REPORT OF THE LAKE ERIE COLDWATER TASK GROUP

28 March 2014

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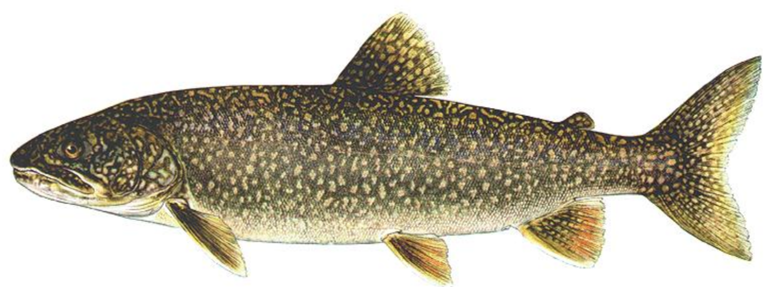
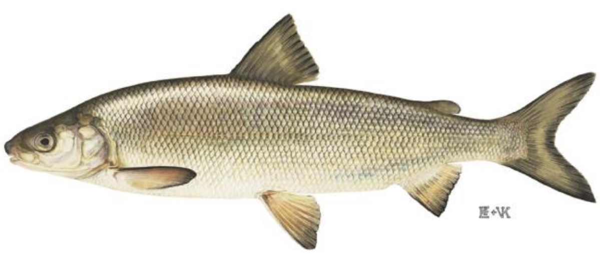
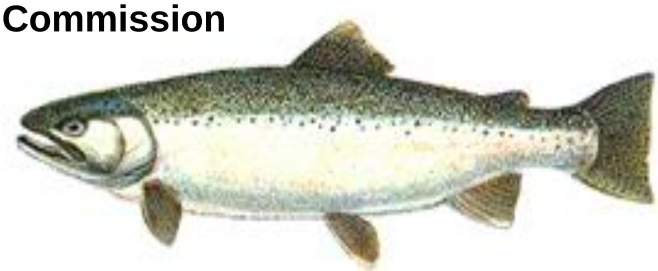




Presented to:

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

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Reporting of 2013 – 2014 Coldwater Task Group Charges

Background

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

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

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

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

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COLDWATER TASK GROUP EXECUTIVE SUMMARY REPORT MARCH 2014

Lake Erie Committee

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

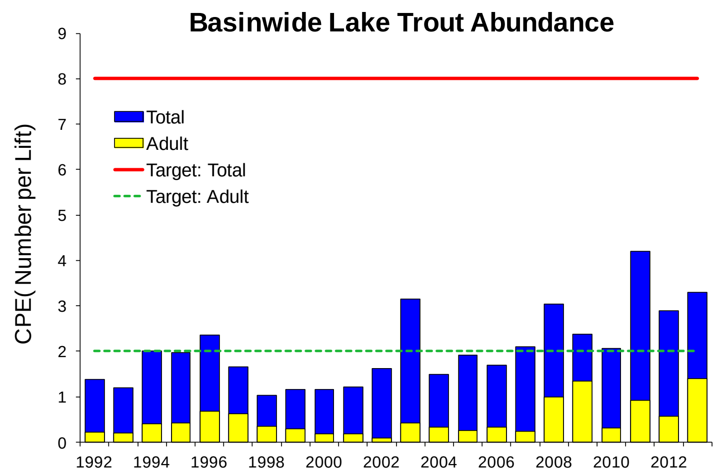
Introduction

This year's Lake Erie Committee (LEC) Coldwater Task Group (CWTG) has produced an Executive Summary Report encapsulating information from the CWTG annual report. 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, Standing Technical Committee (STC), or CWTG representative.

Seven charges were addressed by the CWTG during 2013-2014: (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, and (7) Development of a Cisco impediments document.

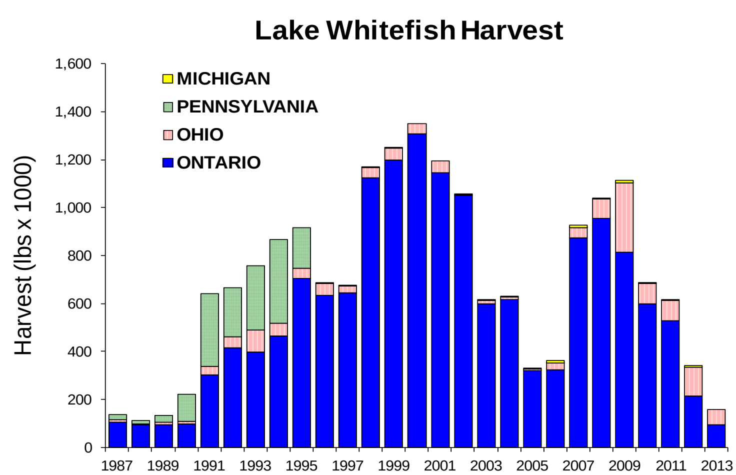
Lake Trout

A total of 720 Lake Trout were collected in 149 lifts across the eastern basin of Lake Erie in 2013. High Lake Trout catches were recorded in all jurisdictions relative to their time series. Young cohorts (ages 1-5) continue to dominate the catches with Lake Trout ages 10 and older only sporadically caught. Basin-wide Lake Trout abundance (weighted by area) was the second highest value in the time series, but remains well below the rehabilitation target of 8.0 fish/lift. Adult (ages 5+) abundance index increased in 2013 to a time series high but remains below target. Recent estimates indicate very low rates of adult survival. 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.



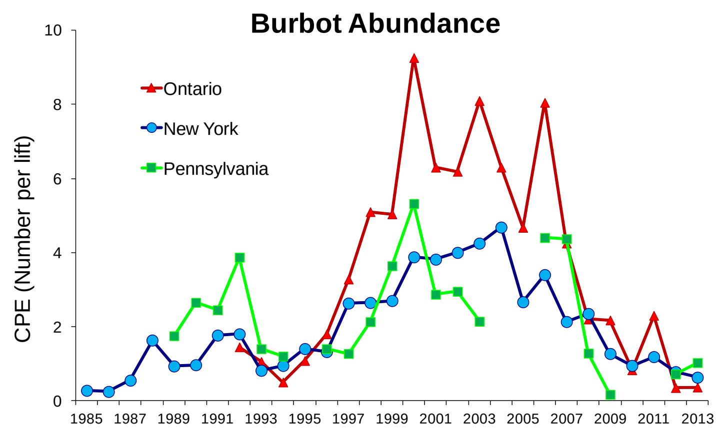
Lake Whitefish

Lake Whitefish harvest in 2013 was 157,919 pounds, distributed exclusively between Ontario (60%) and Ohio (40%). The harvest in 2013 was comparable to low levels observed during the 1980s before recovery. The 2003 year class (age 10) comprised the largest fraction of Lake Whitefish observed in fisheries and assessment surveys in 2013. Lake Whitefish sampled in fisheries and surveys ranged from ages 3 to 26, while young-of-the-year and yearling Lake Whitefish were present as by-catch in commercial trawls that seek Rainbow Smelt. Continued poor recruitment elevates the need for reduced fishing mortality and habitat improvement. Some indicators in 2013 suggest that mean condition factors of male and female Lake Whitefish have dropped below historic averages.

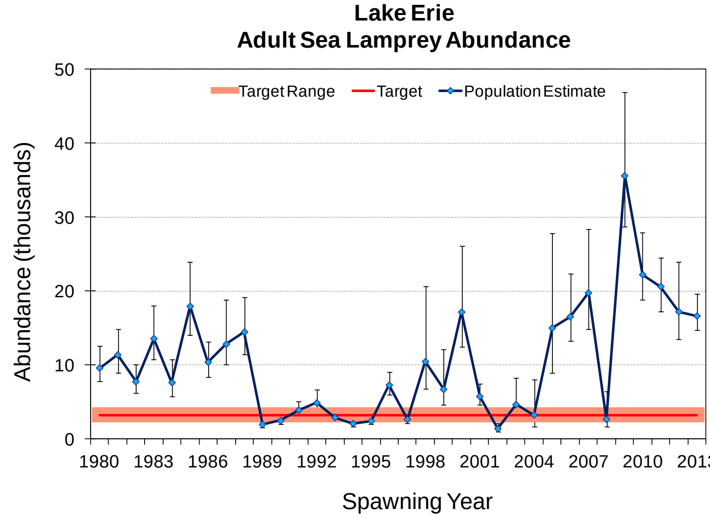


Burbot

Total commercial harvest of Burbot in Lake Erie during 2013 was 1,285 pounds, a 2% decrease from 2012. Burbot abundance and biomass indices from annual coldwater gillnet assessments decreased (NY) or remained at a low level (ON & PA) in 2013, continuing a downward trend since the early- to mid-2000s across east basin areas. Agency catch rates during 2013 averaged 0.36 (Ontario) to 1.03 (Pennsylvania) Burbot per lift, which are about 20 to 3 times lower than mean catch rates observed during 2000-2004, respectively. The Burbot catch ranged in age from 3 to 23 years and 61% were age 13 and older in 2013. Ongoing low catch rates of Burbot in assessment surveys, combined with increasing mean age of adults and persistently low recruitment, signal continuing troubles for this population.

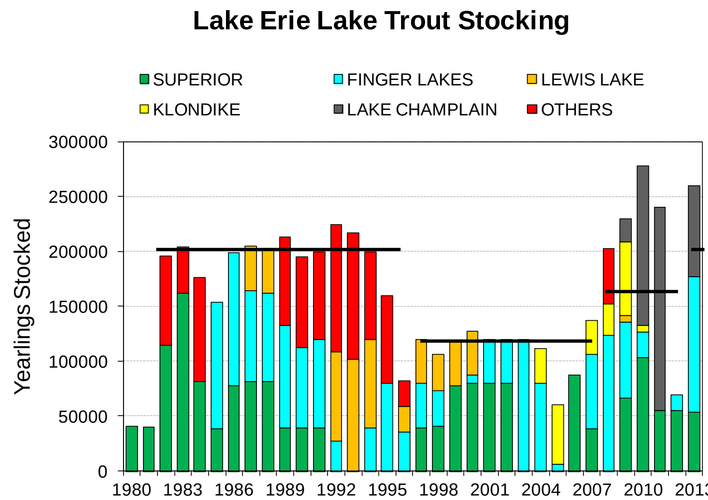


Sea Lamprey



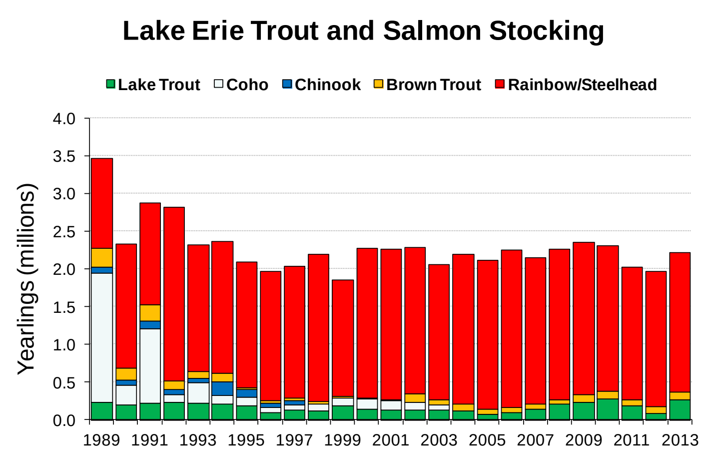
The A1-A3 wounding rate on Lake Trout over 532 mm was 14.3 wounds per 100 fish in 2013. This was a 42% increase from the 2012 wounding rate and a 73% increase over the past two years. The 2013 wounding rate is nearly three times the target rate of five wounds per 100 fish; wounding rates have been above target for 18 of the past 19 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 (164 wounds/100 fish). The estimated number of spawning adult Sea Lamprey (16,641) was similar to the previous year; the five-year average is 22,252, which is nearly seven times the target population. Comprehensive stream evaluations continued in 2013, including extensive surveys of Lake St. Clair and the Detroit River, to determine the source of the Lake Erie population. A mark-recapture study initiated in 2012 will determine if juveniles can successfully migrate through Lake St. Clair into Lake Erie, and quantify the relative contribution of St. Clair River Sea Lamprey to the Lake Erie adult population.

Lake Erie Salmonid Stocking



A total of 2,216,644 salmonids were stocked in Lake Erie in 2013. This was a 13% increase in the number of yearling salmonids stocked compared to 2012, but was 3% below the long-term average. Increases were primarily from Lake Trout, which had reduced stocking in 2012, and Steelhead. By species, there were 260,040 yearling Lake Trout stocked in all three basins of Lake Erie; 104,116 Brown Trout stocked in New York and Pennsylvania waters, 5,000 domestic Rainbow Trout stocked in New York, and 1,847,488 Steelhead stocked across all five jurisdictional waters.

Steelhead



All agencies stocked yearling Steelhead in 2013. The summary of Steelhead stocking in Lake Erie by jurisdictional waters for 2013 is: Pennsylvania (1,072,410; 58%), Ohio (455,678; 25%), New York (255,000; 14%), Michigan (62,400; 3%) and Ontario (2,000; <1%). Steelhead stocking in 2013 (1.847 million) represented a 4% increase from 2012 and was near the long-term average. Annual stocking numbers have been consistently in the 1.7-2.0 million fish range since 1993. The summer open lake fishery for Steelhead was again evaluated by U.S. agencies. Open lake harvest was estimated at 5,247 Steelhead: Ohio, 3,337; Pennsylvania, 1,375; New York, 482; and Michigan, 53. Overall, this harvest was a 48% decrease from the 2012 harvest and 82% below the average harvest from 1999-2012. No creel surveys took place in Ontario in 2013; data describing the open lake Steelhead fishery is limited to diary reports. Based upon creel surveys, the majority (>90%) of the fishery effort targeting Steelhead occurs in the tributaries from fall through spring. Catch rates by tributary anglers in the New York cooperative diary program increased to 0.85 fish/hour in 2013, but in a general New York tributary angler survey conducted in 2012 the overall catch rate was 0.35 fish/hour.

Cisco

Cisco, considered extirpated in Lake Erie, have been reported in small numbers (1-6) in 11 of the past 15 years by Ontario commercial fishers; one age-5 Cisco was captured in 2013. None were captured in 2013 in assessment gear. Preparation of a Cisco management plan began in fall 2007; however, after several drafts, the exercise has stalled due to several key outstanding issues – mainly if a remnant stock still exists in Lake Erie, the abundance of the current population, and if and how to proceed with stocking – that remain unresolved. With these uncertainties, the task group was unable to define a plan to re-establish Cisco in Lake Erie. Within review of the management plan, it was decided that the current plan be reworked into an Impediments Document and presented to the LEC so these issues can be resolved.

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, OMNR, 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/OMNR A5 through A8.

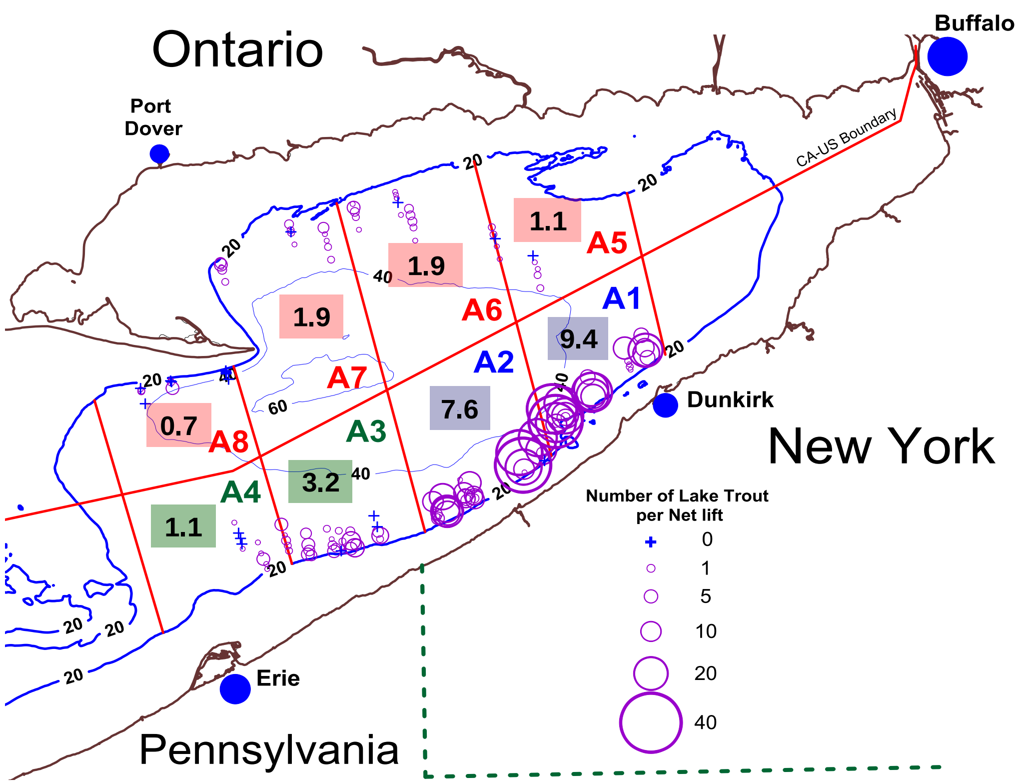


FIGURE 1.1. Standard sampling areas (A1-A8) used for assessment of Lake Trout in the eastern basin of Lake Erie, 2013, and catch per effort of Lake Trout in each area. Circles represent the number of Lake Trout per net lift.

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.

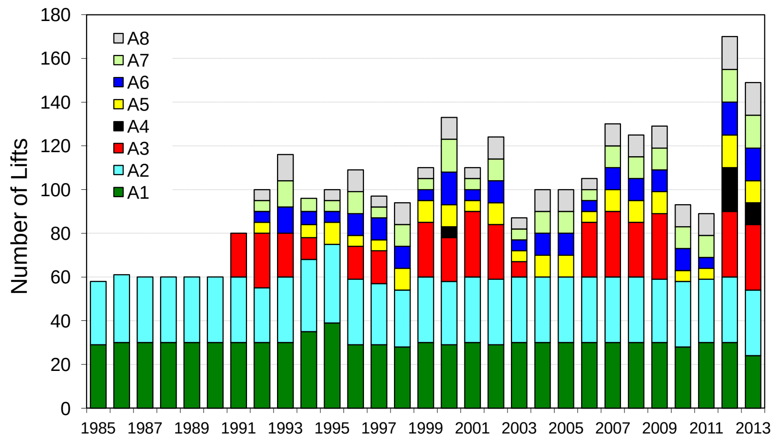


FIGURE 1.2. Number of unbiased coldwater assessment gill net lifts by area in the eastern basin of Lake Erie, 1985-2013.

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 (OMNR) began coordinating with USGS in 1998 to complete standard assessments in Canadian waters. Total effort for 2013 by the combined agencies was 149 unbiased standard Lake Trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 54 lifts by the NYSDEC, 40 lifts by the PFBC, and 55 by USGS/ OMNR. This was the second highest total effort since combined agency assessments began in 1992.

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

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

Results and Discussion

Abundance

Sampling was conducted in all eight of the standard areas in 2013 (Figure 1.1), collecting a total of 720 Lake Trout in 149 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 23 were captured in 2013 and represented eighteen age-classes (Table 1.1). Similar to the past twelve years, young cohorts (ages 1-5) were the most abundant and represented 85% of the total catch in standard assessment nets (Figure 1.3). Cohort abundance continues to decline rapidly after age-5, and low numbers of Lake Trout age-7+ were caught. Lake Trout cohorts ages 10 and older comprised less than 4% of the overall catch in 2013.

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 2013.

A) Lean Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (g)	PERCENT MATURE
1	Male	6	272	195	0
	Female	3	293	233	0
2	Male	3	376	551	0
	Female	0	-----	-----	-----
3	Male	45	563	2198	89
	Female	37	548	1956	11
4	Male	134	637	3211	100
	Female	70	652	3435	76
5	Male	59	677	3774	100
	Female	54	679	3893	96
6	Male	27	720	4541	100
	Female	16	717	4565	100
7	Male	14	752	5236	100
	Female	8	744	5242	100
8	Male	2	653	3353	100
	Female	1	717	4220	100
10	Male	5	808	6386	100
	Female	4	770	6181	100
11	Male	5	811	6542	100
	Female	2	804	7225	100
12	Male	2	905	8571	100
	Female	3	807	7335	100
13	Male	1	766	5845	100
	Female	2	833	8265	100
17	Male	1	892	9170	100
	Female	1	888	8880	100
18	Male	1	844	8540	100
	Female	0	-----	-----	-----
20	Male	1	816	6195	100
	Female	0	-----	-----	-----
21	Male	1	930	10510	100
	Female	0	-----	-----	-----
23	Male	1	905	9245	100
	Female	0	-----	-----	-----

B) Klondike Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (grams)	PERCENT MATURE
5	Male	44	608	2737	100
	Female	57	624	3060	100
6	Male	2	607	2605	100
	Female	5	649	3349	100
7	Male	2	688	3978	100
	Female	1	612	3165	100
9	Male	1	672	4080	100
	Female	1	658	4300	100

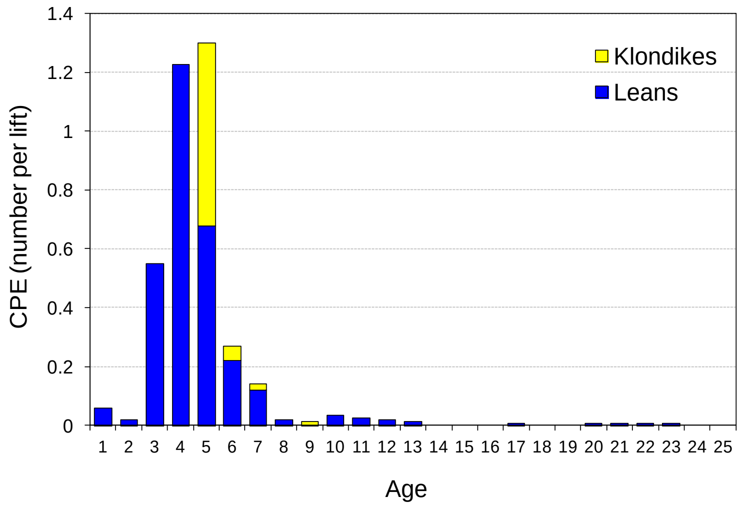


FIGURE 1.3. Relative abundance (number per lift) at age of Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie 2013.

The overall trend in area-weighted mean CPE of Lake Trout caught in standard nets in the eastern basin increased in 2013 to 3.3 fish per lift (Figure 1.4). This was the second highest abundance in the time series. Increases in relative abundance were observed in all jurisdictions in 2013. Basin-wide abundance remains well below the rehabilitation target of 8.0 fish/lift (Markham *et al.* 2008).

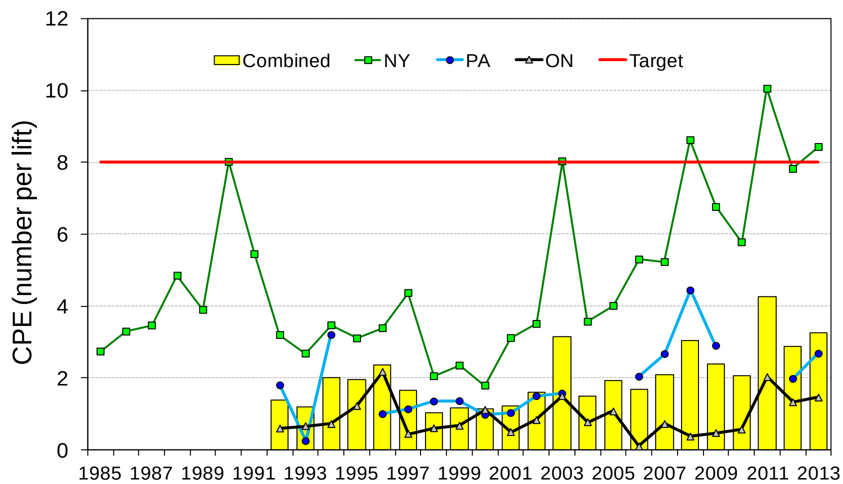


FIGURE 1.4. Mean CPE (number per lift) by jurisdiction and combined (weighted by area) for Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1985-2013.

The OMNR 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 45 Lake Trout were caught in the east basin during the OMNR Partnership Index Fishing Program in 2013; no Lake Trout were caught in the eastern part of the central basin. The Pennsylvania Ridge was not sampled in 2013. The Lake Trout index in the east basin (0.75 fish/lift) was the fourth highest observed in the series and almost double the time series mean (0.39 fish/lift) (Figure 1.5). The increase in abundance in the east basin over the past four years is most likely due to increased stocking by OMNR over the past six years, and coded-wire tags indicated that the majority of the Lake Trout were from the Slate Island strain stocked in Ontario waters. Variability of abundance estimates in this survey is high due to low sample sizes, especially in the Pennsylvania Ridge, and the broad spatial sampling area that may have extended outside preferred Lake Trout habitat.

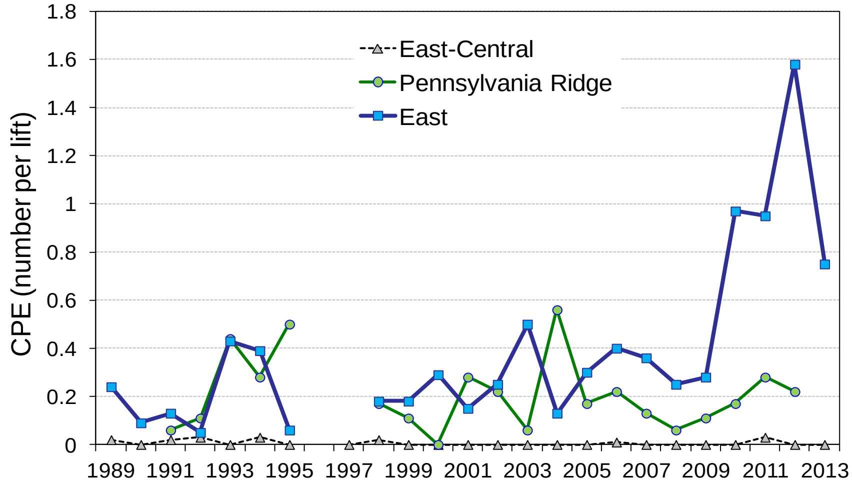


FIGURE 1.5. Lake Trout CPE (number per lift) by basin from the OMNR Partnership Index Fishing Program, 1989-2013. Includes canned (suspended) and bottom gill net sets, excluding thermocline sets.

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 1.4 fish per lift in 2013 (Figure 1.6). The increase in adult abundance was mainly due to a relatively high abundance of age-5 Lake Trout (see Figure 1.3). This was the highest adult abundance index in the series, but remains well below the basin-wide rehabilitation target of 2.0 fish/lift (Markham *et al.* 2008).

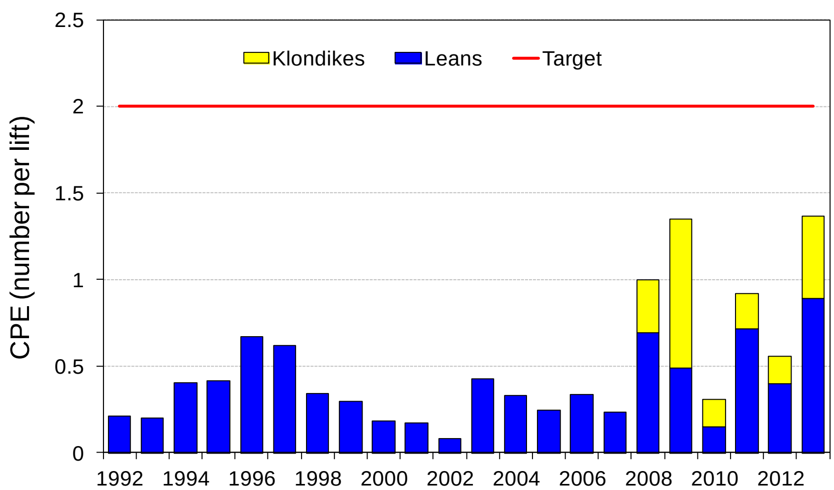


FIGURE 1.6. Relative abundance (number per lift) weighted by area of age 5 and older Lean strain and Klondike strain Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2013.

The relative abundance of mature females over 4500 g, an index of repeat-spawning females ages six and older, also increased in 2013 to 0.22 fish per lift (Figure 1.7). This was the second highest index value in the time series but remains well below the rehabilitation plan basin-wide target of 0.50 fish/lift for adult female abundance (Markham *et al.* 2008). An overall pattern of low and variable abundance of the adult Lake Trout spawning stock may be a key contributing factor to the continued absence of any documented evidence of natural reproduction in Lake Erie.

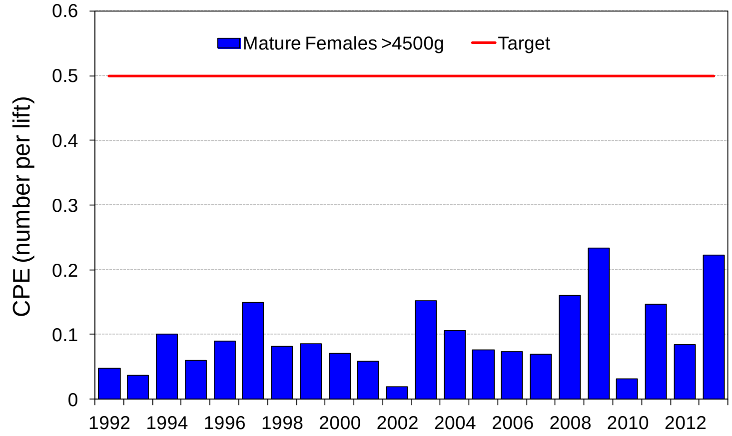


FIGURE 1.7. Relative abundance (all strains combined; number per lift weighted by area) of mature female Lake Trout greater than 4500 g in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2013.

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 from 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 2013 SP index was 0.03, which was below average for the time series and the lowest value since 2007 (Figure 1.8). Age-2 abundance also dropped to its lowest levels since 2007. The low SP index and age-2 CPE values were attributed to the low number of yearling Lake Trout stocked in 2012 (55,330) stocked only in Ontario waters.

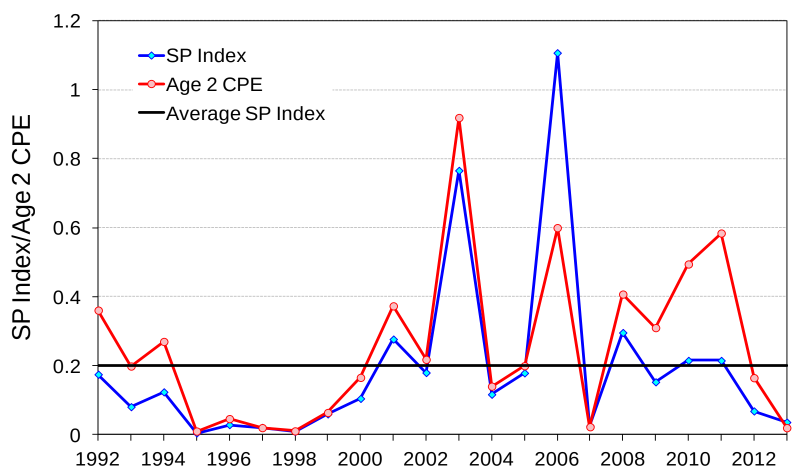


FIGURE 1.8. Stocking Performance (SP) index and age-2 CPE (number per lift) for Lake Trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2013. The SP index is equal to the number of age-2 fish caught per lift for every 100,000 yearling Lake Trout stocked.

Strains

Ten different Lake Trout strains were found in the 613 fish caught with either hatchery-implanted coded-wire tags (CWTs) or fin-clips in 2013 (Table 1.2). The majority of the trout (89%) were comprised of three strains: Lake Champlain (LC; 45%), Finger Lakes (FL; 26%) and Klondike (KL; 18%). These have been the most stocked strains in Lake Erie over the past ten years. Slate Island (SI; 7%) and Apostle Island (AI; 2%) were the only other strains representing a significant portion of the catch; Traverse Island (TI), Lake Erie (LE), Lake Ontario (LO), Lewis Lake (LL), and Michipicoten (MIC) strains each represented less than 1% of the Lake Trout catch. The FL strain continues to show the most consistent returns at older ages; 84% (N=61) of Lake Trout age-7 and older were FL strain fish or FL-hybrids (LO and LE strains).

TABLE 1.2. Number of Lake Trout by stocking strain and age collected in gill nets from the eastern basin of Lake Erie, August 2013. Stocking strain codes are: FL = Finger Lakes, LE = Lake Erie, LO = Lake Ontario, LL = Lewis Lake, KL = Klondike, LE = Lake Erie, SI = Slate Island, TI = Traverse Island, AI = Apostle Island, LC = Lake Champlain, MIC = Michipicoten. Shaded cells indicate cohorts with a stocking history.

AGE	FL	LE	LO	LL	KL	SI	TI	AI	LC	MIC
1	3								6	
2						3				
3						2			81	
4	1					25			172	1
5	62			3	101	13		14	21	
6	43				7					
7	19				3		3			
8	1					2				
9					2					
10	9									
11	7									
12	5									
13	3									
14										
15										
16										
17	2									
18		1								
19										
20	1									
21			1							
22			1							
23	1									
TOTAL	**157**	**1**	**2**	**3**	**113**	**45**	**3**	**14**	**274**	**1**

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.

Preliminary estimates of the 2003, 2004, and 2006 year classes of Klondike (KL) strain fish indicate very low survival rates at adult ages that are comparable to survival rates of SUP strain Lake Trout from the 1997-2001 year classes (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 slightly below 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, 1985–2013. 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: ages 4-10 (2003), 4-9 (2004), 4-8 (2005) or 4-7 (2006).

	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*			0.627	0.256	0.524
2004*				0.410	0.418
2005*			0.584		0.816
2006*			0.692	0.519	0.618
MEAN	**0.592**	**0.575**	**0.733**	**0.395**	**0.592**

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 (2003-2012) 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.

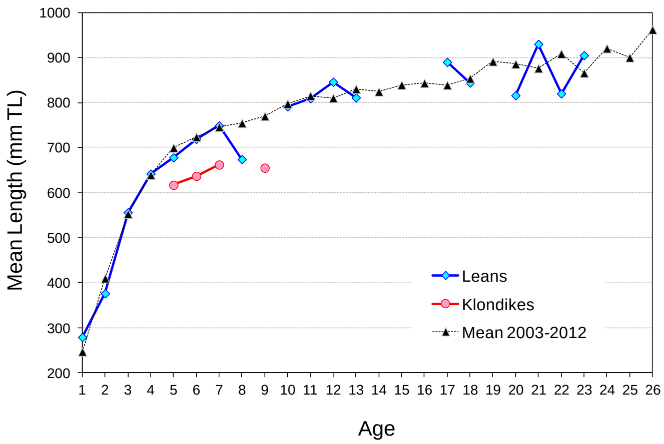


FIGURE 1.9. Mean length-at-age of Lean strain and Klondike strain Lake Trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2013. The previous 10-year average (2003-2012) from New York waters is shown for current growth rate comparison.

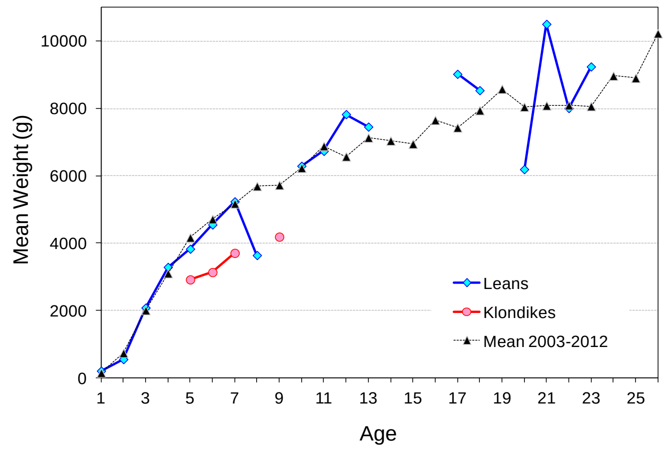


FIGURE 1.10. Mean weight-at-age of Lean strain and Klondike strain Lake Trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2013. The previous 10-year average (2003-2012) from New York waters is shown for current growth rate comparison.

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 slightly lower.

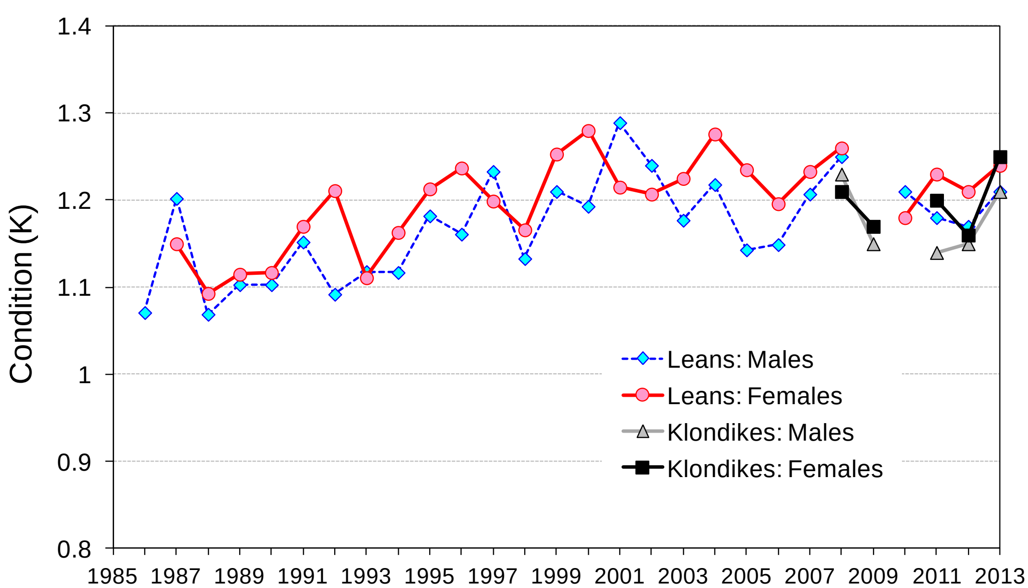


FIGURE 1.11. Mean coefficients of condition for age-5 Lean strain and Klondike strain Lake Trout, by sex, collected in eastern basin assessment gill nets in Lake Erie, August 1985-2013.

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. Approximately 824 Lake Trout were harvested in New York waters out of an estimated catch of 1,805 in 2013 (Figure 1.12). This was the highest estimated harvest of Lake Trout in New York waters of Lake Erie since 1996. An estimated harvest of 176 Lake Trout occurred in Pennsylvania waters in 2013 (Figure 1.12). This was above the series average of 83 fish per year and only the second year harvest was detected since 2006.

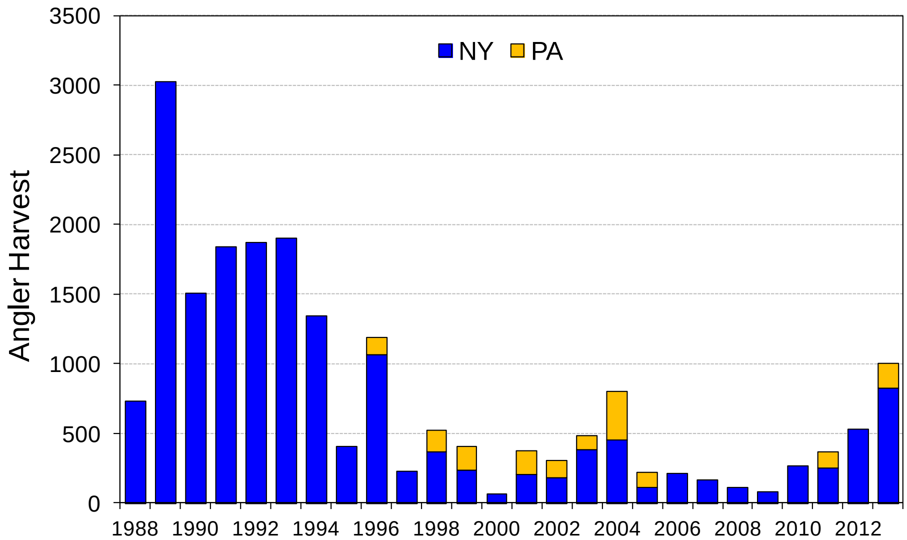


FIGURE 1.12. Estimated Lake Trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2013.

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 2013, making a total of 59 potentially wild Lake Trout recorded over the past 13 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 continued in 2013 due to poor weather conditions.

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 2013 Lake Trout model estimated the Lake Erie population at 272,981 fish and the age-5 and older population at 56,264 fish, about half the number estimated in 1996 when the adult Lake Trout population was at its peak (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.

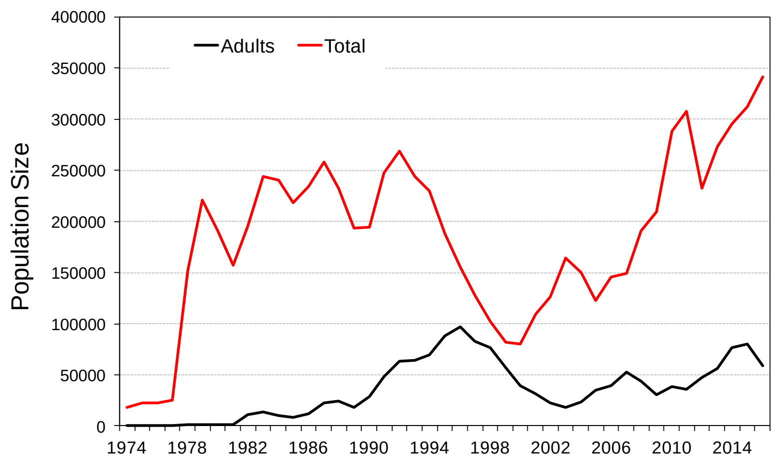


FIGURE 1.16. Projections of the Lake Erie total and adult (ages 5+) Lake Trout population using the CWTG Lake Trout model. Projections for 2014-2016 were made using low rates of Sea Lamprey mortality with proposed stocking rates. The model estimated the lakewide Lake Trout population in 2013 at 272,981 and the adult population at 56,264.

Diet

Seasonal diet information for Lake Trout is not available based on current sampling protocols. Diet information was limited to fish caught during August 2013 in the coldwater gill net assessment surveys in the eastern basin of Lake Erie. Analysis of the stomach contents revealed a similar diet of prey fish species for both Lean and Klondike strain Lake Trout. Rainbow Smelt were most prevalent diet item, occurring in 76% of Lean and 78% of Klondike Lake Trout stomachs (Figure 1.17). Round Gobies were the second most commonly encountered prey item (Leans = 18%; Klondikes = 20%). Similar to past years, Smelt remain the preferred prey item for all Lake Trout when they are abundant. However, in years of lower adult smelt abundance, Lake Trout appear to prey more on Round Gobies. Klondike strain Lake Trout have consistently had higher percentages of Round Gobies in their diets compared to lean strain Lake Trout (Coldwater Task Group 2011). One occurrence of a Yellow Perch in a lean Lake Trout stomach was the only other identifiable prey item found in 2013.

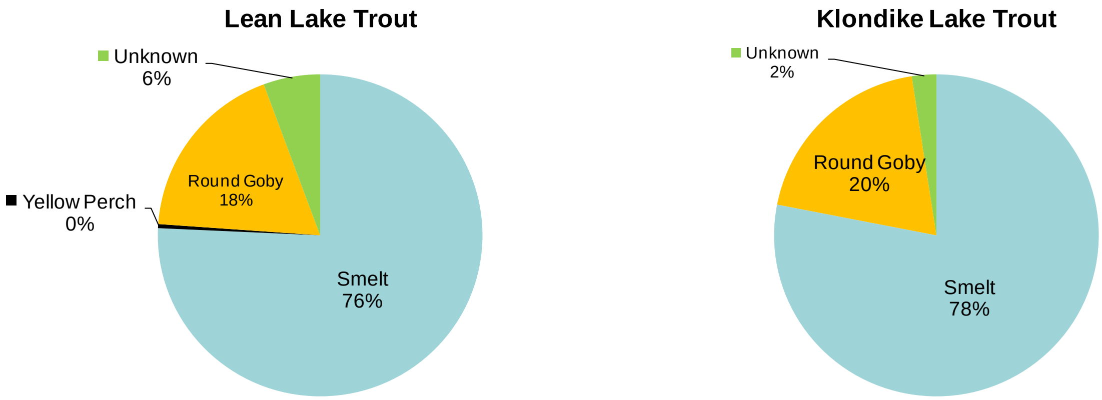


FIGURE 1.17. Frequency of occurrence of diet items from non-empty stomachs of Lean (N=223) and Klondike (N=37) strain Lake Trout collected in gill nets from eastern basin waters of Lake Erie, August 2013.

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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, OMNR and Kevin Kayle, ODW

Commercial Harvest

The total harvest of Lake Erie Lake Whitefish in 2013 was 157,919 pounds (Figure 2.1). Ontario accounted for 60% of the total, harvesting 93,979 pounds, followed by Ohio (40%; 63,940 lbs.), with no harvest in Michigan, Pennsylvania or New York (Figure 2.2). Total harvest in 2013 was 54% lower than the total harvest in 2012. Lake Whitefish harvest in 2013 declined 56% in Ontario and 47% in Ohio from 2012.

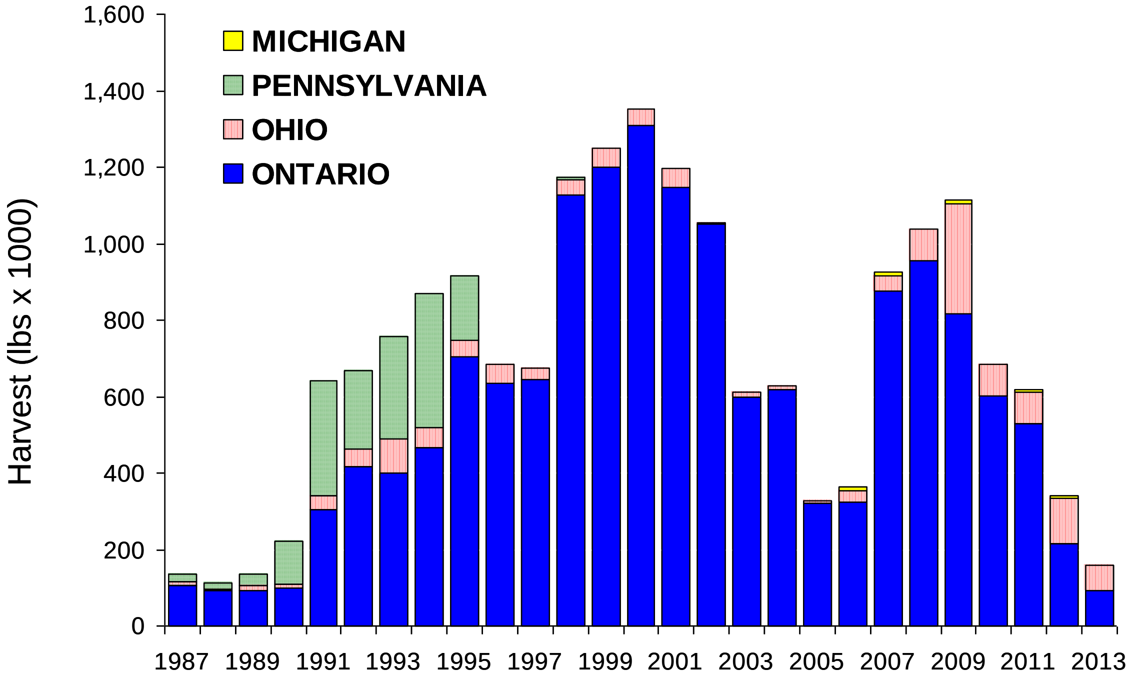

FIGURE 2.1. Total Lake Erie commercial Lake Whitefish harvest from 1987-2013 by jurisdiction. Pennsylvania ceased gill netting in 1996, and Michigan resumed commercial fishing in 2006, excluding 2008.

The majority (99%) of Ontario's 2013 Lake Whitefish harvest was taken in gill nets. The remainder was caught in smelt trawls (1%). The largest fraction of Ontario's Lake Whitefish harvest (79%) was caught in the west basin (Ontario-Erie Unit OE1) followed by OE2 (16%), with the remaining harvest distributed eastward among units OE3 (1%), OE4 (1%) and OE5 (3%). Harvest in OE1 from October to December represented 77% of Ontario's Lake Whitefish harvest. In OE 1, harvest peaked in November (40,526 lbs), whereas OE2 and OE3 harvest peaked during March and April (10,295 lbs). The minimal Lake Whitefish harvest from OE4 was taken during spring and summer, whereas OE5 harvest occurred primarily from June to October. In Ontario, 15% of Lake Whitefish were harvested from gill nets targeting Whitefish, followed by fisheries targeting walleye (54%), white bass (29%), white perch (1%) and rainbow smelt (trawls;1%). During spawning season, targeted Whitefish harvest (7,901 pounds) in Ontario accounted for 14% of Ontario's November-December harvest (54,865 pounds) in western Lake Erie.

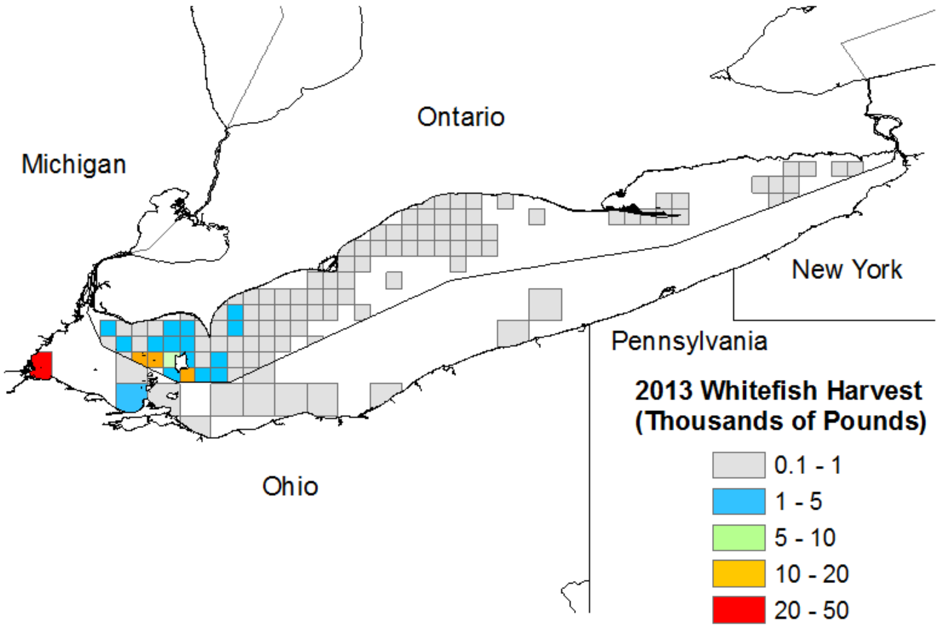

FIGURE 2.2. Lake Erie commercial harvest of Lake Whitefish in 2013 by 5 -minute (Ontario) and 10-minute (Ohio) grids. No Lake Whitefish harvest was reported in Pennsylvania, New York and Michigan.

Ontario annual commercial catch rates for effort targeting Lake Whitefish in 2013 dropped 14% from 2012 in combined quota areas (Figure 2.3). In Quota Area (OE) 1, where 78% of Whitefish harvest occurred, catch rates dropped 40% to 52 kg/ km (Figure 2.3, 2.4). Fall (Oct-Dec) Lake Whitefish catch rates, in nets targeting them, were the lowest in the 1998-2013 time series but varied by month (Figure 2.4). West basin monthly catch rates in 2013 were highest in October, followed by November and December (Figure 2.4A), but fall targeted gill net effort targeting Lake Whitefish in the west basin (OE1) was very low in 2013 (Figure 2.4B) limiting the value of catch rates as indicators. OE1 fall targeted harvest (10,734 pounds) was second lowest since 1998 (Figure 2.4C).

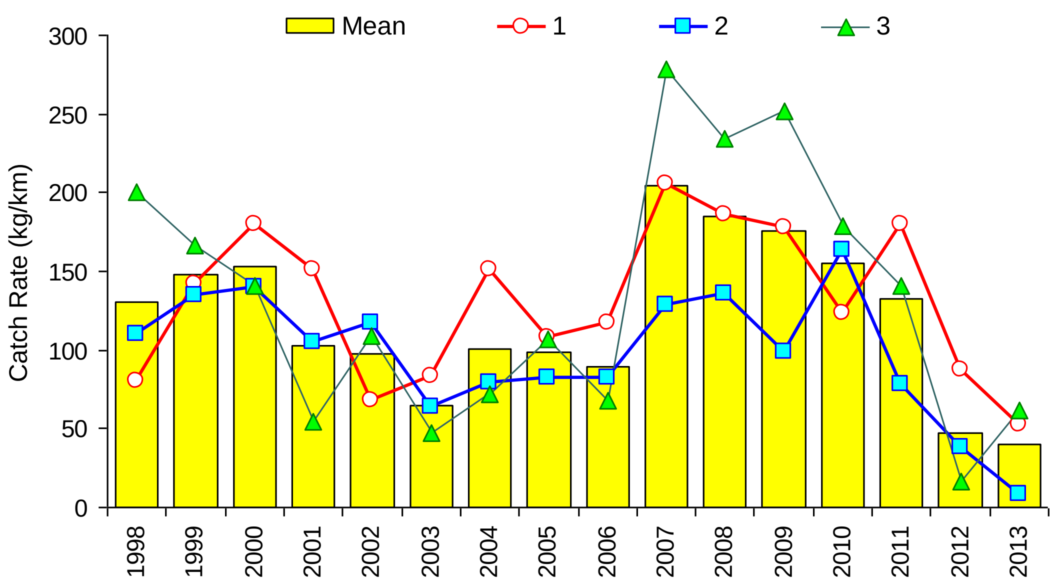

FIGURE 2.3. Ontario annual commercial large mesh gill net catch rates targeting Lake Whitefish by quota zone, 1998-2013. Bars represent averages of catch rates across quota zones. Quota Zone 1 refers to the west basin, Zone 2 extends eastward to the middle of the central basin. The remaining eastern portion is Quota Zone 3.

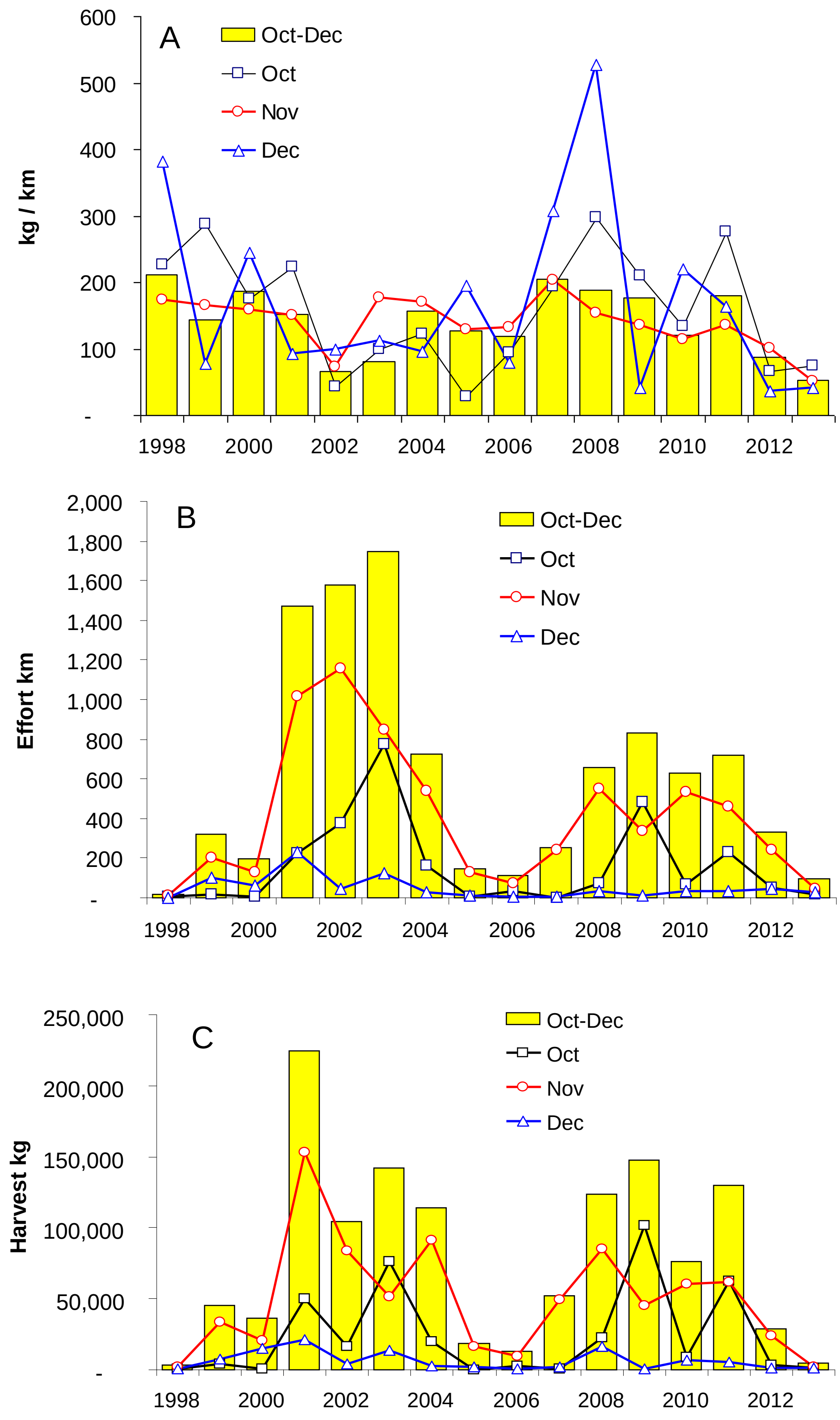

FIGURE 2.4. Targeted large mesh gill net catch rate (A), gill net effort (B) and harvest (C) for Lake Whitefish in the west basin for October, November, December, and pooled (Oct-Dec) 1998-2013.

In Ohio waters during 2013, 98% of the Lake Whitefish trap net harvest occurred in the west basin with the remaining 2% caught in the central basin. Whitefish were harvested from 1,489 trap net lifts in 2013, with lifts distributed among District 1 (37%), District 2 (47%) and District 3 (16%), respectively. The majority of Ohio's Lake Whitefish harvest occurred during November (95%), followed by December (2%) and October (1%), in the western basin. Ohio's remaining Lake Whitefish harvest occurred in the central basin (2%), mainly from May to July. Whitefish yield in 2013 from Ohio trap nets was greatest near the mouth of the Maumee River (59,024 pounds, Figure 2.2). In contrast to the continued Ontario Lake Whitefish fisheries catch rate declines observed, Ohio commercial trap net catch rates in 2013 were higher than 13 of the previous 17 years (Figure 2.5); however, they were significantly lower than peak values observed in 2009 and 2012

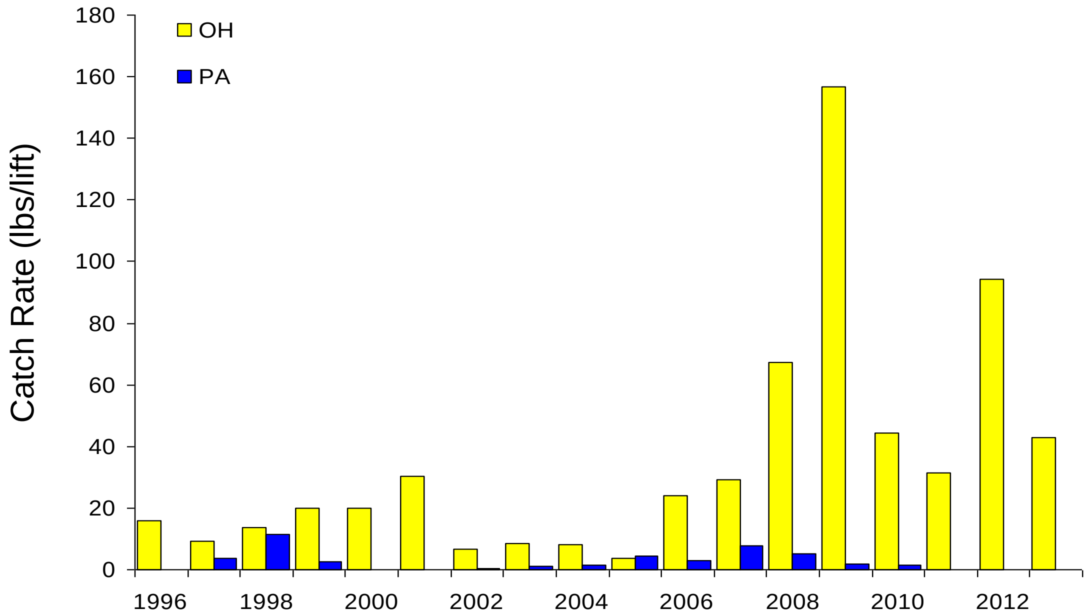

FIGURE 2.5. Ohio and Pennsylvania Lake Whitefish commercial trap net catch rates (pounds per lift), 1996-2013. There was zero harvest of Whitefish in Pennsylvania waters during 2011-2013.

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, Figure 2.6). Most of this fishing effort is occurring in and adjacent to Maumee Bay (Ohio grids 801 and 802) and the Lake Erie Islands (Ohio grid 804; Figure 2.6) as Lake Whitefish aggregate and move to spawning locations. The Ohio Lake Whitefish trap net fishery has changed in the last two decades to capitalize on these aggregations of fish, with over 90% of the harvest coming in November and December (Figure 2.7).

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 Whitefish harvest and high catch rates with little 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. Finding direct cause and effect may be difficult to determine with trophic and climate changes and significant dredge activity in the Maumee Bay area during that season.

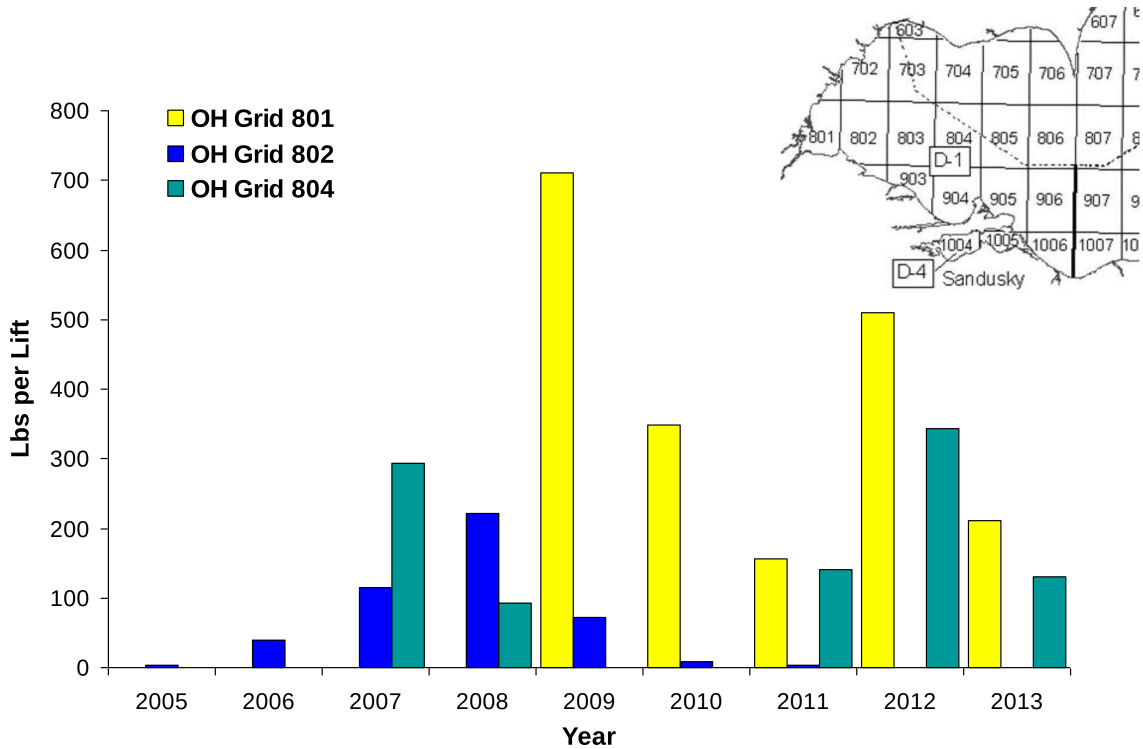

FIGURE 2.6. Ohio Lake Whitefish commercial trap net catch rates (pounds per lift) by grid in western Lake Erie.

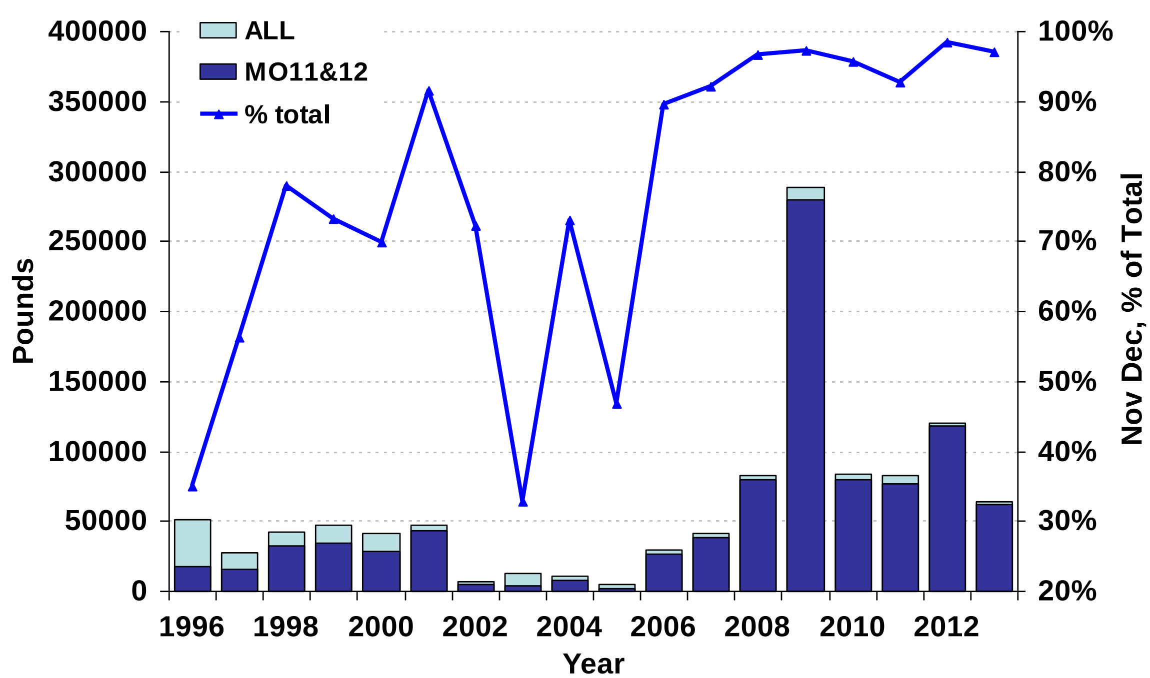

FIGURE 2.7. November and December harvest of Lake Whitefish in Ohio waters of Lake Erie, 1996-2013.

Ontario's west basin fall Lake Whitefish fishery in 2013 was dominated by older fish (Figure 2.8). The age composition of Lake Whitefish harvest from Ontario is presented by target fishery based on standard harvest monitoring using otoliths (N=139; Figure 2.9). For comparison, results are presented from OMNR supplementary 2013 fall Lake Whitefish harvest assessment in processing plants using scales for aging (N=2,784; Figure 2.9). Based on standard monitoring, Ontario's Lake Whitefish harvest in 2013 consisted of fish from ages 3 to 26. The strong 2003 cohort (age 10) was most abundant, representing 40% of the Lake Whitefish harvest sampled in 2013 (Figure 2.9). Ages 8, 12 and 11 collectively accounted for a comparable fraction of the harvest (Figure 2.9). Despite some differences related to sample size and age structures used, harvest age composition was similar between standard and supplementary Lake Whitefish harvest assessment (Figure 2.9). Lake Whitefish harvest mean age was 10.5 yrs using otoliths from the standard fishery assessments; whereas, mean age was 9.2 yrs based on results of supplementary fall fishery assessment ages by scales.

Age composition of the 2013 Lake Whitefish commercial fishery in Ohio was not determined.

The landed weight of roe from Ontario's 2013 Lake Whitefish fishery was 2,040 pounds, most of which came from OE1 during November (67%) and October (27%). The remaining fraction of roe was collected from OE2 (6%) during October and November. The approximate landed value of the roe was CDN $6,007.

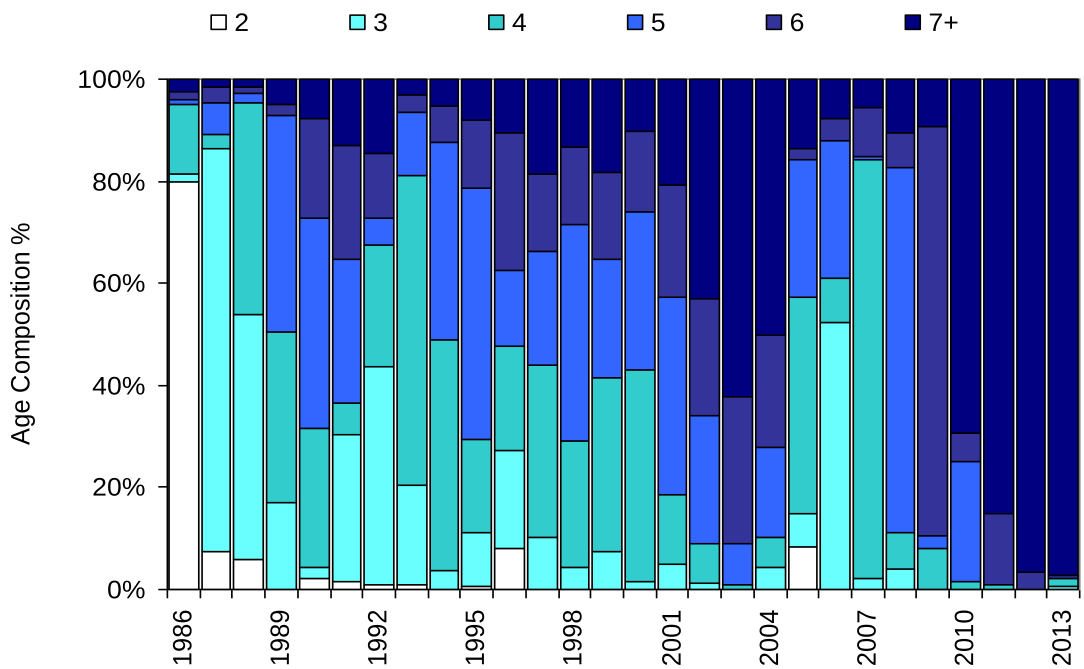

FIGURE 2.8. Ontario fall commercial Lake Whitefish harvest at age composition in OE Statistical District 1, 1986-2013, from effort with gill nets ≥3 inches with Lake Whitefish in the catch from October to December.

Assessment Surveys

Lake Whitefish abundance indices in the 2013 gill net assessments varied from poor to moderate (Figures 2.10 and 2.11). Only one Lake Whitefish was caught in standard index gillnets during the 2013 Partnership index (Figure 2.10). Another one was caught in auxiliary canned index nets in the west-central basin, while only one other was caught in auxiliary commercial style gill nets. Catch rates in the partnership indices were the lowest or near lowest on record (Figure 2.10). The Pennsylvania Ridge survey in which Lake Whitefish were frequently caught, was not completed in 2013, and was excluded from Figure 2.10. Ontario's fall comparison gill net survey employed graded mesh size multifilament nets, and two styles of monofilament nets at 7 sites distributed across the west and central basins. Three (3) Lake Whitefish were caught in these nets.

While New York's coldwater assessment survey catch rate in 2013 (1.8 Whitefish / lift) dropped 44% from 2012, the 2013 catch rate was ranked in the 54th percentile for the time series (Figure 2.11). No Lake Whitefish were caught during 2013 in Ontario coldwater assessment gill nets, consistent with rare catches observed since 2010 (Figure 2.11).

The only two Lake Whitefish captured in Ontario standard and auxiliary index gill nets are represented in Figures 2.12 and 2.13. These Whitefish were aged at 11 and 12 years old. Two (of 3) Whitefish collected during Ontario comparison gill netting were ages 9 and 17.

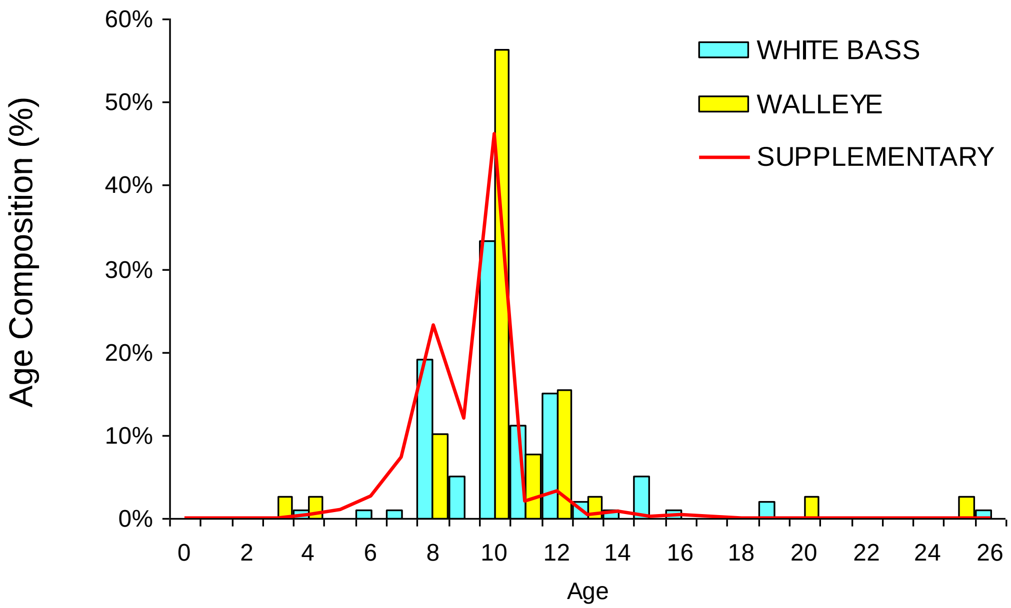

FIGURE 2.9. Age composition of Lake Whitefish caught commercially in Ontario waters of Lake Erie in 2013 by target species fisheries. Otoliths were used to age Lake Whitefish samples (N=139; male 58%, female 42%). Supplementary fall harvest assessment of west and central Lake Erie (red line; N=2,784; ages from scales).

Age composition and mean length at age of Lake Whitefish captured during the 2013 New York coldwater gill net assessment (99 caught; 90 with age data) are presented in Figure 2.14. Ages ranged from 7 to 23 in the 2013 eastern basin survey. The majority of fish were age 10, comprising 34% of the catch, followed by ages 11,8, 9 and 12 in decreasing order of capture abundance.

Lake Whitefish captured and aged from Ohio DNR and USGS assessment surveys (N=18) ranged from age 3 to 17, with age 12 most abundant, followed by ages 10 and 13 (Figure 2.15).

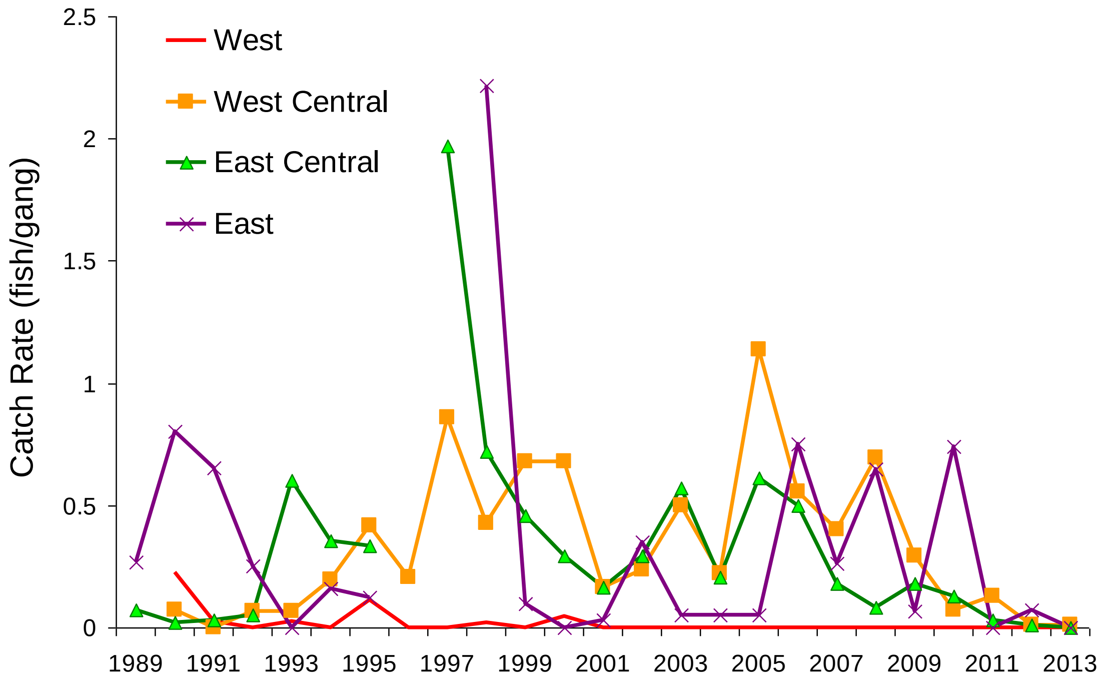

FIGURE 2.10. Catch rate (number per gang) of Lake Whitefish from Ontario partnership index gill netting by basin, Lake Erie, 1989-2013.

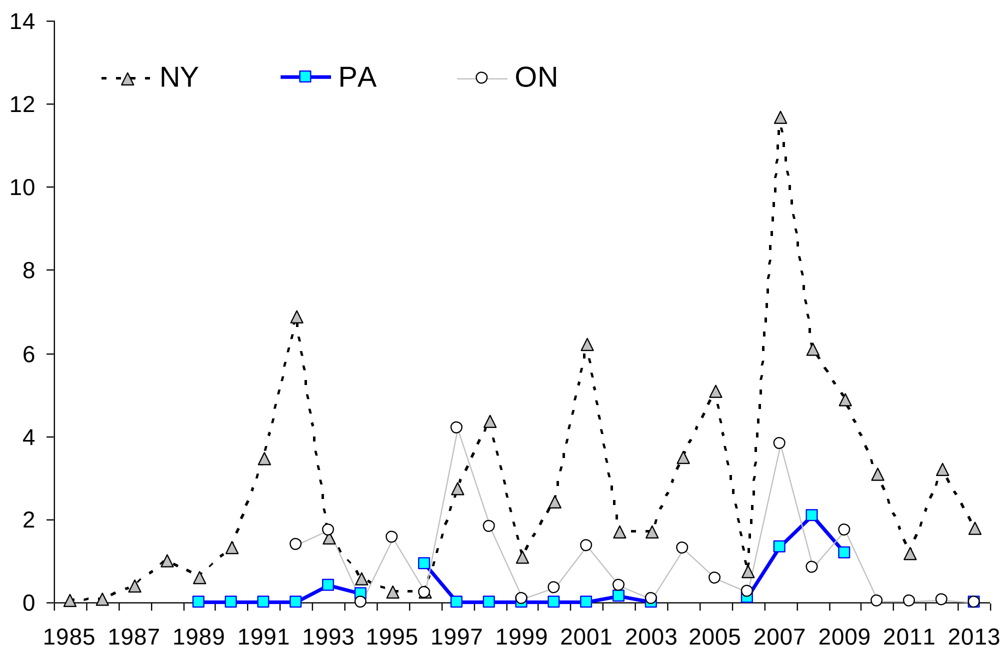

FIGURE 2.11. Catch per effort (number fish/lift) of Lake Whitefish caught in standard assessment gill nets from New York waters of Lake Erie, August 1985-2013 (triangles) Pennsylvania (squares) 1989-2009 and Ontario waters (circles) 1992- 2013. No index sampling took place in Pennsylvania waters 1995, 2004, 2005 and 2010.

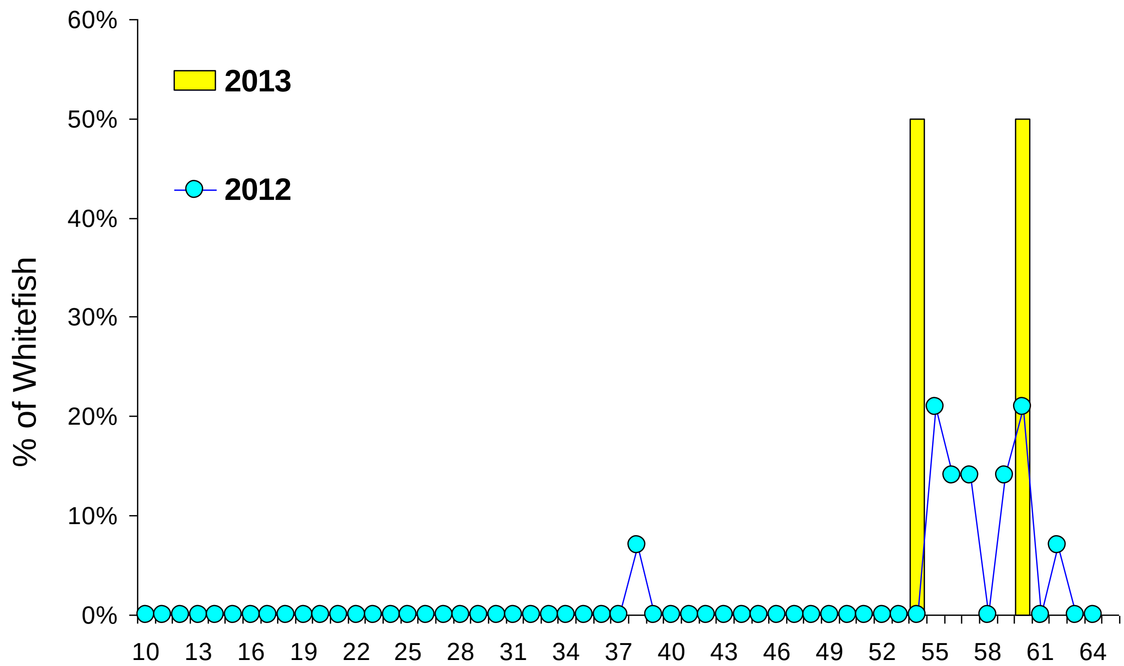

FIGURE 2.12. Age composition by sex and mean length at age of Lake Whitefish collected from index gill nets during the lake-wide partnership index in 2013 (N=2).

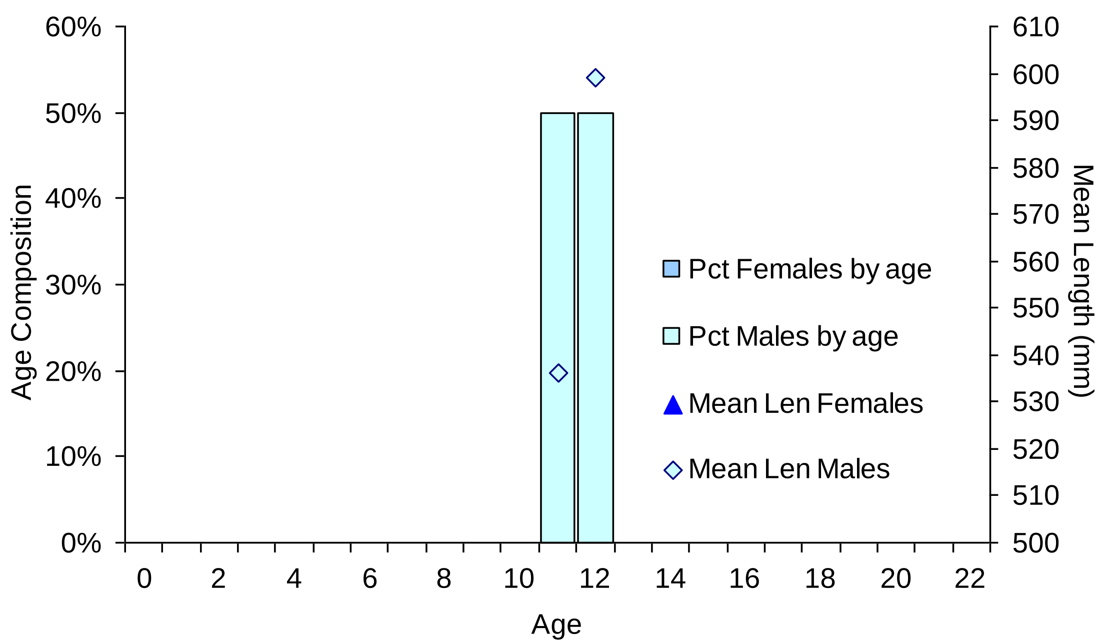

FIGURE 2.13. Length-frequency distributions (cm) of Lake Whitefish collected during lake-wide partnership index fishing, 2012 and 2013.

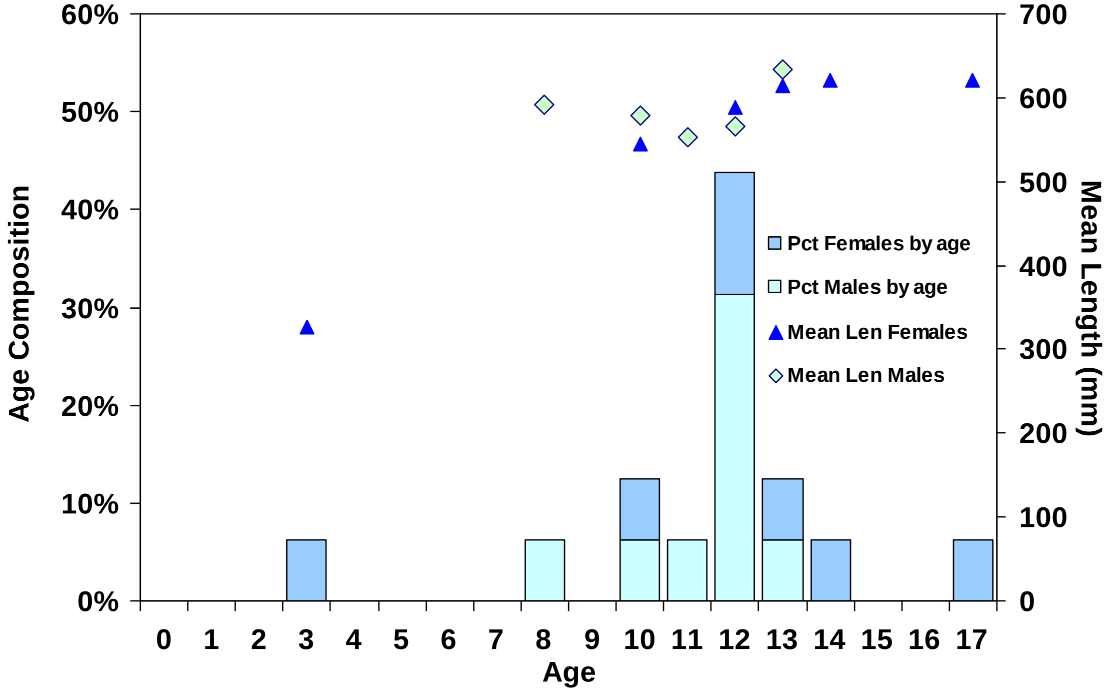

FIGURE 2.14. Age distribution and mean length-at-age of Lake Whitefish collected during standard coldwater gill net assessment surveys in New York waters of Lake Erie during 2013 (N=90).

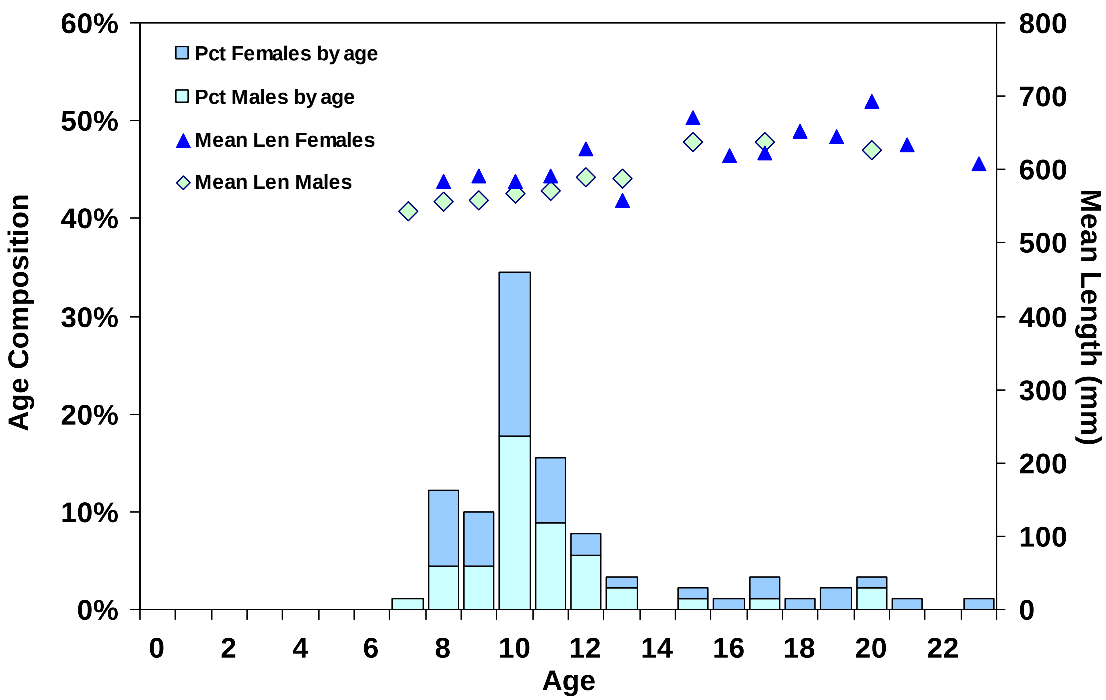

FIGURE 2.15. Age distribution and mean length-at-age of Lake Whitefish collected during trawl and gill net assessment surveys by Ohio DNR and USGS in Lake Erie during 2013 (N=18).

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) only from the 2004, 2005 and 2007 year classes. Yearlings were present in Ohio bottom trawl surveys in central Lake Erie during 2005 and 2006. YOY and yearling Whitefish were absent in 2012 and 2013 assessments in Ohio waters.

Ontario assessed incidental harvest of species caught in commercial smelt trawls in Lake Erie from July to September, 2013. Six juvenile Lake Whitefish were collected, consisting of one (1) young-of-the-year and five (5) yearlings. Aside from the presence of 2012 and 2013 year classes, the significance of these juveniles collected is unclear, as there is no basis for comparison. Twenty (20) adult Lake Whitefish were also collected during on board observation in 2013. The magnitude and potential impact of incidental Lake Whitefish harvest in smelt trawls is currently under evaluation.

The decline in Lake Erie's Lake Whitefish population is evident from both fishery and survey indicators. The magnitude of status deterioration varied between jurisdictions, fisheries and surveys. The Lake Whitefish population is in a state of decline, because in recent years recruitment was exceeded by mortality. Fishing mortality constraints are strongly recommended to slow the decline in Lake Whitefish abundance until recruitment improves.

Growth and Diet

Trends in condition are presented for Lake Whitefish collected by Ohio DNR and USGS (Figure 2.16) and Ontario MNR (Figure 2.17). In Ohio waters, condition of males (mean K= 1.03) was above Van Oosten and Hile's (1947) historic condition reference value (Figure 2.16), whereas mean female condition (0.98) was well below the historic level. Lake Whitefish ages 4 and older collected during the fall from Ontario waters had mean condition (K) values of Female = 1.07 and Male = 0.97, which fell below the historic average conditions of each sex: 1.131 for females and 1.015 for males, respectively (Van Oosten and Hile 1947; Figure 2.16). 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 gillnetting project.

Although no long-term data set has been established for Lake Whitefish sampled in New York's summer coldwater assessment gill net surveys, condition (K) values for Lake Whitefish sampled in 2013 were 1.15 for females and 1.05 for males.

No diet analyses are presented this year; agency catches were too low to make significant statements about dietary composition, diet sample analyses showed relatively high proportions of empty diets, or no diet samples were taken for analysis.

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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.

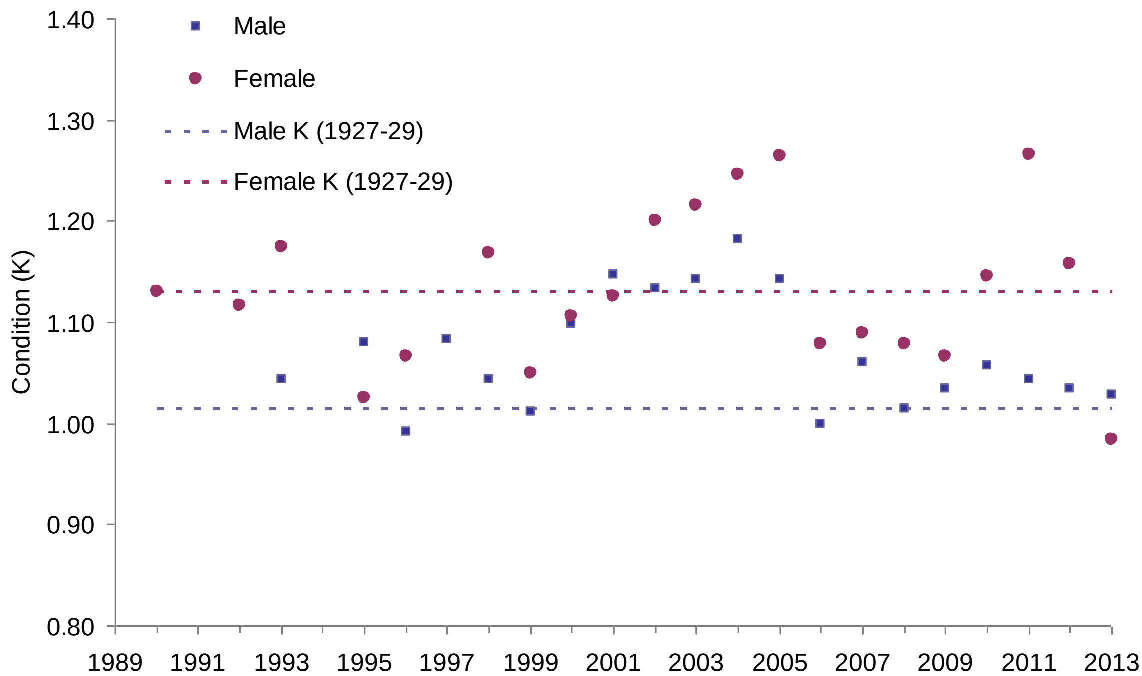

FIGURE 2.16. Mean condition (K) factor values of Lake Whitefish obtained from Ohio DNR and USGS survey data (Aug-Dec) by sex from 1990-2013. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

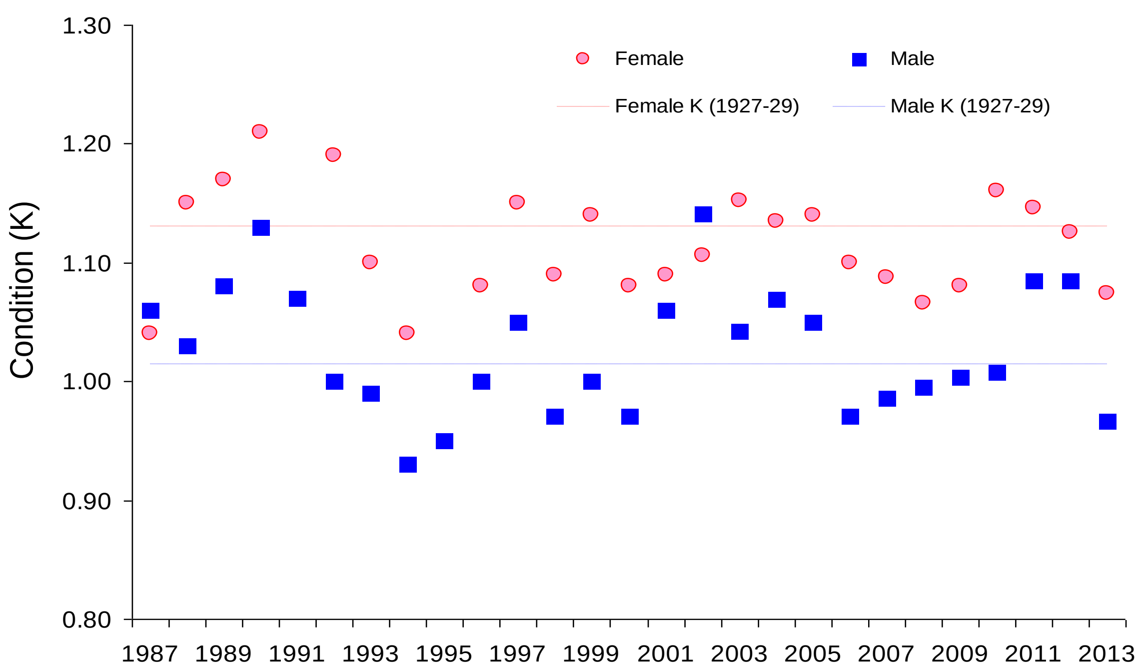

FIGURE 2.17. Mean condition (K) factor values of age 4 and older Lake Whitefish obtained from Ontario commercial and survey data (Oct-Dec) by sex from 1987-2013. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

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

Larry Witzel (OMNR), 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 2013 was 1,285 pounds (583 kg); of which, 73% came from New York by a single fisher (Table 3.1). All jurisdictions recorded less than 1000 lbs of commercial Burbot harvest. In addition, about 153 pounds (64 kg) of Burbot were discarded by Ontario commercial fishers in 2013. The Ontario harvest is now from by-catch in other fisheries. Most of the Burbot caught by the Ontario commercial fishing industry in 2013 was by-catch in trawls from the Rainbow Smelt fishery (58%), followed by the White Perch gill net fishery (17%).

Harvest decreased in Pennsylvania waters after 1995, when the commercial fishery shifted from gill nets to trap nets, resulting from a substantial decrease in the 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 through the 2000s.

Abundance and Distribution

Burbot are seasonally found in all of 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 assessment surveys are conducted each year that can capture Burbot trends: 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 gillnet 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 2013, only two Burbot were captured in the central basin and abundance in the east basin remained at record low numbers (Figure 3.2).

An examination of bottom gill net sets from combined sample locations in the east basin and Pennsylvania Ridge of the Ontario Partnership assessment data shows that the numeric abundance of Burbot (CPE; 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 2013, both abundance measures were at their respective time-series minima (Figure 3.3).

Numeric abundance of Burbot as determined from coldwater assessment gillnetting 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 2.0 or more per lift in all jurisdictions. Burbot abundance has continued to decrease throughout the east basin in recent years. Burbot catch rates were similarly low at 1 or less Burbot/lift across all jurisdictions in 2013 (Figure 3.4).

TABLE 3.1. Burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2013.

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

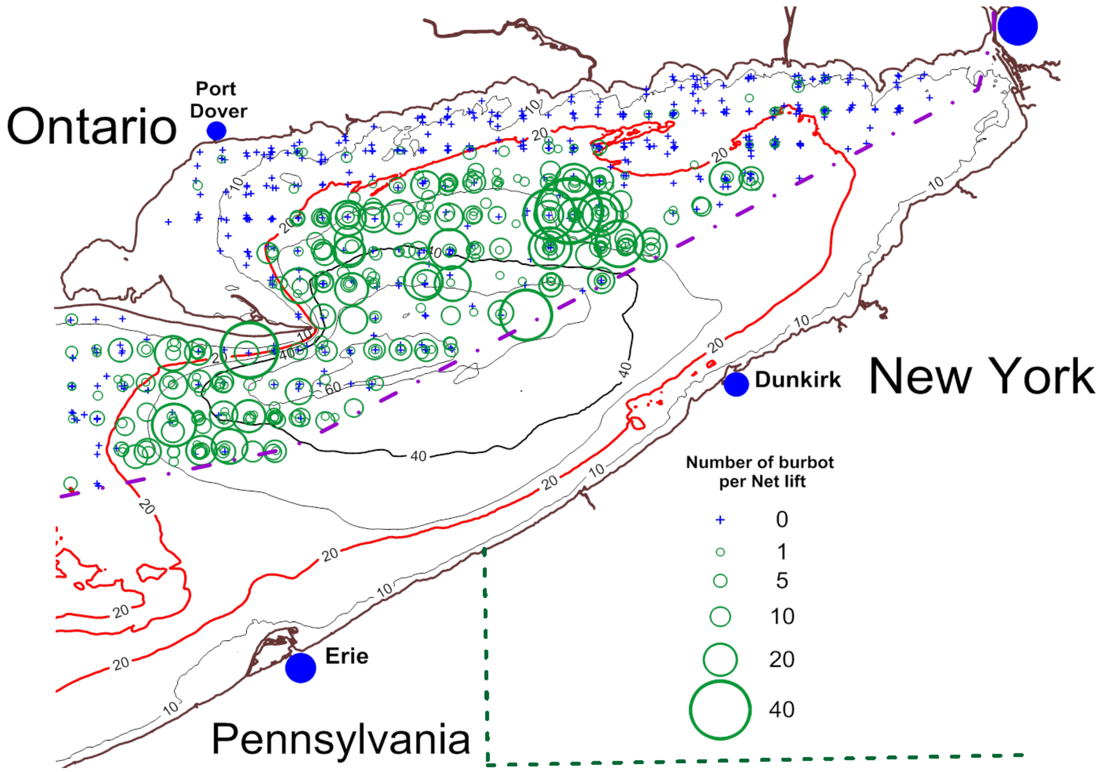

FIGURE 3.1 Distribution of eastern basin Burbot catches (Number per lift) in Ontario Partnership gill nets during August surveys of eastern Lake Erie, 1989-2013.

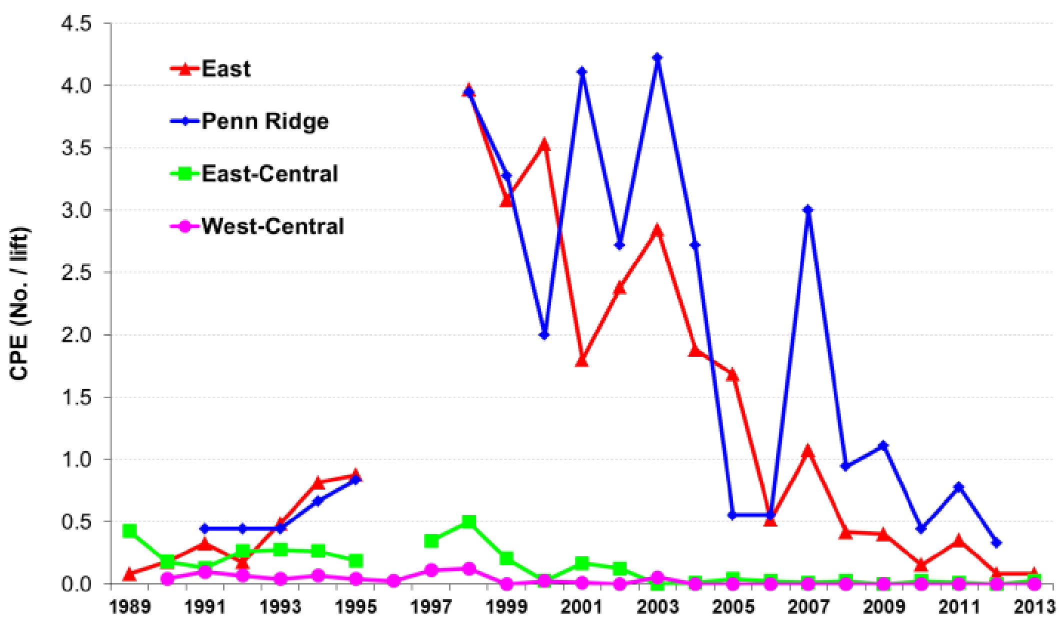

FIGURE 3.2. Burbot CPE (number per lift) by basin from the Ontario Partnership surveys 1989–2013 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets). Pennsylvania Ridge was not sampled in 2013.

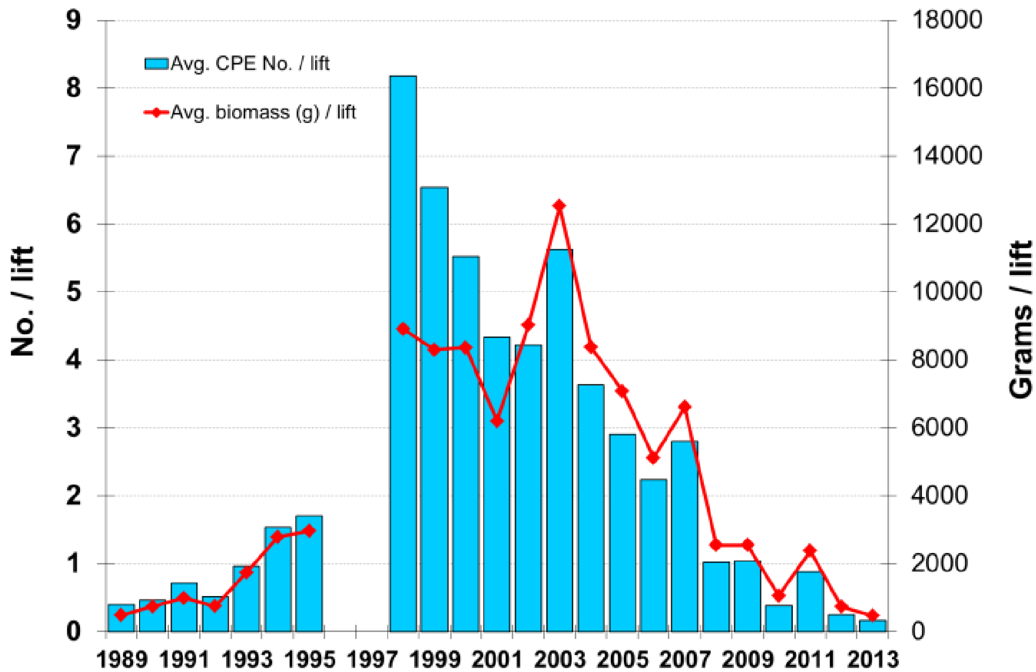

FIGURE 3.3. Average catch rate (CPE as number per lift) and biomass (grams per lift) of Burbot in Ontario waters of eastern Lake Erie, Ontario Partnership gillnet survey 1989-2013 (includes only bottom sets, all mesh sizes; PA-ridge and east basin sample sites). Note: Pennsylvania Ridge was not sampled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

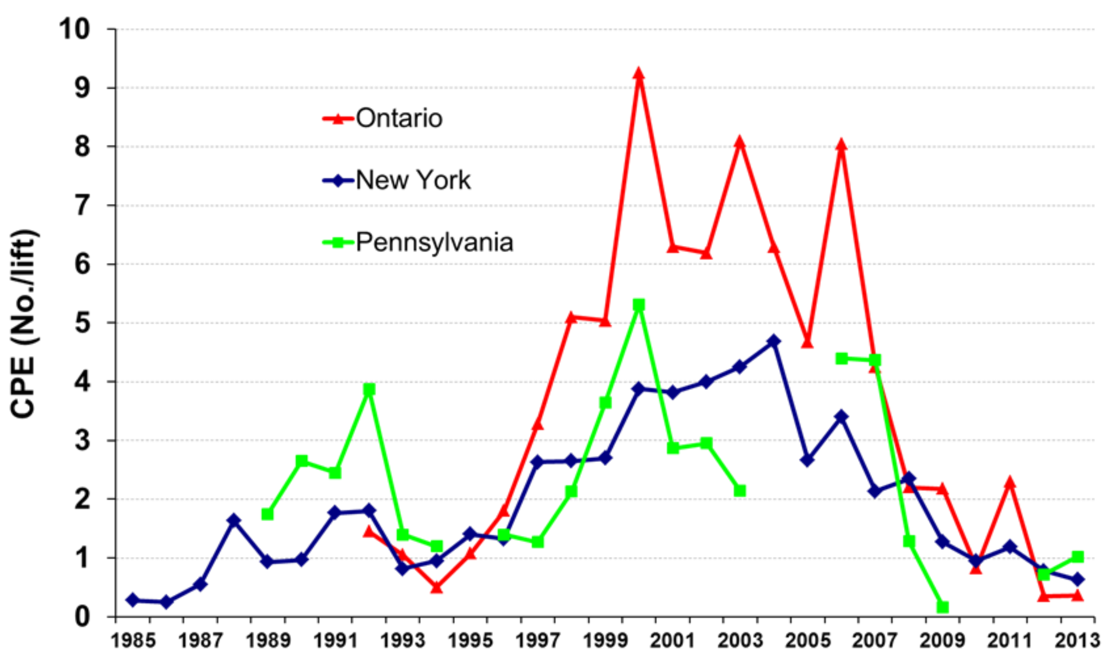

FIGURE 3.4. Average Burbot catch rate (number of fish/lift) from multi-agency summer coldwater assessment gill nets by jurisdiction in eastern Lake Erie, 1985-2013.

In general, Burbot biomass CPE has followed a similar pattern as numeric abundance, except that Burbot catches in summer coldwater gillnet 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 the Burbot biomass CPEs in Ontario (7.0 kg/lift) and New York (3.7 kg/lift) was not sustained during 2012 and 2013. Burbot catch rates in these two jurisdictions decreased into the sub-6thpercentile range of their respective time series (Figure 3.5). In Pennsylvania, the 2009 Burbot biomass estimate was the lowest in their time series at that time. Following two years of no assessment effort (in 2010, 2011), Burbot biomass increased slightly to 2.4 and 3.0 kg/lift in 2012 and 2013, respectively.

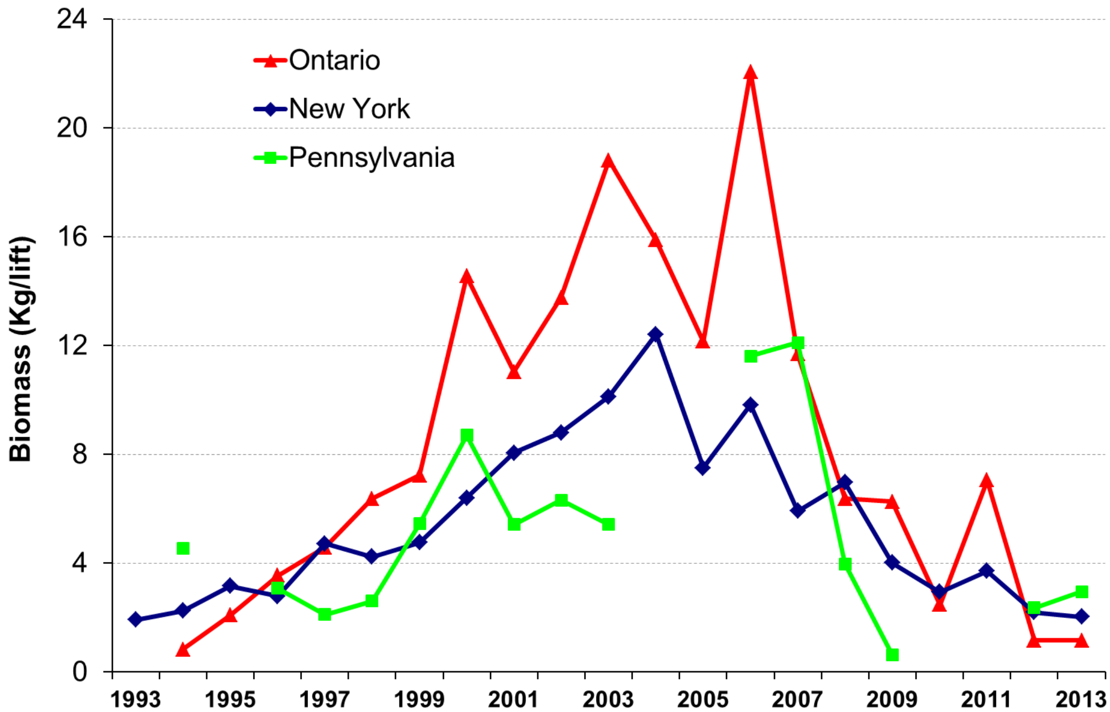

FIGURE 3.5 Average Burbot biomass (kg/lift) from summer multi-agency summer coldwater gillnet assessment by jurisdiction, 1993-2013.

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 the 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 east basin survey area since 2011. The use of thin-sectioned otoliths 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, and from 3 to 23 years in 2013 (Figure 3.6). Burbot older than 12 years represented 74%, 54%, and 61% of the aged fish in 2011, 2012 and 2013, respectively. Mean age of Burbot has increased since 1998, and this trend continued in 2013 (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 2013 (Figure 3.7). All three of the age-4 Burbot shown in Figure 3.6 were captured in New York (N=2) and Pennsylvania (N=1) and therefore do not appear in Figure 3.7. Stapanian et al.(2010) suggested that recruitment during 1997-2007 was negatively correlated with abundance of yearling and older yellow perch when the Burbot were age 0, and positively correlated 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.

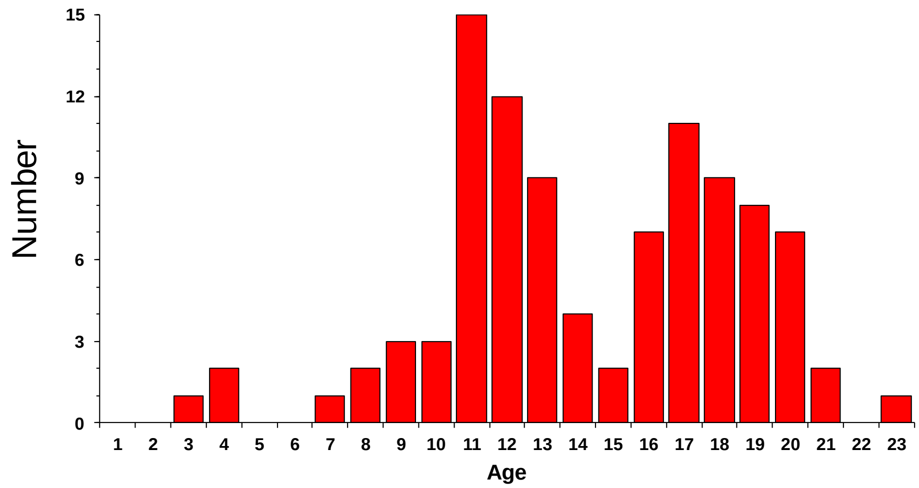

FIGURE 3.6. Age distribution of Burbot caught in multi-agency summer coldwater gillnet assessment surveys in eastern Lake Erie, 2013 (N=99).

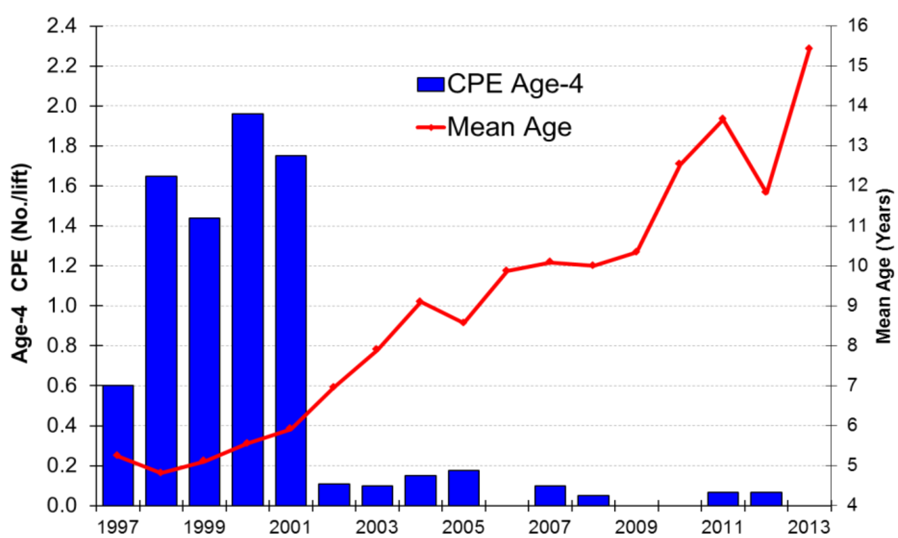

FIGURE 3.7. Mean age and average CPE of AGE-4 Burbot caught in multi-agency summer coldwater gillnet assessment surveys in Ontario waters of eastern Lake Erie during 1997-2013.

Growth

Mean total length of Burbot increased in Ontario and New York in 2013, continuing a trend observed since the late 1990's. Burbot mean total length decreased in 2013 after reaching a time-series maximum in Pennsylvania during 2012 (Figure 3.8). Average weight of Burbot decreased in Ontario and Pennsylvania and increased in New York during 2013 (Figure 3.9). However, increasing average size remains the dominant trend since about 1998 and reflects the increasing mean age of the Burbot population.

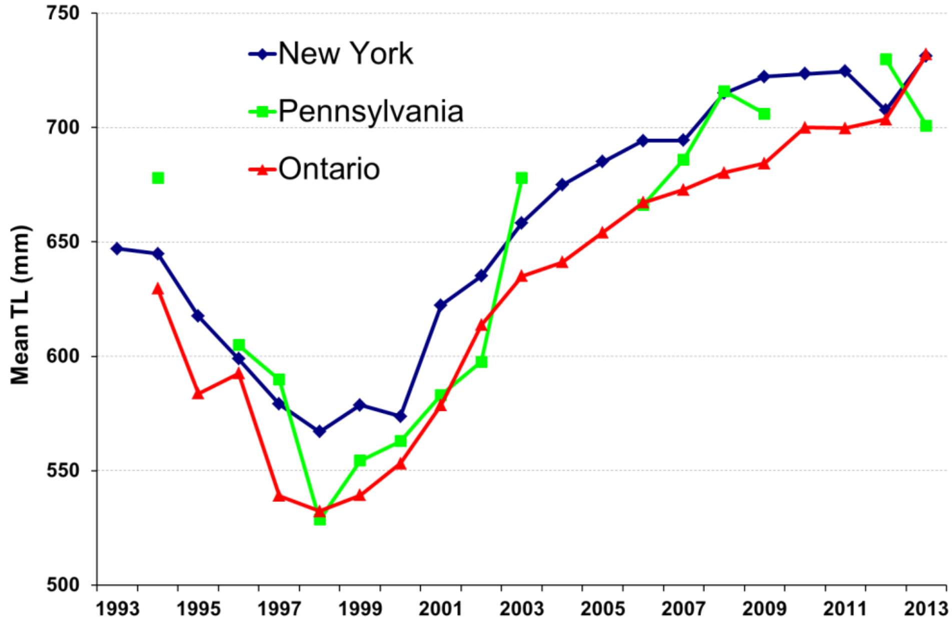

FIGURE 3.8. Average total length (TL) of Burbot caught in multi-agency summer gill net assessments by jurisdiction in eastern Lake Erie during 1993-2013.

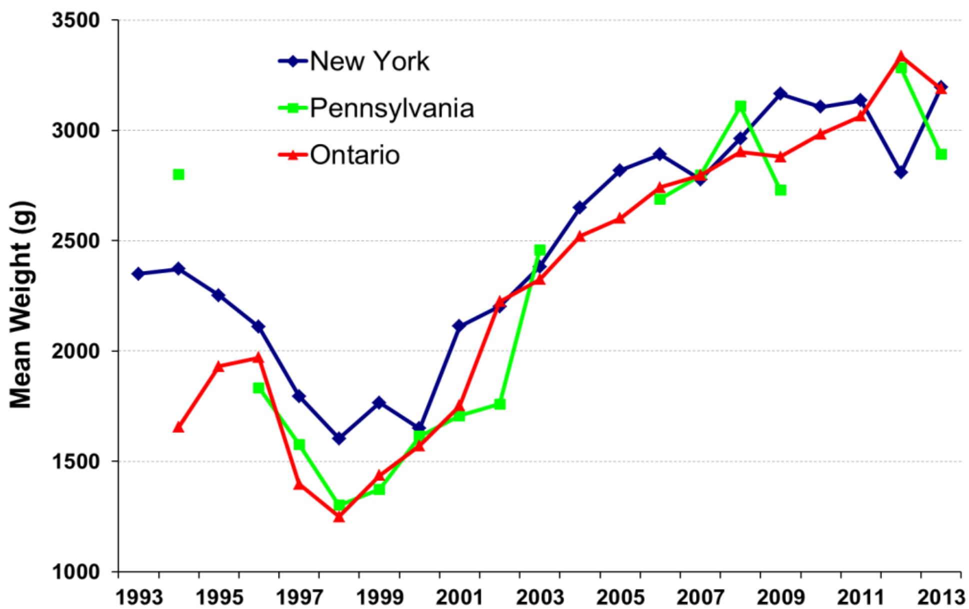

FIGURE 3.9. Average weight of Burbot caught in multi-agency summer gill net assessments by jurisdiction in eastern Lake Erie during 1993-2013.

Diet

Diet information was limited to fish caught during the August 2013 multi-agency coldwater gill net surveys in the eastern basin of Lake Erie. No diet information was collected from the Ontario Partnership Index Fishing Program. Analysis of stomach contents revealed a diet made up mostly of fish, but with a large "unknown fish species" content (Figure 3.10). Burbot diets continued to be diverse, with five different identifiable fish species and one invertebrate species found in stomach samples. Round Goby were the dominant prey item, occurring in 33% of the Burbot stomachs, followed by Rainbow Smelt (12% occurrence). Yellow perch were found in 11% of Burbot stomachs, all from New York and Pennsylvania. Other identifiable taxa, found in 5% of the stomachs, included white bass and dreissenid mussels.

Round Goby has 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 eight of the last 11 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 (≥ 20 m) areas of the eastern basin (Madenjian et al. 2011). Further, size-at-age of Burbot has increased since Round Goby became a significant component of the Burbot's diet (Stapanian et al. 2011). This increase in Burbot size is thought to be associated with reduced competition for food among juvenile Burbot during low recruitment years.

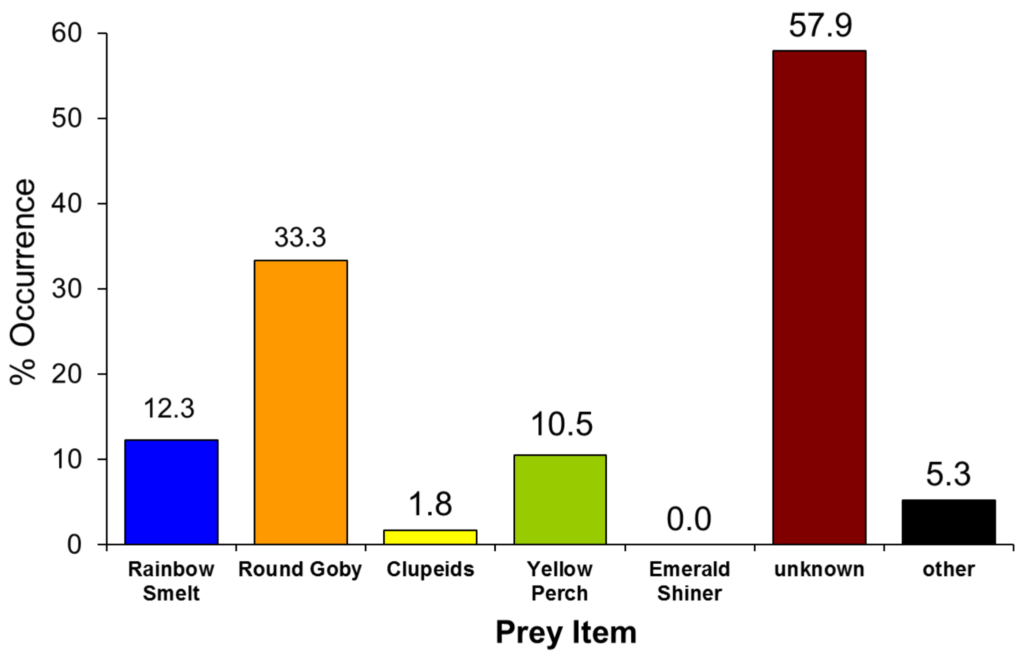

FIGURE 3.10. Frequency of occurrence of diet items from non-empty stomachs of Burbot (N=57) sampled in multi-agency coldwater assessment gill nets from the eastern basin of Lake Erie, August 2013. Unknown includes fish remains that could not be identified to species.

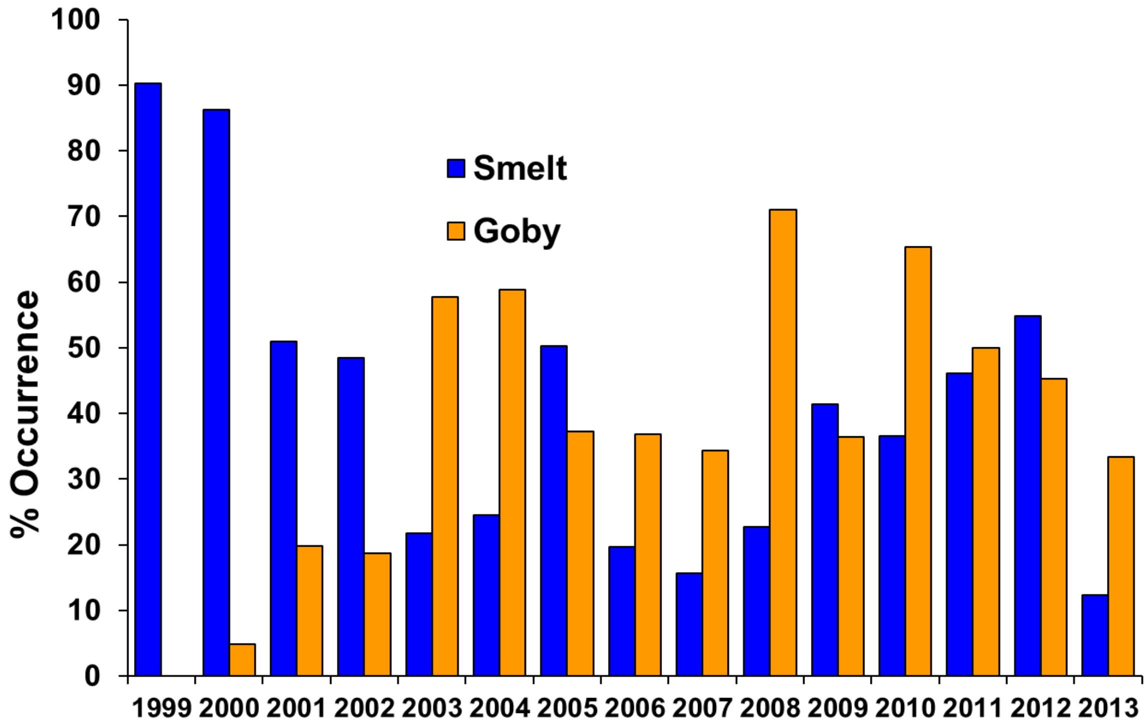

FIGURE 3.11. Frequency of occurrence of Rainbow Smelt and Round Goby in the diet of Burbot caught in summer multi-agency coldwater assessment gillnets in the eastern basin of Lake Erie, 1999-2013.

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

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

Tim Sullivan (USFWS), Fraser Neave (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 83 A1-A3 wounds were found on 581 Lake Trout greater than 532 mm (21 inches) total length in 2013, equaling a wounding rate of 14.3 wounds per 100 fish (Table 4.1; Figure 4.1). This was a 42% increase from the 2012 wounding rate of 10.1 wounds per 100 fish and a 73% increase over the past two years. The current wounding rate is nearly three times the target rate of 5.0 wounds per 100 fish (Lake Trout Task Group 1985; Markham *et al*. 2008). Wounding rates have remained above target for 18 of the past 19 years. Large Lake Trout continue to be the preferred targets for Sea Lamprey; Lake Trout greater than 736 mm (29 inches) total length (TL) had the highest A1-A3 wounding rate (18.6 wounds/100 fish) and fish between 635 and 736 mm TL (25-29 inches) had the second highest wounding rate (15.1 wounds/100 fish) (Table 4.1). Conversely, the 21 Lake Trout in the 432-532 mm (17-21 inch) size category did not have any wounds in 2013.

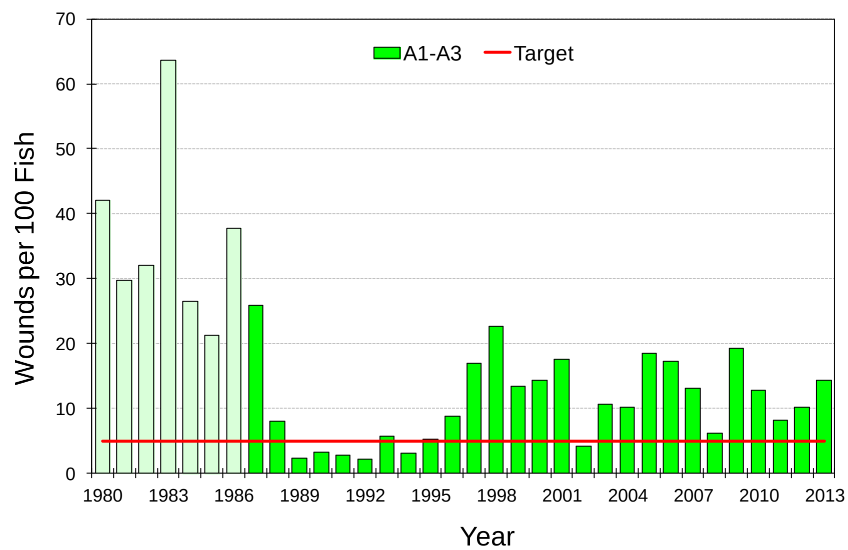

FIGURE 4.1. Number of fresh (A1-A3) Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2013. The target rate is 5 wounds per 100 fish. Lighter shading indicates pre-treatment years.

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 2013.

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	21	0	0	0	0	0.0	0.0
533-634	217	9	4	13	66	12.0	30.4
635-736	305	9	8	29	162	15.1	53.1
>736	59	1	4	6	97	18.6	164.4
>532	581	19	16	48	325	14.3	55.9

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 2013 was 3.3 wounds per adult Lake Trout greater than 532 mm, which was the highest A1 wounding rate since 1998 and well above the series average of 2.0 wounds per 100 fish (Table 4.1; Figure 4.2). A total of 19 A1 wounds were spread across all size categories greater than 532 mm.

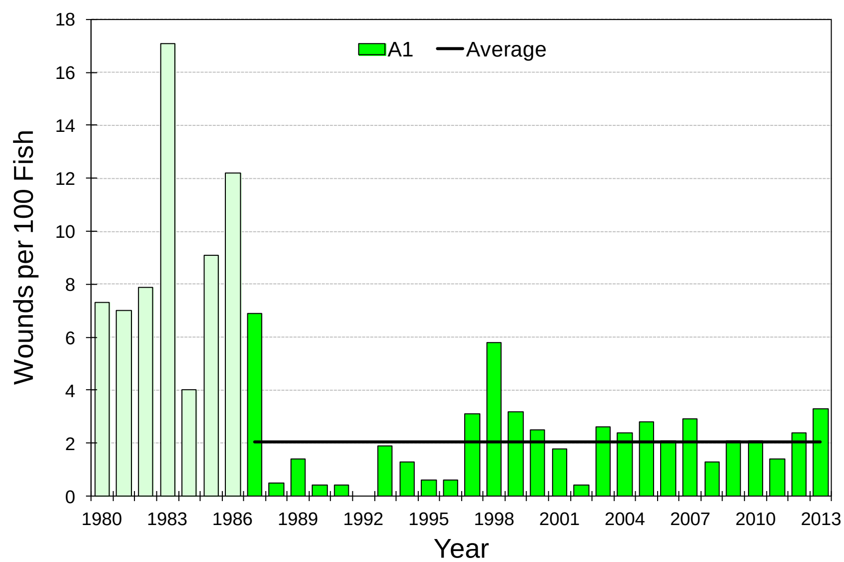

FIGURE 4.2. Number of A1 Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2013. The post-treatment average includes 1987-2012. Lighter shading indicates pre-treatment years.

The past year's cumulative attacks are indicated by A4 wounds. A4 wounding rates increased in 2013 to 55.9 wounds per 100 fish (Figure 4.3). This was second highest A4 wounding rate in the time series and well above average (25.4 wounds per 100 fish). Similar to previous years, A4 wounding rates increased with Lake Trout size and was an alarming 164.4 wounds per 100 fish in Lake Trout larger than 736 mm (29 inches) with many fish possessing multiple wounds (Table 4.1).

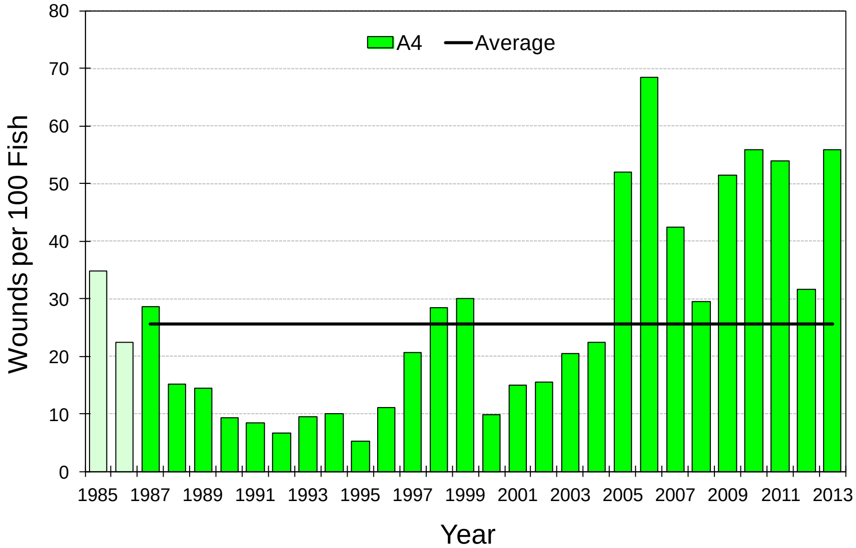

FIGURE 4.3. Number of A4 Sea Lamprey wounds per 100 Lake Trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1985-2013. The post-treatment average includes 1987-2012. Lighter shading indicates pre-treatment years.

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 nearly twice as high on KL strain Lake Trout compared to FL and LC strain Lake Trout, while 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 (KL, TI, AI, SUP, 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 four 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 may perform similarly to 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 2013. AI=Apostle Island, FL=Finger Lakes, KL=Klondike, LC=Lake Champlain, LE = Lake Erie, LL=Lewis Lake, LO = Lake Ontario, MIC = Michipicoten, 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	13	2	1	4	7	53.8	53.8
FL	132	5	2	8	124	11.4	93.9
KL	102	4	4	14	68	21.6	66.7
LC	206	7	3	11	67	10.2	32.5
LE	1	0	0	0	5	0.0	500.0
LL	3	0	1	2	4	100.0	133.3
LO	1	0	1	0	5	100.0	500.0
MIC	1	0	0	0	1	0.0	100.0
SI	43	1	1	4	7	14.0	16.3
TI	3	0	0	0	8	0.0	266.7

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). Wounding rates on Burbot increased in 2013; A1-A3 wounds increased to 3.3 per 100 Burbot while A4 wounds increased to 6.7 per 100 Burbot. This was the third highest A4 wounding rate in the 13 year series.

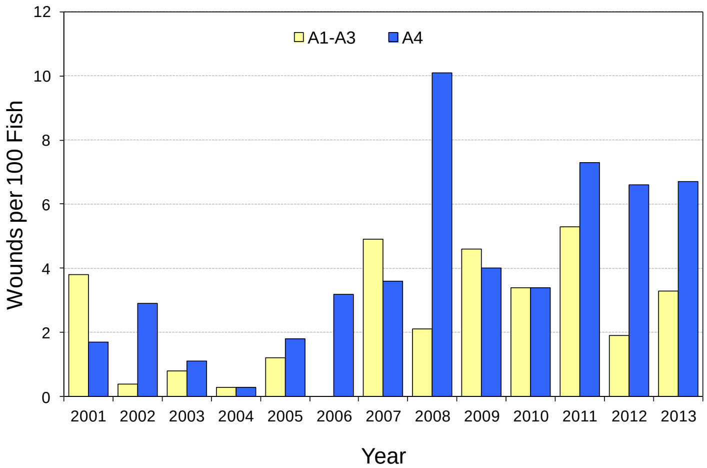

FIGURE 4.4. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Burbot (all sizes) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2013.

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 3 fresh (A1-A3) and 8 healed (A4) wounds were observed on 99 Lake Whitefish in 2013 assessment netting in New York, producing an A1-A3 wounding rate of 3.0 wounds/100 Whitefish and an A4 wounding rate of 8.1 wounds/100 fish (Figure 4.5). These were the highest wounding rates observed on Lake Whitefish in the series. Overall wounding rates on Lake Whitefish are low compared to Lake Trout, which we speculate may be due to higher post-wounding mortality.

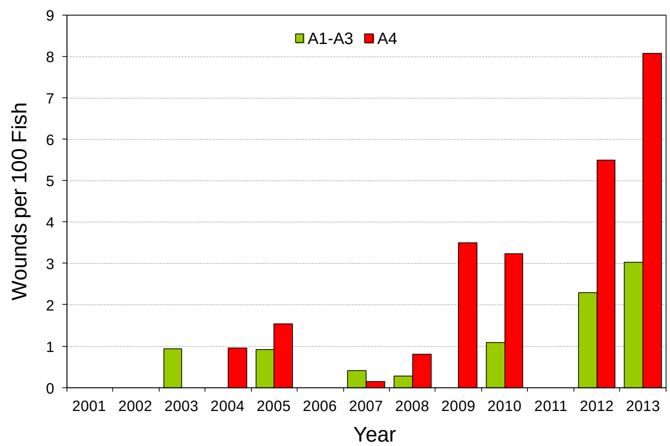

FIGURE 4.5. Number of A1-A3 and A4 Sea Lamprey wounds per 100 Lake Whitefish (all sizes) sampled in assessment gill nets in the New York waters of Lake Erie, August, 2001-2013.

Steelhead Wounding Rates

Similar to Burbot and 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 shortfall. However this data was not collected in 2013.

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 lakewide 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 45 Lake Trout were examined for wounds in 2013. The wounding rate (wounded Lake Trout per 100 examined) of type A1, A2 or A3 was 9.0% (4/43) on adult Lake Trout with total lengths greater than or equal to 532 mm (Figure 4.6). Three of twenty (3/20, 15.0%) Slate Island strain and one of 17 (1/17, 5.9%) Lake Trout of unknown strains had an A1-A3 wound. The scarring rate (A4 and B wounds combined) was also 9.0% (4/43 Lake Trout) (Figure 4.6). Lamprey scars were observed on Klondike (1/3 or 33.3%) and unknown (3/17 or 17.6%) strains of Lake Trout. The majority of the Lake Trout, and wounds, were found in eastern basin waters (Figure 4.6). Sea Lamprey wounds were also recorded on other fish species including Smallmouth Bass and Walleye.

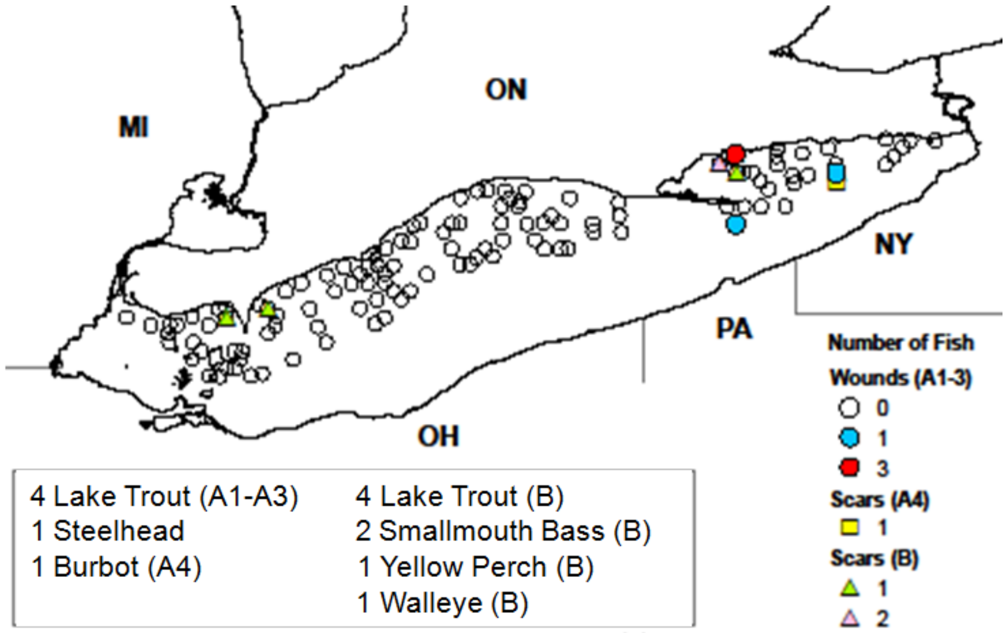

FIGURE 4.6. Number of Sea Lamprey wounds by category and site on fish examined for lamprey wounds during Partnership Index gillnetting, 2013. Includes all index and auxiliary gear.

2013 Sea Lamprey Control Actions

Lampricide Control

Lampricide applications were conducted in 12 streams in 2013 (Table 4.4). Bradley Creek, a tributary to Catfish Creek, was treated for the first time since 1987. Forestville Creek was treated as a result of assessment surveys in 2013 that indicated the presence of larvae upstream of the Sea Lamprey barrier. It was last treated in 1989. North and South creeks, tributaries to Big Creek, were treated upstream of Lehman dam for the first time. However, due to low flows and issues with irrigators, the upper portion of North Creek was not treated. This section of stream has been deferred until 2014. The upper portion of Spitler Creek, tributary to Big Otter Creek, was not treated due to low flows and has been deferred until 2014. Buffalo Creek and Cazenovia Creek, tributaries to Buffalo River, were treated for the first time. Due to insufficient flow, lampricide treatment of Cayuga Creek, a tributary to Buffalo River, was not treated.

Assessment

Assessments were conducted to search for new populations of sea lamprey larvae or to monitor existing populations in 66 tributaries and one offshore lentic area (Appendix 4.1). A population of large larval Sea Lamprey ammocoetes and juveniles was found in the Cazenovia and Cayuga Creeks, both tributaries to the Buffalo River, in New York. No larvae were detected in lotic and lentic surveys conducted in the Cattaraugus River estuary and Clinton River.

An enhanced sampling program was conducted in the St. Clair River and Lake St. Clair. There were 17.75 hectares sampled in the Upper St. Clair River and the three lower St. Clair River Channels (North, Middle, and South). Additionally 3.6 hectares were sampled in Lake St. Clair. There were a total of 444 Sea Lampreys captured in the St. Clair River and Lake St. Clair. No Sea Lamprey larvae were detected in the lower Detroit River after sampling 1.1 hectares with granular Bayluscide.

TABLE 4.4. Lake Erie lampricide treatments during 2013.

Tributary	Date	Distance Treated (km)
Canada		
Catfish Creek		
Bradley Creek	Jun 5	1.0
Big Otter Creek	Sep 6	129.5
Big Creek	Aug 20	102.0
Forestville Creek	Aug 19	3.3
Youngs Creek	Aug 21	0.4
United States		
Buffalo Creek	Jun 1	9.3
Cazenovia Creek	Sep 15	35.4
Delaware Creek	Jun 3	9.3
Cattaraugus Creek	Mar 29	112.1
Crooked Creek	May 3	12.4
Raccoon Creek	Apr 26	2.4
Conneaut Creek	May 7	102.4
Grand River	Apr 29	50.4

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 5,953 adult Sea Lampreys were captured in traps at 6 sites in 5 tributaries (compared to 3,015 caught in 2012). The estimated number of adult Sea Lampreys in Lake Erie during 2013 was 16,641 (Figure 4.7). The five-year average of adult Sea Lampreys is 22,252; this is 6.8X greater than the target and demonstrates a positive slope.

Construction of the Sea Lamprey trap at Scoby Hill Dam on Cattaraugus Creek was completed and the trap was operated during the 2013 trapping season, capturing 2,420 Sea Lampreys. Experimental trapping in Clear Creek, tributary to Cattaraugus Creek, was completed with the assistance of the Seneca Nation. Two fyke nets captured 53 Sea Lampreys.

Barriers

Upon learning of the poor condition of the Grand River Harpersfield Dam and abutments, the Army Corps of Engineers (Corps) 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. During fall 2013, staff from Marquette and Ludington completed electrofishing and larval habitat surveys in the upstream reaches of the Grand River to develop stream production estimates.

Consultations to ensure blockage at barriers were conducted with partner agencies for two sites in two tributaries (Table 4.5).

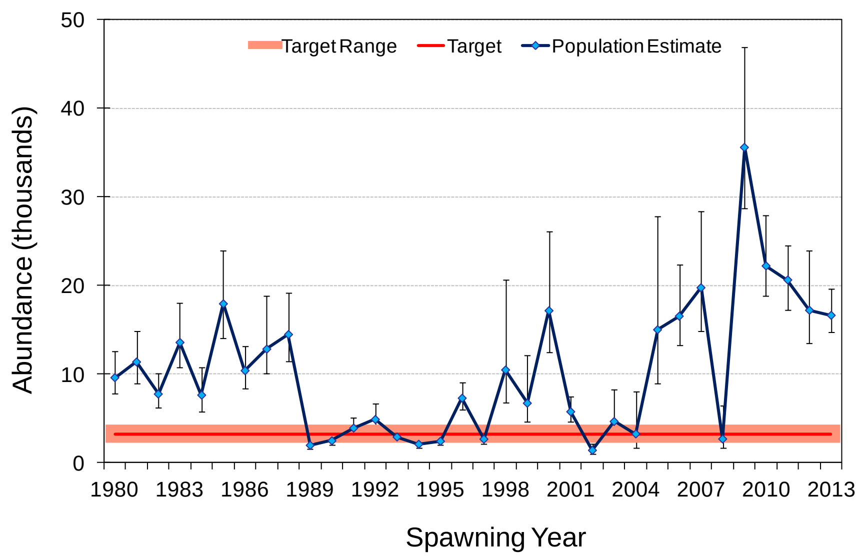

FIGURE 4.7. Lake-wide population estimates of adult Sea Lampreys in Lake Erie during 1980-2013 with 95% confidence intervals (black vertical lines). The target population level of 3,244 spawning adults (red horizontal line) with 95% confidence bounds (pink shading) is also shown.

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
Toussaint River		USFWS[1]	Install water control structure at dike	Concur	Will not affect SLC operations
Raisin River	South Br.	USFWS[1]	Tecumseh Dam	Concur	Upstream of blocking barrier

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

2014 Sea Lamprey Control Plans

Lampricide Control

Treatment of the upper Conneaut Creek has been proposed for 2014. North Creek (tributary to Big Creek) and Spitler Creek (tributary to Big Otter Creek) are scheduled for treatment.

Assessment

DFO is hoping to collaborate with Walpole Island First Nations to both quantify habitat and determine Sea Lamprey larval densities in the waters adjacent to their territory in the lower St. Clair River.

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

All Sea Lamprey caught in adult assessment traps in Lake Erie tributaries will be scanned for coded wire tags. This work is 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 transformers released in the HEC and eastern Lake Erie tributaries.

A Sea Lamprey production potential study is planned for the Grand River (Ontario) in 2014. This type of investigation focuses on the production potential for Sea Lamprey in tributaries above a critical barrier by sampling habitat and native lamprey populations as a surrogate for Sea Lamprey.

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 2015. In 2014, an additional two removable stoplogs with a total of 20 cm (8”) height will be installed on the Forestville Creek barrier.

Risk Management

A bioassay 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*).

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 2013 and plans for 2014.

Stream	History	Surveyed in 2013	Survey Type[1]	Results	Plans for 2014
Canada					
St. Clair River	Positive	Yes	Evaluation	Positive	Evaluation
Talford Creek	Negative	Yes	Detection	Negative	
Thames River	Positive	Yes	Evaluation	Positive	Evaluation
Belle River	Negative	Yes	Detection	Negative	
Puce River	Negative	Yes	Detection	Negative	
Pike River	Negative	Yes	Detection	Negative	
Turkey River	Negative	Yes	Detection	Negative	
Canard River	Negative	Yes	Detection	Negative	
Detroit River	Negative	Yes	Detection	Negative	
Cedar Creek	Negative	Yes	Detection	Negative	
East Creek	Positive	Yes	Evaluation	Positive	
Catfish Creek	Positive	No			Evaluation
Silver Creek	Positive	Yes	Evaluation	Negative	Evaluation
Big Otter Creek	Positive	Yes	Treat-Eval	Positive	Treat-Eval
South Otter Creek	Positive	No			Evaluation
Clear Creek	Positive	No			Evaluation
Big Creek	Positive	Yes	Evaluation	Positive	Treat-Eval
Dedrich Creek	Negative	Yes	Detection	Negative	
Forestville Creek	Positive	Yes	Evaluation	Positive	Treat-Eval
Normandale Creek	Positive	No			Evaluation
Fishers Creek	Positive	Yes	Evaluation	Negative	
Unnamed (E-116)	Negative	Yes	Detection	Negative	
Youngs Creek	Positive	No			Treat-Eval
Hay Creek	Negative	No			Detection
Grand River	Negative	Yes	Detection	Negative	Detection
United States					
Niagara River	Positive	No			Evaluation
Buffalo River	Positive	Yes	Eval/Dist	Positive	Treat-Eval
Delaware Creek	Positive	No			Treat-Eval
Muddy Creek	Negative	Yes	Detection	Negative	
Cattaraugus Creek	Positive	Yes	Treat-Eval	Positive	Evaluation
Cattaraugus Creek (estuary)	Positive	Yes	Treat-Eval	Negative	Evaluation
Big Sister Creek	Negative	No			Detection

Stream	History	Surveyed in 2013	Survey Type[1]	Results	Plans for 2014
Halfway Brook	Positive	Yes	Evaluation	Negative	
Beaver Creek	Negative	No			Detection
Canadaway Creek	Positive	No			Evaluation
Van Buren Creek #3	Unknown	Yes	Detection	Negative	
West Forest Ave. Creek	Unknown	Yes	Detection	Negative	
Chautauqua Creek	Positive	Yes	Evaluation	Negative	
Shore Haven # 3 Creek	Unknown	Yes	Detection	Negative	
Ripley Creek #1	Unknown	Yes	Detection	Negative	
Ripley Creek #2	Unknown	Yes	Detection	Negative	
Barden Rd. Creek #1	Unknown	Yes	Detection	Negative	
N. Brockaway Creek #2	Unknown	Yes	Detection	Negative	
Wiley Creek #1	Unknown	Yes	Detection	Negative	
Wiley Creek #2	Unknown	Yes	Detection	Negative	
Barnes Rd. Creek	Unknown	Yes	Detection	Negative	
Ripley Airport Creek	Unknown	Yes	Detection	Negative	
Shortman Creek	Unknown	Yes	Detection	Negative	
Stateline Creek	Unknown	Yes	Detection	Negative	
Walnut Creek	Negative	No			Detection
Trout Run Creek	Negative	No			Detection
Lake Erie Park Creek	Negative	No			Detection
Crooked Creek	Positive	Yes	Treat-Eval	Negative	Evaluation
Camp Lambec Creek #2	Unknown	Yes	Detection	Negative	
Camp Lambec Creek #3	Unknown	Yes	Detection	Negative	
Raccoon Creek (PA.)	Positive	Yes	Treat-Eval	Positive	Evaluation
Conneaut Creek	Positive	Yes	Treat-Eval	Positive	Treat-Eval
Conneaut Park Creek	Unknown	Yes	Detection	Negative	
Kingsville on the Lake Creek	Unknown	Yes	Detection	Negative	
North Kingsville Creek	Unknown	Yes	Detection	Negative	
Ashtabula River	Negative	Yes	Detection	Negative	
Geneva on the Lk. Creek	Unknown	Yes	Detection	Negative	
Cowles Creek	Negative	Yes	Detection	Negative	
Camp Roosevelt Creek #1	Unknown	Yes	Detection	Negative	
Camp Roosevelt Creek #2	Unknown	Yes	Detection	Negative	
Grand River (OH)	Positive	Yes	Treat-Eval	Negative	Evaluation
Grand River (above	Negative	Yes	Barrier	Negative	

Stream	History	Surveyed in 2013	Survey Type[1]	Results	Plans for 2014
Mechanicsville Dam)					
McKinley School Creek	Unknown	Yes	Detection	Negative	
Chagrin River	Positive	Yes	Evaluation	Positive	Evaluation
Ninemile Creek (OH)	Unknown	Yes	Evaluation	Negative	
Doan Brook	Unknown	Yes	Detection	Negative	
Beulah Beach Creek #1	Unknown	No			Detection
Beulah Beach Creek #2	Unknown	No			Detection
Beulah Beach Creek #3	Unknown	No			Detection
Cranberry Creek	Unknown	No			Detection
Huron River (East & West Br.)	Negative	No			Detection
Rye Beach Creek	Unknown	No			Detection
Meadow Brook	Unknown	No			Detection
Portage River	Negative	No			Detection
La Carpe Creek	Unknown	No			Detection
River Raisin (Barrier)	Negative	Yes	Barrier	Negative	
Black River (MI)	Positive	Yes	Evaluation	Negative	
Mill Creek (trib Black River)	Positive	No			Evaluation
Pine River (St. Clair Co.)	Positive	Yes	Evaluation	Positive	Evaluation
Belle River	Positive	Yes	Evaluation	Negative	Evaluation
Clinton River	Positive	Yes	Evaluation	Negative	Evaluation
St. Clair River	Positive	Yes	Evaluation	Positive	Evaluation
Detroit River	Negative	Yes	Detection	Negative	Detection
Madison on the Lk. #1	Unknown	Yes	Detection	Negative	
Madison on the Lk. #2	Unknown	Yes	Detection	Negative	
Camp Wingfoot Creek	Unknown	Yes	Detection	Negative	
North Perry Park Creek	Unknown	Yes	Detection	Negative	

[1]Evaluation survey – conducted to detect larval recruitment in streams with a history of Sea Lamprey infestation.
Detection survey – conducted to detect larval recruitment in streams with no history of Sea Lamprey infestation.
Distribution survey – conducted to determine 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, 260,040 Lake Trout were stocked in Lake Erie in 2013, the second 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 first time ever, Lake Trout stocking occurred in each of the Lake Erie basins: yearling Lake Trout were stocked in Ohio at both Catawba (40,900) and Fairport Harbor (41,300), in Pennsylvania at Northeast (82,400), and in New York offshore of Dunkirk (41,200). In addition, the Ontario Ministry of Natural Resources stocked 54,240 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. These were the first yearling Lake Trout stocked from this hatchery since it was closed for disinfection and maintenance in 2006 and re-opened in 2012. Slate Island strain Lake Trout were stocked in Ontario waters.

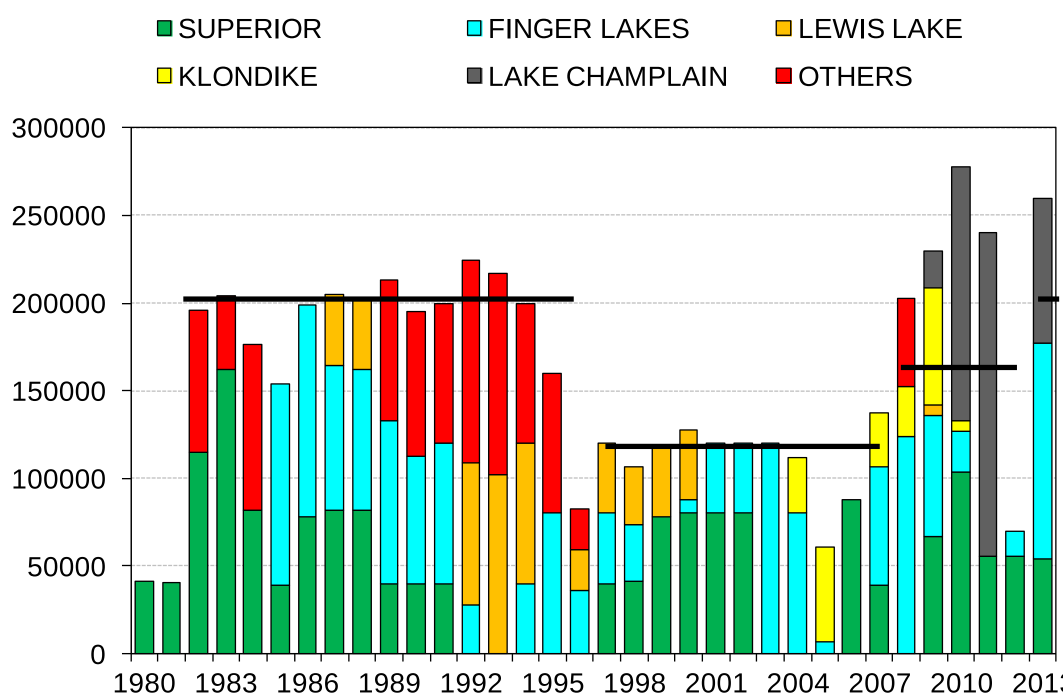

FIGURE 5.1. Lake Trout (in yearling equivalents) stocked by all jurisdictions in Lake Erie, 1980-2013, by strain. Stocking goals through time are shown by black lines dark lines; the current stocking goal is 200,000 yearlings per year. Superior includes Superior, Apostle Island, Traverse Island, Slate Island, and Michipocten strains; Others include Clearwater Lake, Lake Ontario, Lake Erie, and Lake Manitou strains.

Stocking of Other Salmonids

In 2013, over 2.2 million yearling trout and salmon were stocked in Lake Erie, including Rainbow/Steelhead Trout, Brown Trout and Lake Trout (Figure 5.2). Total salmonid stocking increased 13% from 2012, but was 3% below the long-term average (1990-2012). 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 1,852,488 yearling

Rainbow/Steelhead Trout were stocked in 2013, accounting for 83% of all salmonids stocked. This was a 4% increase in Steelhead Trout stocking from 2012, and very near the long-term (1990-2012) average (1,850,105 yearlings). Rainbow Trout/Steelhead stocking decreased 90% in Ontario waters (due to problems at their NGO hatchery) and 3% in Michigan waters from 2012, increased 7% in Ohio waters and 5% in Pennsylvania waters, and remained the same in New York waters compared to 2012. A full account of Rainbow/Steelhead Trout stocked in Lake Erie by jurisdiction for 2013 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.

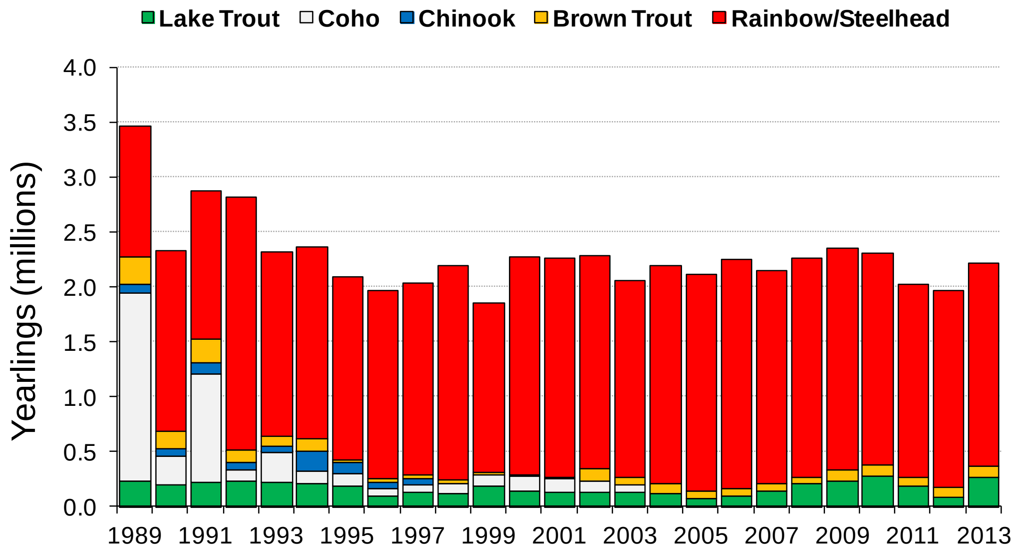

FIGURE 5.2. Annual stocking of all salmonid species (in yearling equivalents) in Lake Erie by all agencies, 1989-2013.

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 (~36%) are also stocked to provide adult trout for the opening day of trout season in Pennsylvania. Brown Trout stocking is expected to continue at this rate for 2014 in both New York and Pennsylvania.

Brown Trout stocking in Lake Erie totaled 104,116 yearlings in 2013. This was a 3% increase from 2012 and a 34% increase over the long-term (1990-2012) average annual stocking of 77,808 Brown Trout. The NYSDEC stocked 32,630 yearling Brown Trout in Cattaraugus Creek, Barcelona Harbor, Point Breeze and Dunkirk Harbor between 18 April and 29 April 2013. 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 9 April and 22 April, 29,700 adult Brown Trout were stocked by the PFBC to provide catchable trout for the opening of the 2013 Pennsylvania trout season. Yearling and fall fingerling Brown Trout were also stocked in Pennsylvania waters in support of a put-grow-take Brown Trout program that was initiated in 2009. This program is currently being supported through the annual donation of 100,000 certified IPN-free eggs from the NYSDEC. Various Pennsylvania NGO's stocked a total of 39,100 yearling Brown Trout in May which were adipose fin-clipped. The PFBC stocked an additional 30,766 fall fingerlings between 1 October and 4 October; 5,006 (16%) of these were stocked in Presque Isle Bay and were left ventral (LV) fin-clipped; the remaining 25,760 (74%) were stocked in nursery streams and marked with a right ventral (RV) fin clip. An evaluation of this fishery continues.

TABLE 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1990-2013.

	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, 1990-2013.

	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**

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 2013 (Table 6.1). Based on these efforts, a total of 1,847,488 yearling Steelhead and 5,000 domestic rainbow trout (NY) were stocked in 2013, representing a 4% increase from 2012 and a 2% increase from the long-term (1990-2012) average. Nearly all of the Steelhead stocked in Lake Erie originated from naturalized Great Lakes strains. A Lake Erie strain accounted for 58% of the strain composition, followed by a Lake Michigan strain (28%) and a Lake Ontario strain (14%); 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. Additionally, Pennsylvania stocked 185,000 surplus Steelhead spring fingerlings (57mm) and Ohio stocked 140,000 surplus fall fingerlings (74mm).

TABLE 6.1. Rainbow Trout/Steelhead stocking by jurisdiction and location for 2013.

Jurisdiction	Location	Strain	Number	Life Stage	Yearling Equivalents	
Michigan	Huron River	Manistee River, L. Michigan	62,400	Yearling	**62,400**	**Sub-Total**
Ontario	Mill Creek	Ganaraska River, L. Ontario	1,750	Adult	1,750	
	Lake Erie at Wheatley Harbour	Ganaraska River, L. Ontario	250	Adult	250	
					2,000	**Sub-Total**
Pennsylvania	Conneaut Creek	Trout Run, L. Erie	75,000	Yearling	75,000	
	Crooked Creek	Trout Run, L. Erie	74,000	Yearling	74,000	
	Elk Creek	Trout Run, L. Erie	240,896	Yearling	240,896	
	Fourmile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Godfrey Run	Trout Run, L. Erie	18,500	Yearling	18,500	
	Godfrey Run	Trout Run, L. Erie	141,100	Fingerling	1,411	
	Presque Isle Bay	Trout Run, L. Erie	83,413	Yearling	83,413	
	Raccoon Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Sevenmile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Sixteenmile Creek	Trout Run, L. Erie	18,500	Yearling	18,500	
	Trout Run	Trout Run, L. Erie	46,250	Yearling	46,250	
	Trout Run	Trout Run, L. Erie	44,000	Fingerling	440	
	Twelvemile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Twentymile Creek	Trout Run, L. Erie	111,000	Yearling	111,000	
	Walnut Creek	Trout Run, L. Erie	185,000	Yearling	185,000	
	Lake Erie	Trout Run, L. Erie	70,000	Yearling	70,000	
					1,072,410	**Sub-Total**
Ohio	Chagrin River	Manistee River, L. Michigan	108,353	Yearling	108,353	
	Conneaut Creek	Manistee River, L. Michigan	75,184	Yearling	75,184	
	Grand River	Manistee River, L. Michigan	90,149	Yearling	90,149	
	Rocky River	Manistee River, L. Michigan	106,996	Yearling	106,996	
	Vermilion River	Manistee River, L. Michigan	67,917	Yearling	67,917	
	Vermilion River	Manistee River, L. Michigan	60,161	Fingerling	2,124	
	Lake Erie at Ashtabula	Manistee River, L. Michigan	79,039	Fingerling	2,790	
	Lake Erie @Fairport	Manistee River, L. Michigan	61,326	Fingerling	2,165	
					455,678	**Sub-Total**
New York	Erie Basin Marina	Domestics	1,000	Yearling	1,000	
	Buffalo River	Domestics	4,000	Yearling	4,000	
	Eighteen Mile Creek	Washington	20,000	Yearling	20,000	
	Eighteen Mile Creek (South Branch)	Washington	20,000	Yearling	20,000	
	Buffalo Creek	Washington	15,000	Yearling	15,000	
	Buffalo River Net Pens	Washington	10,000	Yearling	10,000	
	Canadaway Creek	Washington	20,000	Yearling	20,000	
	Cattaraugus Creek	Washington	90,000	Yearling	90,000	
	Cayuga Creek	Washington	10,000	Yearling	10,000	
	Cazenovia Creek	Washington	10,000	Yearling	10,000	
	Chautauqua Creek	Washington	40,000	Yearling	40,000	
	Silver Creek	Washington	10,000	Yearling	10,000	
	Walnut Creek	Washington	10,000	Yearling	10,000	
					260,000	**Sub-Total**
					1,852,488	**Grand Total**

State fisheries management agencies are responsible for 98% of all stocking effort in Lake Erie. Approximately 4% of the Steelhead stocking is through sportsmen's organizations in Pennsylvania (70,163 yearlings) and Ontario (2,000 yearlings). Fisheries agency stocking of spring yearlings took place between February and May, when smolts averaged about 181 mm in length (Range: 127 mm (NY) – 204 mm (MI)) (Table 6.2). No tagging and only a limited amount clipping have been conducted on Lake Erie Steelhead since 1999. There were no fin clipped Steelhead stocked in 2013 (Table 6.3).

TABLE 6.2. Yearling Steelhead stocking summaries for 2013 by fisheries agency.

Agency	Range of Dates Stocked	mean length (mm)	N of yearlings stocked
Michigan Dept. of Natural Resources	16 April - 17 April 2013	204	64,500
New York Dept. of Environmental Conservation	2 April - 17 April 2013	127	255,000
Ohio Division of Wildlife	26 March - 10 May 2013	189	420,787
Pennsylvania Fish and Boat Commission	19 February - 8 April 2013	191	1,000,396

TABLE 6.3. Fin clips of Steelhead stocked in Lake Erie, 2000-2013.

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	-	-	-	-	-

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

NYSDEC Steelhead Smolt and Predator Diet 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 newly stocked Steelhead was detectable in predator diets. 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. These sites were sampled once prior to stocking in April, and then post-stocking twice each week through the remainder of April and once each week during May. A mid-stream sampling location was later added in Canadaway Creek due to low catches observed at the upper site. Predator diets were assessed from fish collected by two, 200-ft gill net gangs fished overnight, off the two survey stream mouths during both April and May. Timing of the netting was planned to coincide with peak emigration of stocked Steelhead.

Results of this pilot study showed stark differences in emigration patterns between these two streams. Over 40% of the total sample at the upper/middle sites on Canadaway Creek was collected on the first sample date, and over 70% was caught within the first three sampling dates. Very few Steelhead were caught at the river mouth site. Conversely, catches of Steelhead at the upper site on Chautauqua Creek remained consistently high throughout most of the sampling dates, and catches at the mouth peaked in early May. The reasons for the differences between the two streams are unclear.

Our study indicates that a high percentage of stocked Steelhead smolts do not emigrate to Lake Erie. This was particularly evident on Chautauqua Creek where good numbers of stocked Steelhead remained just downstream of the stocking site until the end of May. At the upper site on Chautauqua Creek, fish in the upper length categories of the stocking distribution that were present in April were no longer present in May, and mean length of sampled fish declined from April to May. Companion results from Canadaway Creek were less definitive due to low sample sizes. Studies on the Pacific coast (Chrisp and Bjornn 1978; Bjornn *et al.* 1979) and in Michigan (Seelbach 1987) determined that percent smolting and percent adult returns are insignificant when the average stocked size of Steelhead is less than 160 mm. These studies found the minimum size at smolting is 150-160 mm; stocked Steelhead smaller than this length threshold will not smolt but will remain in the stream for an additional year or more, and become subject to high mortality rates with little chance of providing benefits to the fishery. According to our length-frequency distribution of stocked fish in 2013, only 13.4% of our stocked Steelhead were larger than150 mm. If Michigan and Pacific coast study results apply to NY's stocked Steelhead, then only 13% of NY's stocked Steelhead smolt and out-migrate, while 87% remain in the stream with little chance of survival.

The predator diet investigation was not able to identify predation on Steelhead smolts in these streams. Emigration patterns showed that Steelhead did not exit the streams in large numbers following stocking but trickled out in smaller numbers. While numbers of potential predators were high in the nearshore areas following stocking, especially in Canadaway Creek, diet analysis indicated that almost all of the walleye were not actively feeding at this time, and other predators such as smallmouth bass were targeting benthic species such as crayfish and round gobies.

PFBC Steelhead Smolt Emigration Study

Godfrey Run in Pennsylvania is a small tributary to Lake Erie that is used by the Pennsylvania Fish and Boat Commission (PFBC) as a secondary brood stock site for collecting adult Steelhead for gametes in support of their Steelhead hatchery program. This tributary is designated as a nursery stream and is closed to fishing. It is secured by a fence, making it an excellent location for doing Steelhead assessment. The PFBC Lake Erie Unit conducted a pilot Steelhead smolt emigration study on Godfrey Run during the spring of 2013. Godfrey Run was stocked with 18,500 yearling Steelhead smolts by PFBC hatchery staff on 12 March 2013. The release site is where Godfrey Run passes under PA Route 5, and is approximately 1.15 river miles (1.85 km) upstream from the mouth of the tributary at Lake Erie. Emigrating smolt counts were initiated on 13 March. A trap was situated in a weir, approximately 70 meters upstream of the mouth, such that all emigrating smolts would be contained for counting and measuring. The stream distance between the stocking site and weir is approximately 1.75 km. The trap was cleared on a daily basis. Between 13 March and 3 May, smolt counts and length measurements were conducted on 26 days (out of a total 52 days). A total of 2,216 smolts were counted and 1,345 were measured. Weather and staffing limitations precluded more frequent sampling.

Daily average discharge (Q) data was obtained from a USGS gauging station at Walnut Creek (USGS 04213152), approximately 5 miles (8 km) east of Godfrey Run. Daily temperature data was collected at Godfrey Run when smolt counts were obtained. Based on the discharge data from the Walnut Creek gauging station, there were four significant discharge events between 13 March-3 May (Figure 6.1). The largest discharge event was seen between 27 March-3 April. Sizable changes in temperature in Godfrey Run were also observed between 4 April-9 April and 17 April-19 April. The largest smolt emigration counts were observed on 28 March, 9 April, 10 April, and 19 April.

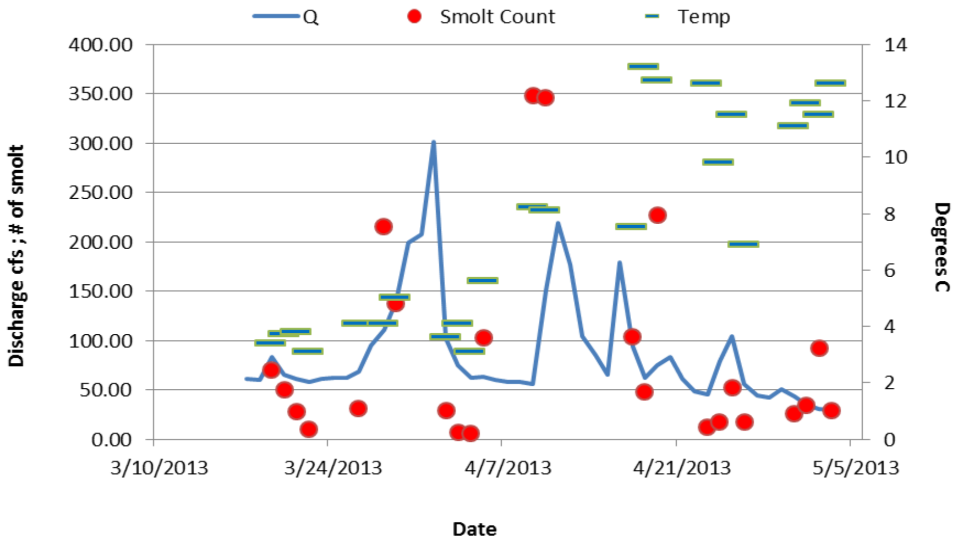

FIGURE 6.1. Average daily discharge (Q) at Walnut Creek and daily smolt counts and stream temperatures at Godfrey Run between 13 March and 3 May, 2013.

Assuming that smolts encountered in the trap represent emigrating smolt behavior, a few observations can be made. Emigration appears to be influenced by discharge and temperature. Average stream residency time for smolts stocked in Godfrey run was 26 days. Larger smolts tended to emigrate sooner than smaller smolts (Figure 6.2). Several very large smolts (>250 mm) that were encountered during the survey were likely escapees from a cooperative sportsmen's hatchery located at the headwaters of Godfrey Run, but they could also be hold-over or wild fish. Emigration could not be quantified when discharge was high. This information would be important to know to compare volitional vs. acute, physically- (flow-) induced emigration.

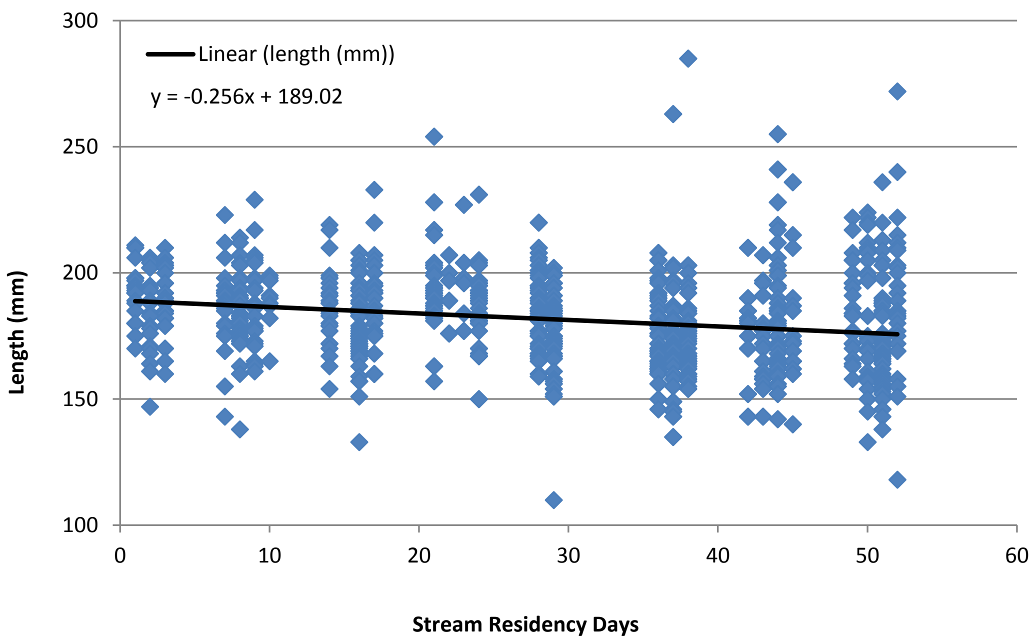

FIGURE 6.2. Length of emigrating steelhead smolts in Godfrey Run as related to days of stream residency.

Exploitation

While 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 estimated Steelhead harvest from the summer open-water boat angler fishery in 2013 was 5,247 Steelhead in all U.S. waters; a 48% decrease from the 2012 estimated Steelhead harvest (Table 6.4). Ohio and Pennsylvania accounted for nearly 90% of the 2013 open lake harvest. Harvest declined sharply in Ohio (51%) and Pennsylvania (53%), but increased moderately in New York and significantly in Michigan waters. Most jurisdictions also showed a decrease in harvest from the long-term (14 year) average; Ohio's harvest was 78% below average, Pennsylvania's harvest was 65% below average and New York's harvest was 29% below average. Among the U.S. jurisdictions, over 76% of the reported harvest was concentrated in central basin waters of Ohio (55%) and Pennsylvania (21%). The west-central basin waters of Ohio accounted for 5% the harvest. The east basin accounted for 15% of the harvest, mostly in New York waters (9%). The eastern basin waters in Pennsylvania accounted for 5% of the open lake Steelhead harvest. Atypical of most years, about 4% of the 2013 Steelhead harvest took place in the West basin waters of Ohio (3%) and Michigan (1%).

Open-lake Steelhead angler harvest rates declined in all areas of Lake Erie in 2013 (Figure 6.3). 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 2012, the 2013 Steelhead harvest rates declined significantly in Ohio and Pennsylvania and remained stable in Ontario. Steelhead boat angler harvest rates in 2013 were highest in Ontario waters (0.07 Steelhead/angler hr) followed by Pennsylvania waters (0.05 Steelhead/angler hr) and Ohio (0.01 Steelhead/angler hr). The Ontario Steelhead angler catch rate improved 7% from 2012, but was 26% below the long-term average of 0.10 Steelhead per angler hour. The combined harvest rate for 2013 across all reporting agencies (0.13 Steelhead/angler hr) was 13% above the long-term interagency average of 0.12 Steelhead per angler hour.

TABLE 6.4. Estimated harvest by open lake boat anglers in Lake Erie, 1999-2013.

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	13,645
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
1999-2012 mean	15,443	3,974	683	33,025	42	29,577

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

** 2004 OMNR sport harvest data is July and August, central basin waters only

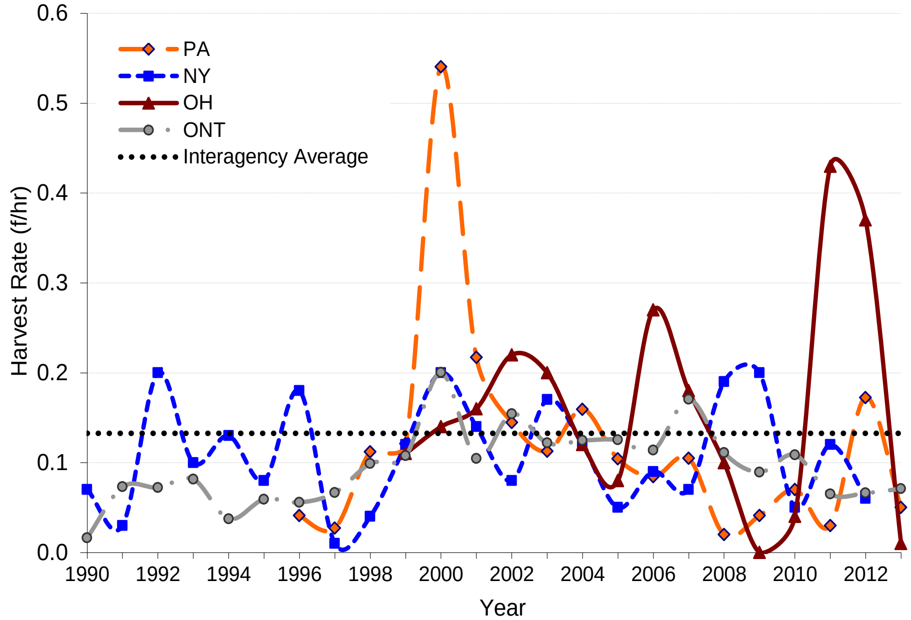

FIGURE 6.3. Targeted Steelhead harvest rates (fish/angler hr) in Lake Erie by open lake boat anglers in Ohio, Pennsylvania, New York, and Ontario 1990-2013.

The Ontario Ministry of Natural Resources did not conduct open water angler surveys during 2013 that could provide comprehensive estimates of Steelhead harvest, effort or catch rates in open-lake waters of Lake Erie. However, they collected angler diary reports that can detail trends over time by area of the lake. In 2013, diarists reported 57 targeted Steelhead (Rainbow Trout) angler trips in west-central basin and 41 targeted trips in the east-central basin waters of Lake Erie. Only four trips targeting Steelhead were recorded through the diary program in the east basin for 2013. Angler diary reports from Ontario in west-central basin waters show that rod-hours for Steelhead in 2013 declined 17% from 2012 and were 31% below the 23-year (1990-2012) mean. The 1,898 rod-hours reported by diarists in 2013 was the lowest since 1992 (Figure 6.4). Steelhead catch rates in the west central basin (0.07 fish/rod-hr) were 44% lower than 2012, and 53% lower than the long-term average of 0.145 fish per rod-hour. The 1,209 rod-hours recorded by anglers fishing the east central basin for Steelhead was a significant increase (48%) from 2012, but remained 17% below the 23-year average of 1,451 rod-hours (Figure 6.5). The catch rate of 0.046 fish per rod-hour was a 59% improvement from 2012, but was 39% below the long-term average (0.08 fish/ rod-hr).

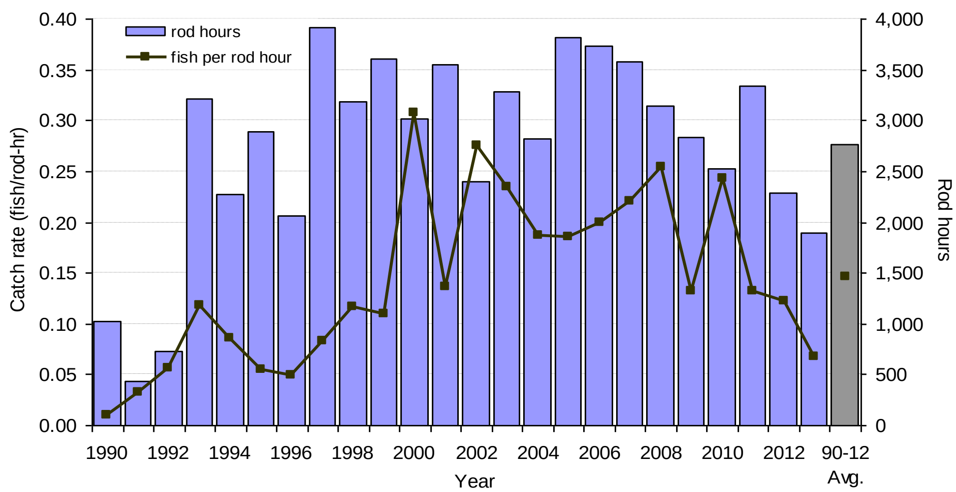

FIGURE 6.4. Targeted Steelhead effort and catch rates in Lake Erie's west-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2013.

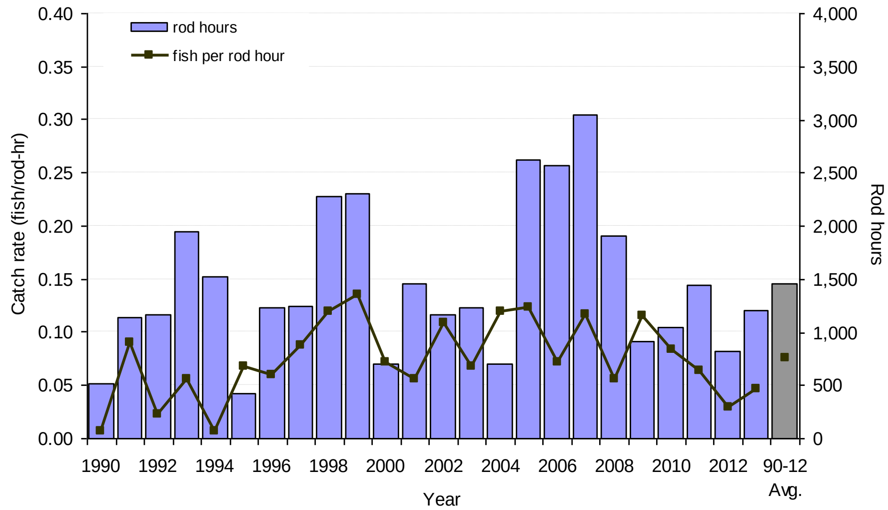

FIGURE 6.5. Targeted Steelhead effort and catch rates in Lake Erie's east-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2013.

Tributary Creel 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.

An angler diary program maintained by the NYSDEC Lake Erie Fisheries Unit provides the best review of annual catch rates by tributary anglers through 2012. This data shows that catch rates by Steelhead anglers in New York streams had steadily increased throughout most of the last two decades and peaked in 2006. Catch rates remained high through 2008, declined sharply in 2009 and 2010, and those rose again in 2011 and 2012 (Figure 6.6). Diary cooperator catch rates in 2012 were 0.84 Steelhead/hour, which was a time series high and well above the long-term series average of 0.49 Steelhead per angler hour.

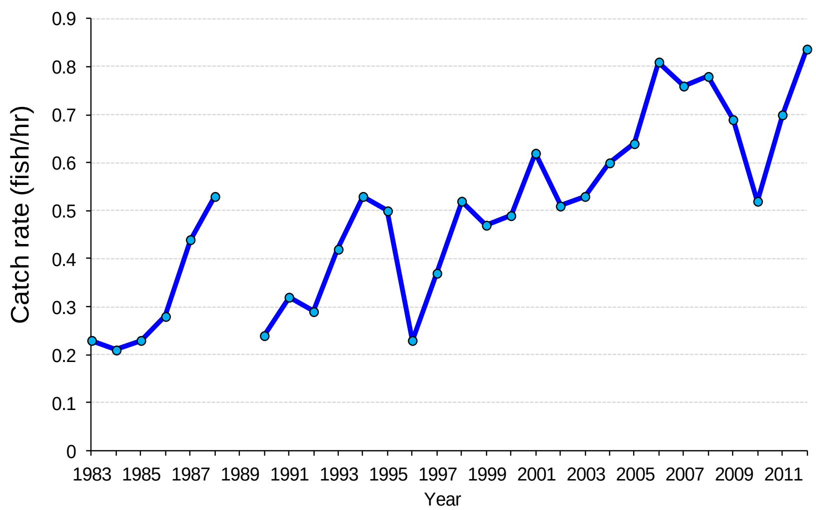

FIGURE 6.6. Targeted Steelhead catch rates (fish/angler hour) in Lake Erie tributaries by New York angler diary cooperators, 1987-2012.

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

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

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 catches 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 coincided with 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 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 2013). The most recent, acoustically derived, estimate of yearling-and-older Smelt abundance is low (1,754/hectare; 2013) relative to a recent peak in 2009 (~12,000/hectare; Forage Task Group 2013). Alewives have never been very abundant in Lake Erie due to overwinter temperatures that frequently prove lethal (Ryan et al. 1999). An apparent natural recovery from historic lows of other coldwater species (i.e. Lake Whitefish and Burbot) together with the current, relatively low abundance of Rainbow Smelt 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 success of their 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 10 of the last 12 years, the majority of which involve the surrendering of samples by commercial fishermen. It is difficult to assess abundance from these reports as they represent the passive submission of bycatch by the small number of fishers who recognize their importance. Recent reports and collections are summarized in Table 7.1. Individual Ciscoes have been caught in both trawl and gillnet fisheries, with the highest number of occurrences associated with the tip of Long Point, near the north-shore division of the eastern and central basins (Figure 7.1). In 2013, one 5-year old, male Cisco was captured south of Long Point by a commercial trawler.

Despite a great deal of effort using both trawl and gillnet throughout the basin, Cisco observations in fishery assessment surveys are rare. The annual OMNR Partnership index gillnet program, a spatially intensive survey of all Ontario waters has only one Cisco observation in its 25-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 the central basin close to Fairport Ohio, in 2000. Questions arise as to the efficacy of relying on assessments (methodologies, gear configuration) designed for other species or fish communities as a whole.

Concerted efforts to target Cisco have been few and results hit-and-miss. An OMNR-OCFA partnership to test an experimental selective trawl gear near Long Point in the early 1990s resulted in nine specimens. An onboard observer program meant to detail non-target bycatch in the commercial trawl fishery was implemented in 2013 but did not result in any additional observations. Designed to observe and detail the bycatch of all non-target fish species, the protocol was not ideally suited for capturing one rare species. Targeting historical Cisco spawning locations in the western basin during the fall of 2011 and 2012, USGS-Lake Erie Biological Station conducted a limited amount of gillnet sampling near Kelley's Island, western basin reefs, and Vermilion, OH. No Cisco were caught even though expected habitat conditions and fish assemblages, from historical descriptions of Cisco spawning areas, were observed (CWTG 2013; Charge 7, page 5).

Recent observations of Cisco in Lake Erie represent a range of size and year classes (Table 7.1), and thus, suggest ongoing recruitment from some source or sources. It remains uncertain if these sources are internal or external to the lake. Ongoing work within the Saint Clair-Detroit River System (SCDRS) may provide some insight into the possibility of immigration into Lake Erie from the Upper Lakes. Surveys conducted as part of a collaborative effort to assess the corridor have documented young (larval and juvenile) coregonine fishes within both the Saint Clair and Detroit Rivers. Two larvae were collected (12.0 mm TL) on May 11-12, 2010, and one on June 16, 2011, in the St. Clair River (Edward Roseman, USGS-GLSC, pers. comm.; 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 a further 39 were captured using D-frame nets in June and July. It should be noted that transient larvae of a variety of coldwater species were found throughout the main channel of the river in 2013, including Lake Whitefish, Bloater and a large number of Burbot larvae (Edward Roseman, USGS-GLSC, pers. comm.). Three Cisco larvae were also captured in the Detroit River main channel in 2013; possibly representing the first confirmation of larval Cisco in this part of the system.

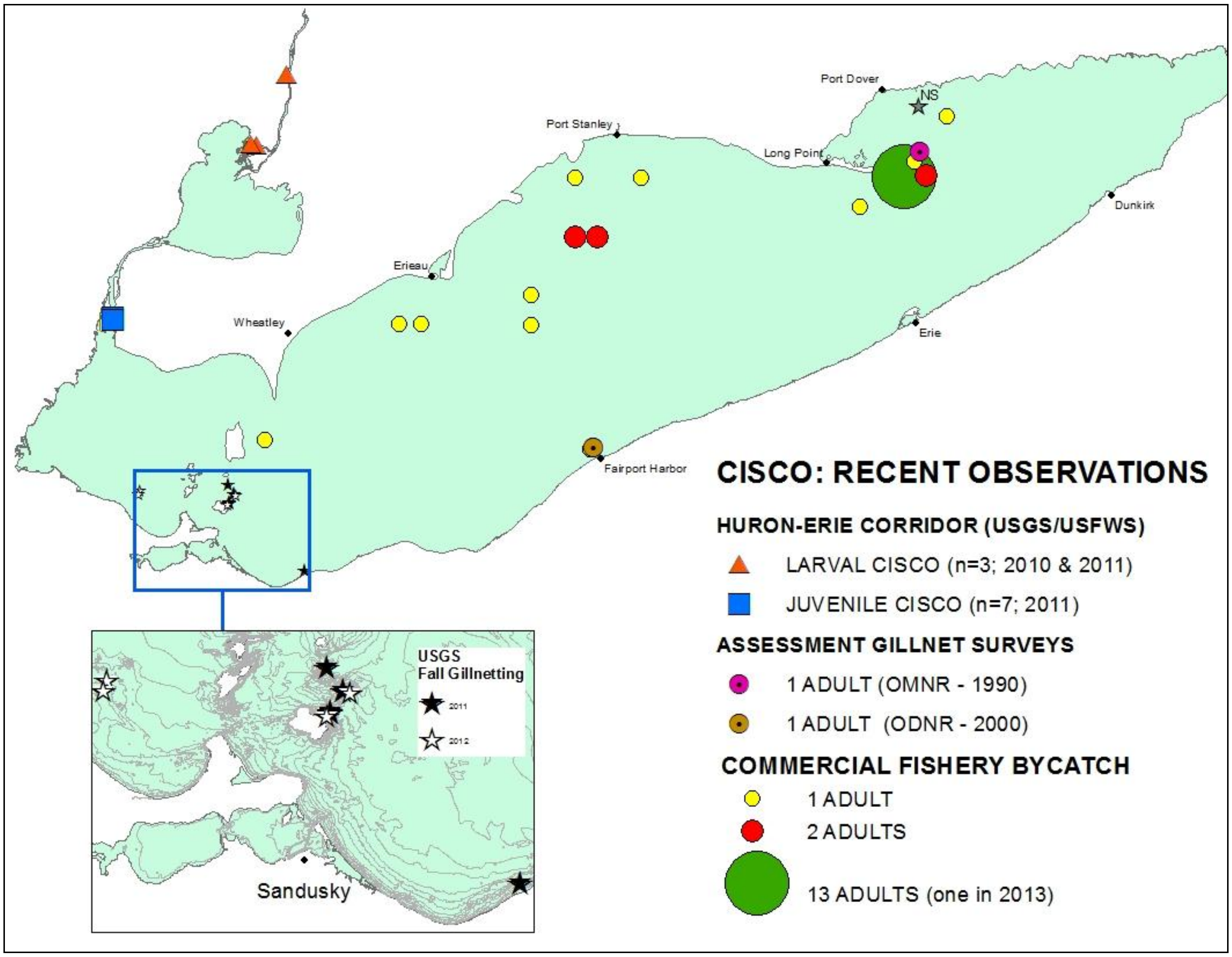

FIGURE 7.1. Cisco observations in Lake Erie and the Huron-Erie Corridor. Relative abundance of adult specimens from the commercial fishery and agency surveys is indicated with proportional, colored circles. Locations of larval and juvenile Cisco observations (USGS, USFWS) are indicated with triangles and squares (not proportional). An inset map shows the locations of USGS fall gillnet surveys targeting historic Cisco spawning reefs. NS - marks the location of a comparable fall gillnet survey at Nanticoke Shoal in the eastern basin

TABLE 7.1. Sampling details from a selection of Cisco captured during commercial and assessment fishing efforts, 1996-2013.

Observation Year	Basin	Year Class	Sex	Number
1996	Central	1991	F	1
1999	Central	1998	F, M	3
	East	1997	F	1
		1998	F, M	2
2002	East	1996*	F	1
		2001*	F	1
2003	Central	1998*	u	1
		2001	M	1
		2002	M	1
	East	1999*	F	1
2004	East	u	u	1
2005	Central	2001	F	2
2007	East	2000	F	2
2008	Central	2001	F, M	2
2010	West	2001	F	1
	East	1998	F	1
		2001	F	1
		2003	M	1
2011	East	2007	F	1
			u	1
		2006	F	1
		2005	M	1
2012	Central	2009	F	1
2013	Central	2008	M	1

* indicates age extrapolated from total length measure

F = female; M = male; u = unknown

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 trend 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)?
- 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 on a remnant population? Is there currently a genetic bottleneck?

For 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. 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 will recommend multiple lines of attack 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 will be presented to the LEC during 2014. In the interim, some of the proposed approaches have been proactively acted upon.

<u>Targeting Cisco in fall at potential spawning locations</u>

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 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 and 2012 (Figure 7.1) 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 and so future sampling should target late November through December (CWTG 2013). A limited amount of gillnetting in October and November 2013 similarly caught Lake Whitefish but not Cisco. The utility and logistics of this exercise will be discussed in 2014 prior to further 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 coregonine 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, and 2013. In 2013, 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, make this shoal a candidate for future fall assessments. The late-fall gillnet assessment will continue in 2014 and discussions are underway as to how to alter both gear and locations to maximize potential to capture Cisco.

Targeting Cisco in fishery bycatch

In previous reports, the CWTG has noted Maumee Bay as a recognized current Lake Whitefish spawning location; producing the highest catches in the Ohio commercial fishery. 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 in 2014 are being proposed.

The Ontario commercial trawl fishery, targeting Rainbow Smelt, has been a consistent source of Cisco 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 a 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, preliminary plans have been made to expand the observer program seasonally and to include the gillnet fishery throughout the lake. Special care will be taken to learn from the 2013 program and to design sampling protocols to increase the probability of observing rare species such as Cisco. The fall targeted gillnet fishery for Lake Whitefish in the western basin may be one important target. One challenge is detecting a rare species within a large catch that needs to be handled and iced-down immediately to preserve quality. OMNR 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.

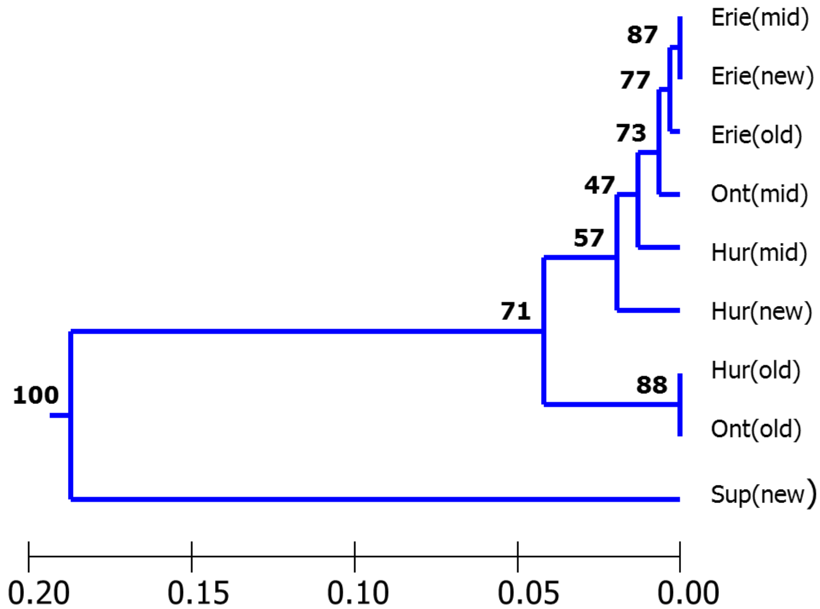

FIGURE 7.2. Tree diagram showing genetic distance of various Cisco populations (Nei's (1978) unbiased distance UPGMA). From Rocky Ward, unpublished data.

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. Currently, task group members and associated researchers are seeking ways to fund the continuance of this approach to impediments.

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 efforts on Lake Ontario to raise and introduce Bloater sourced from Lake Huron.

Proposed CWTG Activities for 2014

In 2014, the Coldwater Task Group members solicit comment on the draft impediments document from the LEC and external reviewers and will create 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 pending available funding. Impediments to be addressed will be prioritized but will also be acted upon opportunistically as funding and logistic options present themselves.

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