario Ministry of Natural Resources and Forestry (OMNRF) also conducted a creel survey in 2014 and estimated the open-lake Steelhead Trout harvest at 4,165 fish. Harvests were down considerably in both US waters (-66%) and Canadian (-86%) waters compared to historical harvest levels. Pennsylvania harvest increased 86% from 2013, and Ohio harvest increased 5% from 2013. New York harvest fell 13% from 2013, and Michigan did not record any harvest from open lake boat anglers in 2014. Ontario had the greatest open lake harvest among all jurisdictions in 2014, but the total Steelhead Trout harvest of 4,165 in Canadian waters was down was significantly from the harvest levels seen in previous surveys (1999-2002, 2004). Among the US jurisdictions, over 83% of the reported harvest was concentrated in central basin waters of Ohio (47%) and Pennsylvania (36%). The west-central basin waters of Ohio accounted for 6% the harvest. The east basin accounted for 10% of the harvest, mostly in New York waters (6%). The eastern basin waters in Pennsylvania accounted for 3% of the open lake Steelhead harvest. A small amount (1%) of harvest was seen in the western basin waters in Ohio.

TABLE 6.4. Estimated harvest by open lake boat anglers in Lake Erie, 1999-2014.

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
1999-2013 mean	14,636	3,801	670	30,050	42	29,165

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

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 2013, the 2014 Steelhead harvest rates increased significantly in Ohio, doubled in Pennsylvania, and dropped by one-third in Ontario. Steelhead boat angler harvest rates in 2014 were highest in Ohio waters (0.22 Steelhead per angler hour; hereafter f/hr) followed by Pennsylvania waters (0.11 f/hr) and Ontario (0.04 f/hr). The combined harvest rate for 2014 across all reporting agencies (0.12 f/hr) was equal to the long-term interagency average (Figure 6.1)

The 2014 Ohio angler harvest rate of 0.22 f/hr ranked 4th in the 16-year time series (1999-2014) and was about 35% above the average 0.16 f/hr. Pennsylvania angler catch rate of 0.11 f/hr ranked 7th and was slightly below the average of 0.12 f/hr for that time series (1996-2014). The Steelhead Trout catch rate by Ontario anglers (areas combined) was 0.04 f/hr ranked 23 across a 25-year time series and was 34% below the long-term average (1990-2015) of 0.10 f/hr.

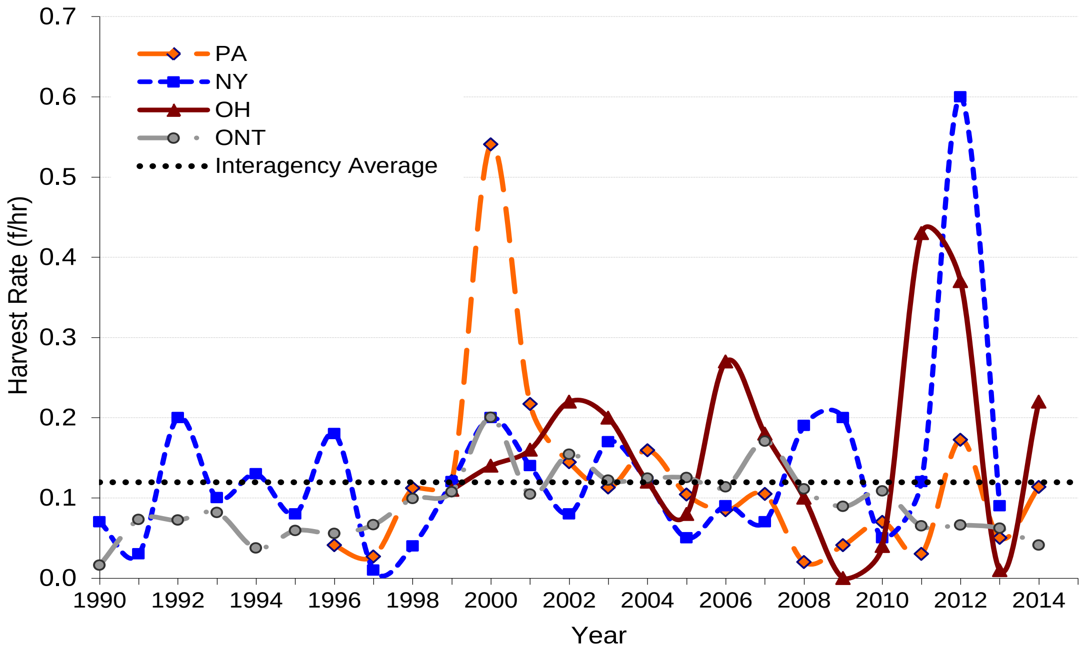

FIGURE 6.1. Targeted Steelhead harvest rates (fish/angler hr) in Lake Erie by open lake boat anglers in Ohio, Pennsylvania, New York, and Ontario, 1990-2014.

The OMNRF collected open water angler diary reports that can detail trends over time by area of the lake. In 2014, diarists reported 38 targeted Steelhead (Rainbow Trout) angler trips in west-central basin and 22 targeted trips in the east-central basin waters of Lake Erie. Only one trip targeting Steelhead was recorded through the diary program in the east basin for 2014.

Angler diary reports from Ontario in west-central basin waters show that rod-hours for Steelhead in 2014 declined 34% from 2013 and were 54% below the 24-year (1990-2013) mean. The 1,254 rod-hours reported by diarists in 2014 was the lowest since 1992 (Figure 6.2). Steelhead catch rates in the west central basin (0.03 fish per rod-hour) were 56% lower than 2013, and 79% lower than the long-term average of 0.142 f/rod-hr.

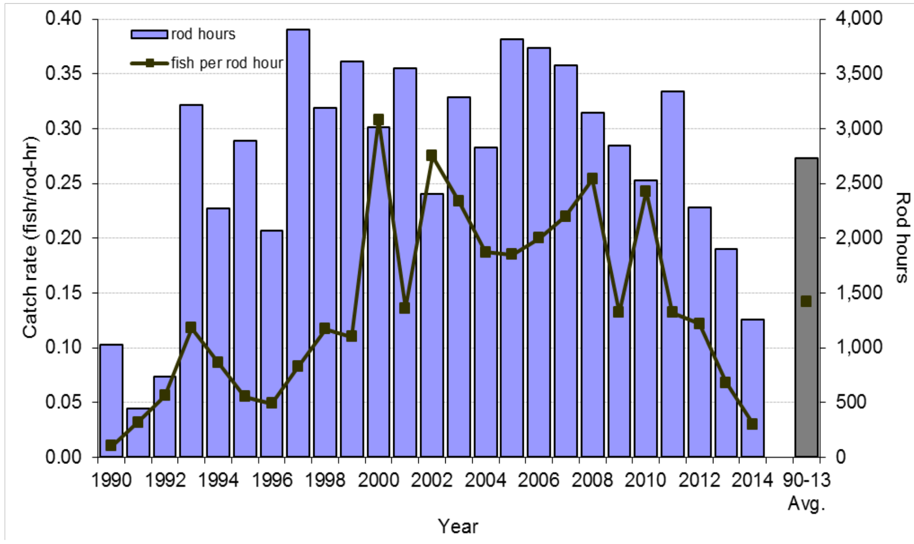

FIGURE 6.2. Targeted Steelhead effort and catch rates in Lake Erie's west-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2014.

The 593 rod-hours of effort recorded by anglers fishing the east-central basin for Steelhead was a significant decrease from 2013 (-51%) and the 24-year average of 1,451 rod-hours (Figure 6.3). The 2014 catch rate of 0.03 f/rod-hr was a 35% decline from 2013 and 59% below the long-term average (0.07 f/ rod-hr).

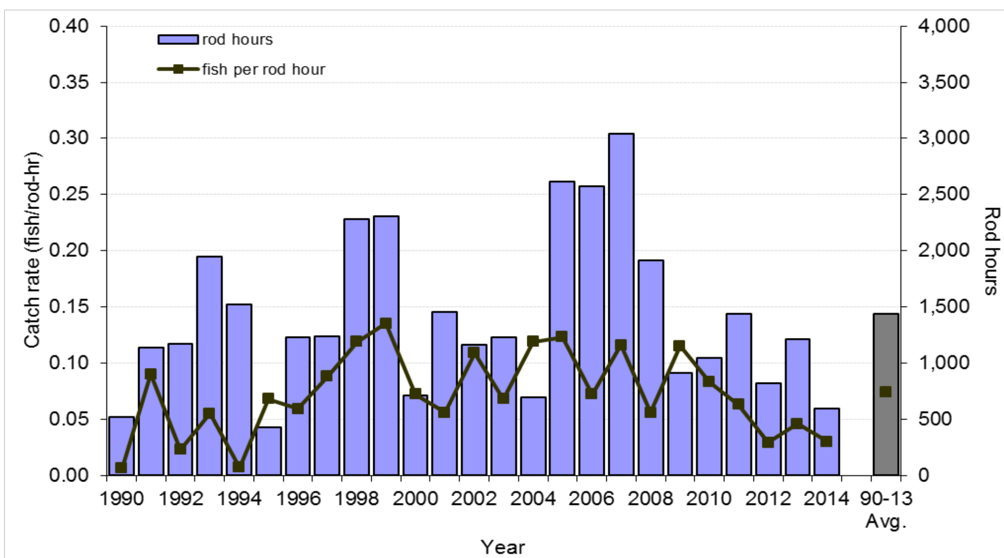

FIGURE 6.3. Targeted Steelhead effort and catch rates in Lake Erie's east-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2014.

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 6.6). 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 0.35-0.40 fish/hour.

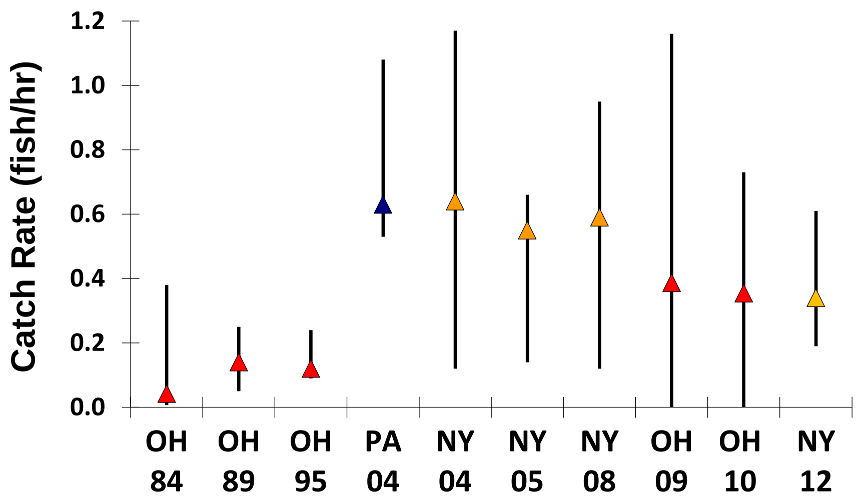

FIGURE 6.6. Targeted Steelhead catch rates (fish/angler hour) in Lake Erie tributary angler surveys by year and jurisdiction, 1984-2012.

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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, 2013 estimate of yearling-and-older Rainbow Smelt abundance is low (1,754/hectare) 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, 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, 2013).

Current Status of Cisco

Cisco observations have been documented in 16 of the last 20 years. Of the 37 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 Ciscoes have been caught in both trawl fisheries targeting Rainbow Smelt (13 observations), gillnets targeting Yellow Perch and to a lesser extent gillnets for White Bass and Lake Whitefish (22 observations combined). These captures have occurred in all months that commercial vessels operate (March through November). They have been captured in all lake basins; however, the highest number of occurrences (n=18) are associated with the tip of 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 2014, two Cisco were captured in the spring, at opposite ends of the lake, by commercial fisheries targeting Yellow Perch with small-mesh (2.25") gillnets; the first in the west central basin, near Erieau (April 25th) and the second in the east basin near Port Colborne (May 20th).

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 26-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 logistic and staffing limitations.

Concerted efforts to target Cisco have been few, and results are hit-and-miss. In the early 1990s, an OMNRF partnership with the Ontario Commercial Fisheries Association (OCFA) to test an experimental selective trawl gear, focused to reduce bycatch, near Long Point resulted in nine Cisco specimens. 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).

Collectively, all of this information suggests that the best approach to increasing observations/sample sizes 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. Recognizing the limitations to aging coregonid fishes using scales, otoliths from 14 of the most recent Cisco samples are currently (spring 2015) being used to derive alternative age estimates. Regardless, it is likely that these observations represent production in more than one year in the past decade. The outstanding question remains 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) coregonid 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.; Figure 7.1, Table 7.2). Two of those were verified as Cisco through genetic analysis. In December 2011, eight young coregonids (Figure 7.1, Table 7.2) 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 39 more 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.

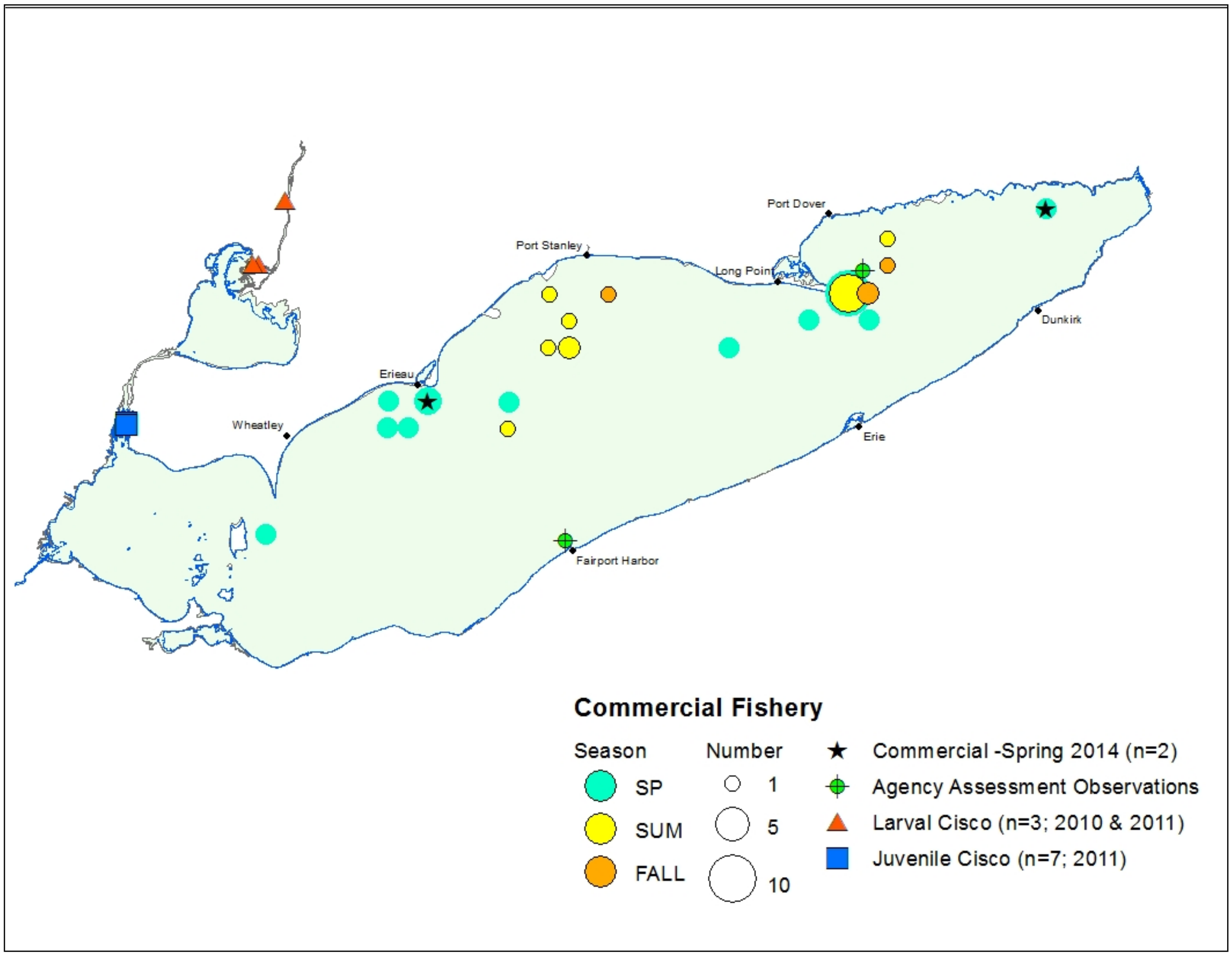

FIGURE 7.1. Cisco observations in Lake Erie and the Huron-Erie Corridor, 1995-2014. Relative abundance of adult specimens from the commercial fishery are indicated with proportionally sized circles. Color is used to indicate season of capture (SP-spring; SUM-summer and FALL). Locations of 2014 commercial observations are indicated by a star. Locations of larval and juvenile Cisco observations (USGS, USFWS) are indicated with triangles and squares. Locations of assessment survey observations are shown with a green symbol.

TABLE 7.1. Sampling details from Cisco captured during commercial (C) and assessment (A) fishing efforts, 1990-2014. Length = Total Length (mm); Sex = female (F); male (M) or unknown (U). Gear is described as gillnet (GN) or trawl (TR) and sample Source as agency (A) or commercial (C) fisheries

Year	Month	Length	Sex	Gear	Source	Target Species
1990*	September	260	F	GN	A	
1995	April	443	F	GN	C	Lake Whitefish
1996	April	371	F	GN	C	Lake Whitefish
1999	May	323	M	U	U	
1999	August	153	F	TR	C	Rainbow Smelt
1999	August	158	M	TR	C	Rainbow Smelt
1999	August	211	F	GN	C	Lake Whitefish
1999	Summer	156	F	U	U	
1999	September	140	M	TR	C	Rainbow Smelt
1999	September	U	F	TR	C	Rainbow Smelt
2000	September	238	F	GN	A	
2001	October	173	U	TR	C	Rainbow Smelt
2002	September	315	F	TR	C	Rainbow Smelt
2002	September	170	F	TR	C	Rainbow Smelt
2003	May	298	M	GN	C	White Bass
2003	June	341	F	GN	C	Yellow Perch
2003	July	301	U	GN	C	Yellow Perch
2003	August	278	F	GN	A	Coldwater species
2003	September	298	M	TR	C	Rainbow Smelt
2003	September	222	M	TR	C	Rainbow Smelt
2004	June	U	U	GN	U	
2005	June	U	F	GN	C	Yellow Perch
2005	August	U	F	GN	C	Walleye
2007	May	389	F	GN	C	Lake Whitefish
2007	May	333	F	GN	C	Yellow Perch
2008	March	464	M	GN	C	White Bass
2008	March	413	F	GN	C	White Bass
2010	April	438	F	GN	C	White Bass
2010	June	322	M	GN	C	Yellow Perch
2010	June	355	F	GN	C	Yellow Perch
2010	June	366	F	GN	C	Yellow Perch
2011	April	319	F	TR	C	Rainbow Smelt
2011	May	308	M	GN	C	Yellow Perch
2011	July	262	F	TR	C	Rainbow Smelt
2011	August	250	U	TR	C	Rainbow Smelt
2012	November	292	F	GN	C	Yellow Perch
2013	July	277	M	TR	C	Rainbow Smelt
2014	April	335	U	GN	C	Yellow Perch
2014	May	330	F	GN	C	Yellow Perch

***Report refers mainly to most recent 15 years, 1995-2014**

TABLE 7.2. Sampling details of larval and juvenile coregonids collected in the Huron Erie Corridor, 2010-2012.

DATE	LOCATION	SITE DESCRIPTION	SPECIES*	TOTAL LENGTH (mm)	GEAR
12/11	Detroit River	Livingstone Channel	Cisco	67	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Cisco	54	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Cisco	51	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Cisco	71	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Cisco	60	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Cisco	75	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Cisco	65	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Unidentified Coregonid	55	Surface Fyke Net
12/11	Detroit River	Livingstone Channel	Unidentified Coregonid	56	Surface Fyke Net
12/10/12	Detroit River	Livingstone Channel	Unidentified Coregonid	73	Surface Fyke Net
5/11/10	St. Clair River	just off Pine R., town of St. Clair	Cisco	12	500 micron mesh bongo net
5/12/10	St. Clair River	North Channel	Cisco	12	500 micron mesh bongo net
6/16/11	St. Clair River	North Channel	Unidentified Coregonid		500 micron mesh bongo net

*Species confirmed by genetic analysis (Wendylee Stott, USGS Great Lakes Science Center).

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.

A complete draft of this document was presented to the LEC during 2014 with comments received in 2015. Among the reviewer comments was a request to include more direction for the management decision process. An online survey was conducted to gather data on the severity of perceived impediments and the importance (and feasibility) of addressing them. Results from the survey will be included in the revised document and submitted to the LEC in spring 2015. In the interim, some of the proposed approaches within the document have been proactively acted upon.

Targeting Cisco in Fall at Potential Spawning Locations

The impediments document benefits from previous attempts to seek advice and experience developed on the Upper Great Lakes. For example, ongoing communications, following an expert advice conference call with external Cisco biologists in May 2011, have informed our expectations about drawing conclusions based on established Lake Erie fisheries surveys. These exchanges have highlighted the fact that current fisheries assessments may not be sufficient for detecting and assessing the presence

and abundance of Cisco. Based on assessments in the Upper Great Lakes, Cisco are most vulnerable when in spawning aggregations from mid-October through December in shallow areas (<10m) associated with historic Cisco and Lake Whitefish spawning. It was determined that many of the historical spawning sites for Cisco in Lake Erie, especially around the western basin islands, are not currently targeted by scientific monitoring or commercial fishing. Attempts by USGS-Lake Erie Biological Station to target these areas in 2011, 2013, and 2014 in late October and through November (historical early Cisco spawning period for Lake Erie) were unsuccessful at capturing Cisco. However, information gained is being used to refine the timing of the assessment. Lake Whitefish were not found in great numbers until late November, so future sampling should target late November through December (CWTG 2013). The 2014 USGS effort was greatly hindered by weather, which also affected the commercial Lake Whitefish fishery (see Charge 2; above), and highlighted limitations to this approach. The utility and logistics of this exercise will be discussed with implications for future surveys.

Efforts to document use of habitat by Lake Trout in late fall on the lake's north shore have provided additional insight into potential coregonid spawning locations in the eastern basin. Lake Whitefish in spawning condition have been observed on Nanticoke Shoal (Figure 7.1) in mid- to late- November in 2011, 2012, 2013, and 2014. In 2014, gillnetting on November 28 and 29 captured four spawning condition male Lake Whitefish at this location. Though not historically documented as a spawning area for Cisco, the presence of Lake Whitefish, and its proximity to the historic nursery habitat of Long Point Bay, makes this shoal a candidate for future assessments. Similar to the western basin surveys, weather continues to place restrictions on the extent of these late fall surveys.

Targeting Cisco in Fishery By-catch

In previous reports, the CWTG has noted Maumee Bay as a recognized Lake Whitefish spawning location routinely producing the highest catches in the Ohio commercial fishery (Charge 2). It may therefore be possible to seek cooperation from commercial fishermen to look for Cisco in their catches. Although not acted upon to date, plans to take this approach are being proposed. The value of surveying the commercial catch will be susceptible to the fishery; for example, weather in fall 2014 resulted in limited effort and low harvest (Charge 2).

The Ontario commercial trawl fishery, targeting Rainbow Smelt, is a recognized source of individual Cisco specimens from east central and eastern Lake Erie. In 2013 an onboard observer program, funded by the Canada-Ontario-Agreement, was conducted whereby biologists accompanied commercial trawlers, subsampled trawl catches, and recorded catches of non-target species. While a variety of bycatch species were observed, no additional Cisco were obtained using this approach. It was noted that this approach may be insufficient for rare species as, despite considerable effort, only 6-7% of total commercial trawl effort was observed. Of the 400,000 pounds of Rainbow Smelt harvest that was observed, only 4% was hand sorted. In 2014, an onboard observer program examining bycatch in the gillnet fisheries in the west and west central basins similarly examined only a small portion of the total gillnet effort and did not discover any Cisco specimens. OMNRF is additionally considering ways to actively solicit samples from the Ontario commercial fishery and will continue discussions with the Ontario Commercial Fisheries Association as to identifying the best approach. Using both targeted assessment and bycatch observation, we hope to both obtain additional samples for genetic analysis and improve our understanding of key locations for future fisheries and habitat assessment.

Ongoing Genetics Assessment Research Strategy

In an effort to determine if a remnant Cisco stock still exists in Lake Erie, nine recently (1990s) collected Cisco specimens from Lake Erie were shipped to the USGS Leetown Science Center, Northern Appalachian Research Laboratory for genetic analysis using microsatellite markers. Recent and museum specimen Cisco from Lake Erie and other Great Lakes, including archived Lake Erie specimens from 1955-1965, were compared to determine if the Lake Erie specimens are genetically distinct from other Great Lakes stocks (i.e., remnant population) or are strays from other populations. The results indicate that the recently caught Cisco are 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; Figure 7.2). The extant surviving Cisco that is most similar to the Lake Erie remnant is from Lake Huron.

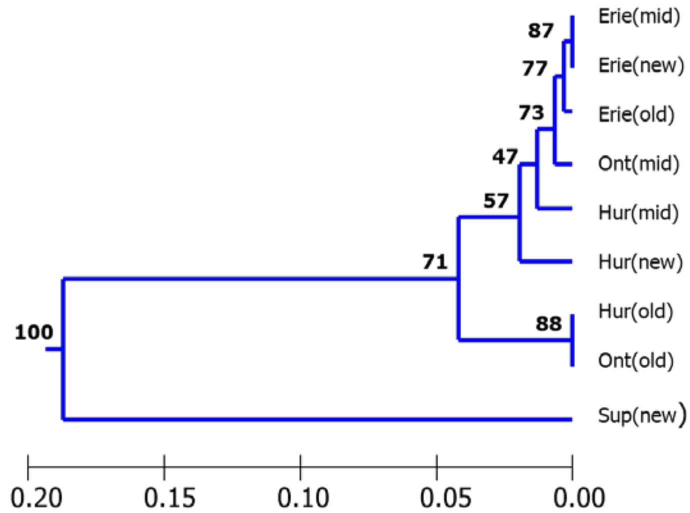

FIGURE 7.2. Tree diagram showing genetic distance of various Cisco populations (Nei's (1978) unbiased distance UPGMA). From Rocky Ward, unpublished data.

In order to further refine our understanding of genetic relationships among historic and contemporary Lake Erie and Lake Huron Cisco populations, Task Group members are working with Wendylee Stott (USGS Great Lakes Science Centre) to test the following hypotheses: i) Cisco from Lakes Huron and Erie existed as a single population, ii) recent Lake Erie observations represent a true remnant stock (see above), and iii) Lake Huron Cisco are suitable as a potential source of broodstock for stocking Lake Erie.

This genetic analysis will build on the previous examination (described above). It will utilize the previous samples and will greatly increase the sample size by incorporating tissue samples collected from the commercial fishery in the interim as well as DNA extracted from a large archive of historic scale samples.

During 2012 and 2013, preliminary work, 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 will be the comparative foundation from which questions regarding the origin of recently caught adult (L. Erie) and larval (HEC) Cisco can 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; A total of 27 current DNA samples (17 tissue and 10 scale) will be analyzed in 2015. Task group members and associated researchers continue to seek ways to fund the continuance of this approach to overcome an impediment to rehabilitation.

A new opportunity to explore historical stock structure in Lake Erie became available in 2014 when a cache of historical Cisco scale samples (N=1214) was located. These scale samples were collected at ports during 1949-1962; the last period of intense commercial Cisco fishing in Lake Erie. Sampling effort distribution and exact catch locations are unknown for these samples, and thus, should not be used to infer historical Cisco population distribution. However, they may be useful (condition dependent) for understanding genetic stock structure before the final Cisco population collapse.

Considerations Relevant to Stocking

In recognizing that stocking is one possible outcome of the management decision process, and realizing that a long lead time is necessary between the decision to stock and the first stocking event,

proactive disease testing of potential broodstock from viable sources has begun. Positive results for BKD from Lake Superior bloaters in 2005 have eliminated this lake as a potential source of Cisco broodstock gametes. Ciscoes collected from eastern Lake Ontario from November 2006 through 2009 were screened for various diseases by the NYSDEC Fish Disease Control Unit. Tests for VHS, IHN, IPN, BKD, heterosporis, and furunculosis were all negative for these fish. Negative results are required for three consecutive years before the collection of broodstock or gametes can be considered. There is a need to investigate the possibility of using Lake Huron or other systems as a source of broodstock. The CWTG continues to follow and learn from Bloater rehabilitation efforts at Lake Ontario to raise and introduce fish sourced from Lake Huron.

Proposed CWTG Activities for 2015

In 2015, the Coldwater Task Group members will finalize the draft impediments document based on LEC reviews and suggestions to produce a finalized report. Task Group members will work toward improved reporting from the Ontario Commercial Fisheries Association and other commercial fishing organizations. Pressing genetic questions will be asked using contemporary specimens. Historical samples will be included as necessary and feasible for meeting genetic delineation objectives as funding permits. Other impediments to be addressed will be prioritized, but will also be acted upon opportunistically as funding and logistic options present themselves. Future steps towards rehabilitation will be better directed by LEC input that is informed by the finalized impediments document.

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