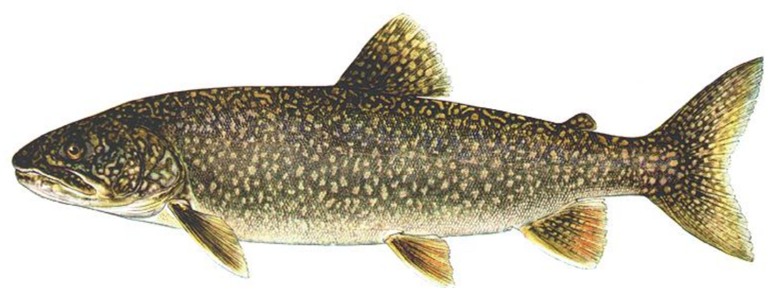
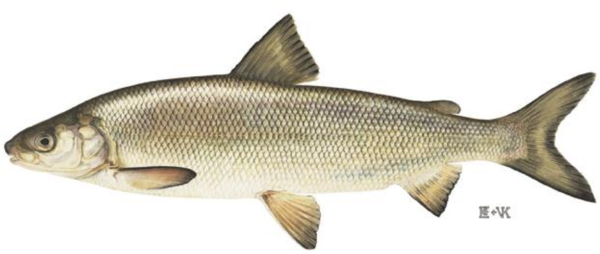
Report of the Lake Erie Coldwater Task Group

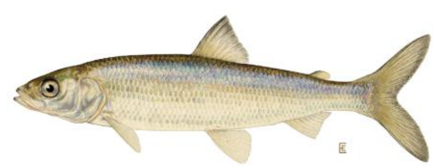
28 March 2013

Members:

Kevin Kayle	Ohio Division of Wildlife (Co-Chair)
Tom MacDougall	Ontario Ministry of Natural Resources (Co-Chair)
Jeff Braunscheidel	Michigan Department of Natural Resources
Andy Cook	Ontario Ministry of Natural Resources
James Markham	New York Department of Environmental Conservation
Chuck Murray	Pennsylvania Fish and Boat Commission
Fraser Neave	Department of Fisheries and Oceans, Canada
Mark Rogers	United States Geological Survey
Tim Sullivan	United States Fish and Wildlife Service
Elizabeth Trometer	United States Fish and Wildlife Service
Larry Witzel	Ontario Ministry of Natural Resources

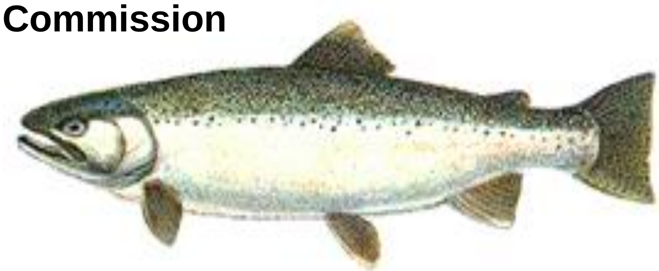






Presented to:

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. 2013. Report of the Lake Erie Coldwater Task Group, March 2013. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

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Raver, Duane. 1999. Duane Raver Art. U.S. Fish and Wildlife Service. Shepherdstown, West Virginia, USA.

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TABLE OF CONTENTS

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 2013 in Niagara Falls, New York. 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.

References

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Coldwater Task Group Executive Summary Report March 2013

Lake Erie Committee

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

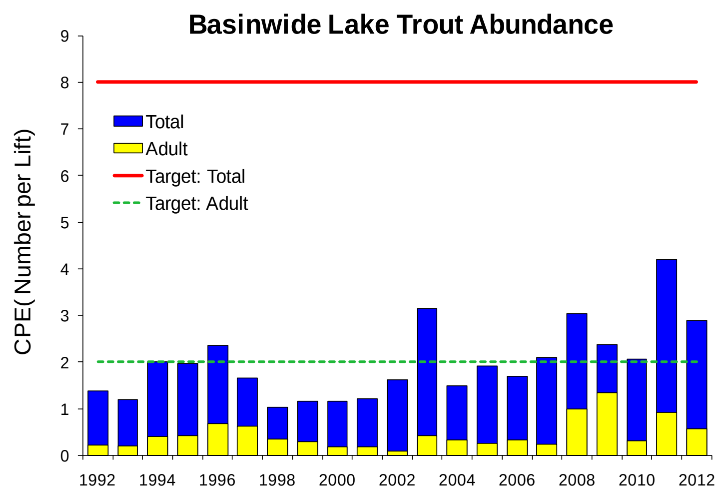
Introduction

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 GLFC'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 2012-2013: (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 management plan.

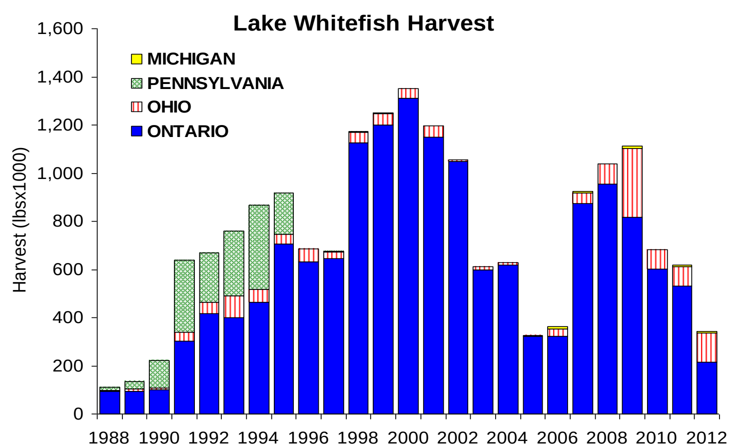
Lake Trout

A total of 677 lake trout were collected in 170 lifts across the eastern basin of Lake Erie in 2012. High lake trout catches were recorded in New York surveys but average catches were observed in both Ontario and Pennsylvania surveys. 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 fourth highest value in the time series, but remains below the rehabilitation target of 8.0 fish/lift. Adult (ages 5+) abundance decreased in 2012 and remains well 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.



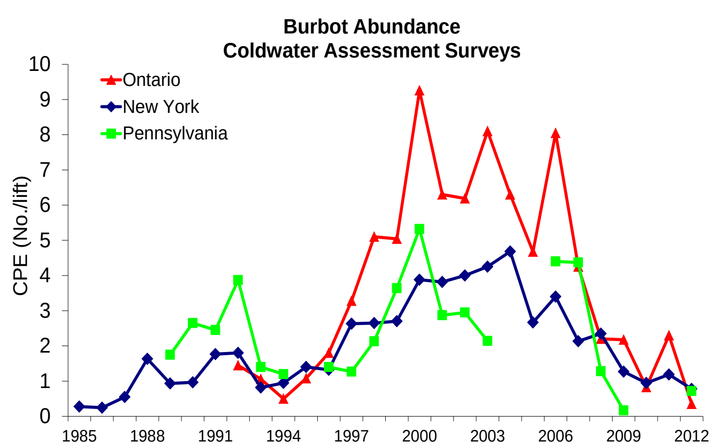
Lake Whitefish

Lake whitefish harvest in 2012 was 341,374 pounds, distributed among Ontario (63%), Ohio (35%), and Michigan (2%) commercial fisheries. The 2003 year class (age 9) dominated the population age structure in the observed harvest and assessment surveys in 2012. Ages present in the 2012 population ranged from 3 to 24, with no evidence of young-of-the-year or yearling whitefish in assessment surveys lake-wide. With recruitment sparse or absent, population abundance continues to decline. Fisheries in 2013 will continue to rely on the 2003 year class, followed by cohorts from other adjacent year classes. In 2012, mean condition factors of mature female and male whitefish were at or above the historic average.

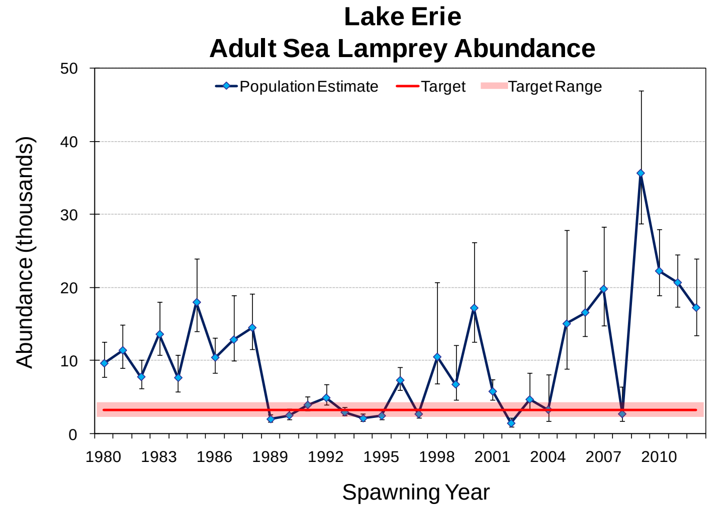


Burbot

Total commercial harvest of burbot in Lake Erie during 2012 was 1,308 pounds, a 55% decrease from 2011. Burbot abundance and biomass indices from annual coldwater gillnet assessments decreased in 2012, continuing a downward trend observed across east basin areas following time-series maxima during the early- to mid-2000s. Agency catch rates during 2012 ranged from 0.35 (Ontario) to 0.78 (New York) burbot per lift, which are far lower than mean catch rates observed during 2000-2004 peak catches. Burbot catches ranged in age from 4 to 22 years, and 54% were age 13 and older in 2012. Rainbow smelt and round gobies continue to be the dominant prey items in burbot diets in eastern Lake Erie. Continued low catch rates of burbot in assessment surveys, combined with increasing mean age of adults and persistent low recruitment, signal continuing troubles for this population in Lake Erie.

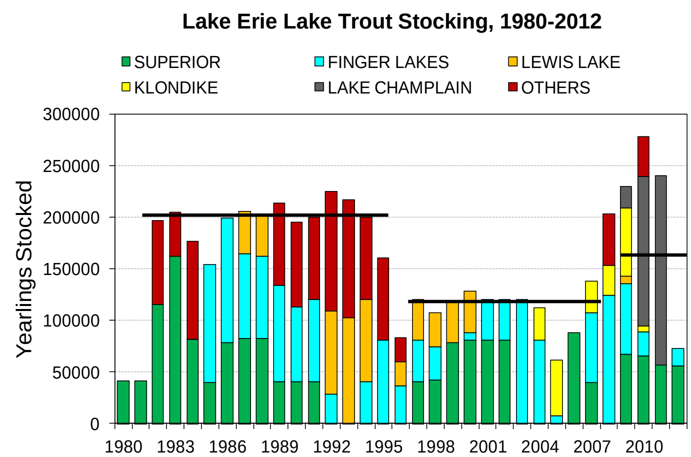


Sea Lamprey



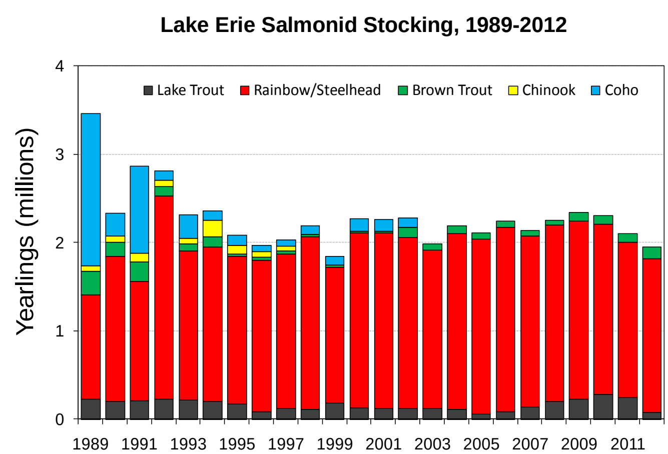
The A1-A3 wounding rate on lake trout over 532 mm was 10.1 wounds per 100 fish in 2012. This was a 23% increase from the 2011 wounding rate of 8.2 wounds per 100 fish and the first increase in wounding rates since 2009. The 2012 wounding rate still exceeds the target rate of five wounds per 100 fish; wounding rates have been above target for 17 of the past 18 years. Large lake trout over 736 mm continue to be the preferred targets for sea lamprey. A1 wounding rates on lake trout were above average and were at their highest rate since 2007. A4 wounding rates decreased in 2012 to 31.6 wounds per 100 fish, the second lowest wounding rate in the past eight years. A4 wounding rates on lake trout over 736 mm remained very high (148 wounds/100 fish). The estimated number of spawning adult sea lampreys decreased from 20,638 in 2011 to 17,211 in 2012. This is the third consecutive decline in the estimated adult sea lamprey population, but abundance remains well above targets. Comprehensive stream evaluations continued in 2012, including extensive surveys of Lake St. Clair and the Detroit River, to determine the source of the untreated Lake Erie population. A mark-recapture study was implemented to determine if juveniles can successfully migrate through Lake St. Clair into Lake Erie, and to quantify the relative contribution of St. Clair River sea lamprey to the Lake Erie adult population.

Lake Erie Salmonid Stocking



A total of 1,962,516 salmonids were stocked in Lake Erie in 2012. This was a 9% decrease in the number of yearling salmonids stocked compared to 2011 and the long-term average from 1989-2011. Declines were primarily due to temporary reductions in 2012 of lake trout and steelhead/rainbow trout stockings. By species, there were 72,473 yearling-equivalent lake trout stocked in Ontario and Ohio; 101,204 brown trout stocked in New York and Pennsylvania waters, and 1,788,839 steelhead/rainbow trout stocked in all five jurisdictional waters.

Steelhead



All agencies stocked yearling steelhead/rainbow trout in 2012. The summary of steelhead stocking in Lake Erie by jurisdictional waters for 2012 is: Pennsylvania (1,018,101; 57%), Ohio (425,188; 24%), New York (260,000; 15%), Michigan (64,500; 4%) and Ontario (21,050; 1%). Steelhead stocking in 2012 (1.789 million) represented a 2% increase from 2011, but was 2% below the long-term average. Annual stocking numbers have been consistently in the 1.7-2.0 million range since 1993.

The summer open lake fishery for steelhead was again evaluated by Ohio, Pennsylvania and New York. Open lake harvest was estimated at 10,165 steelhead: Ohio, 6,865; Pennsylvania, 2,917; New York, 374; and Michigan, 9. Overall, this harvest was a 127% increase from the 2011 harvest, but 67% below the average harvest from 1999-2011. Open lake steelhead harvest increased in all jurisdictions from 2012, but was not assessed in a general creel survey in Ontario waters of Lake Erie. Catch rates in the open water fishery were lower in 2012 with the exception of Pennsylvania. 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 0.68 fish/hour in 2012, but in a general New York tributary angler survey, 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-3 cisco was captured in 2012. None were captured in 2012 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 and Larry Witzel, OMNR

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.

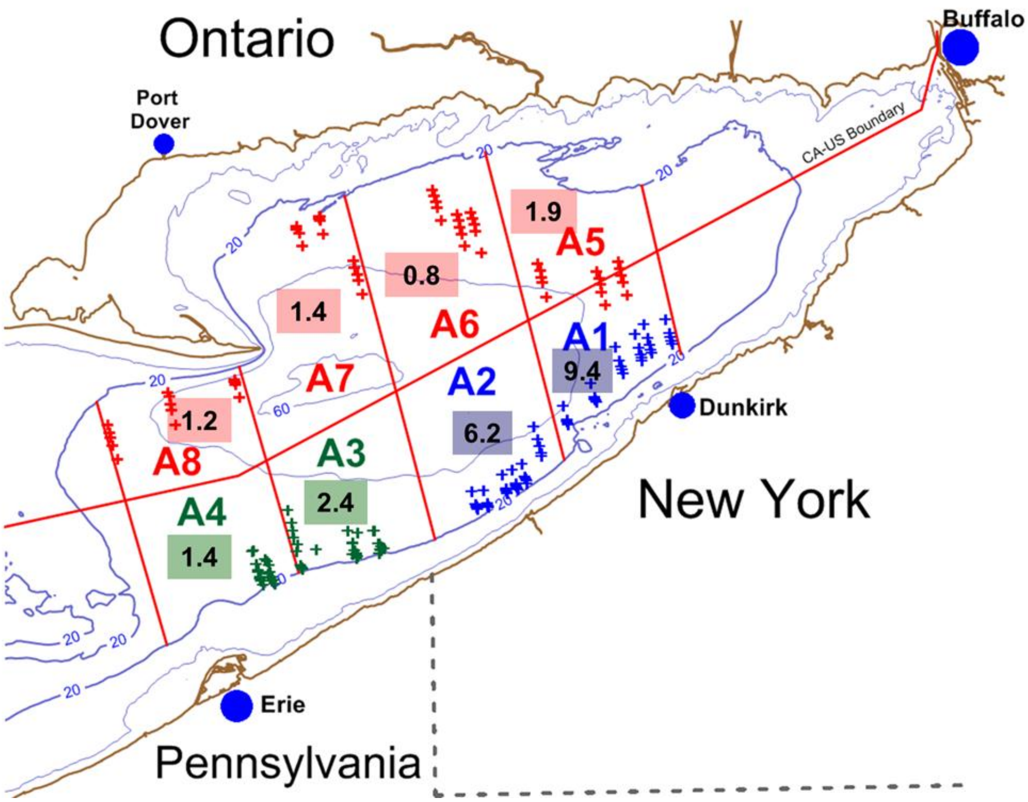


FIGURE 1.1. Standard sampling areas (A1-A8) used for assessment of lake trout in the eastern basin of Lake Erie, 2012, and catch per effort (No. per lift) of lake trout in each area. Plus signs (+) represent net location placement in 2012.

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.

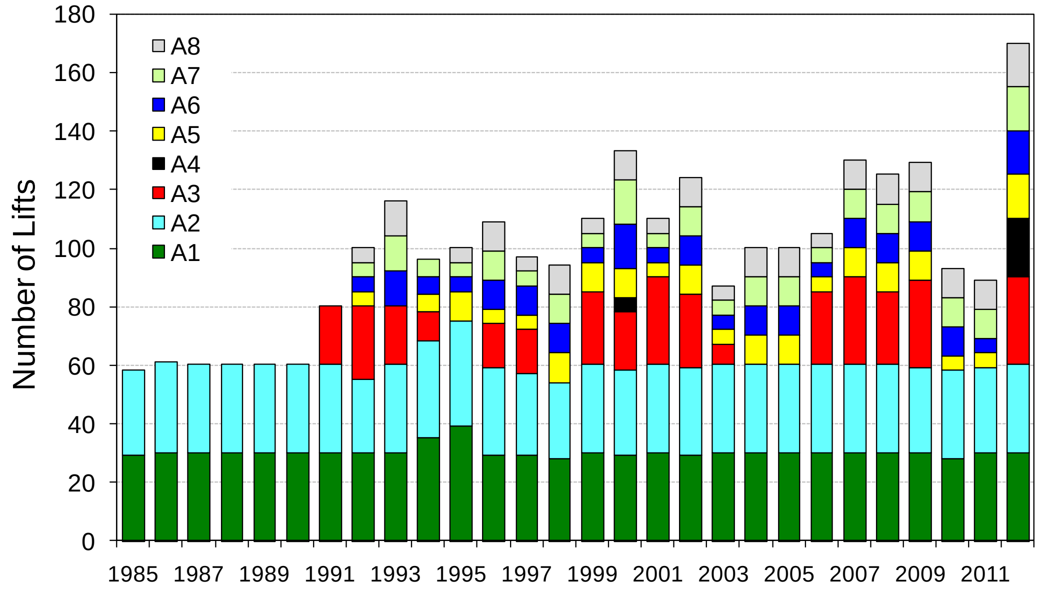


FIGURE 1.2. Number of unbiased coldwater assessment gill net lifts by area in the eastern basin of Lake Erie, 1985-2012.

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 inches; in 0.5 inch increments). Panels are arranged randomly in each gang. A series of five gangs per transect are set overnight, on bottom, along the contour and perpendicular to a randomly selected north/south-oriented transect during the month of August or possibly into early September, prior to fall turnover. New York State Department of Environmental Conservation (NYSDEC) personnel modified the protocol in 1996 using gill 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 gill 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 2012 by the combined agencies was 170 unbiased standard lake trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 60 lifts by the NYSDEC, 50 lifts by the PFBC, and 60 by USGS/OMNR. This was the highest total effort since coordinated agency assessments began in 1992.

All lake trout are routinely examined for total length, weight, sex, maturity, fin clips, and wounding 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), and 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 2012 (Figure 1.1), collecting a total of 677 lake trout in 170 unbiased lifts. Areas A1 and A2 again produced the highest catch per unit effort (CPE) values (Figure 1.1), coinciding with stocking areas of yearling lake trout. 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.

Fourteen age-classes of lake trout, ranging from ages 2 to 28, were represented in the 2012 catch of known-aged fish (Table 1.1). Similar to the past eleven years, young cohorts (ages 1-5) were the most abundant, representing over 90% of the total catch in standard assessment nets (Figure 1.3). Cohort abundance continues to decline rapidly after age-5, and lake trout older than age-10 were poorly represented; comprising less than 2% of the overall catch in 2012.

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 2012.

A) Lean Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (g)	PERCENT MATURE
2	Male Female	15 13	410 428	774 872	0 8
3	Male Female	148 43	563 554	2162 1924	90 17
4	Male Female	81 30	616 624	2765 2881	97 44
5	Male Female	27 39	657 682	3362 3918	96 97
6	Male Female	13 15	699 729	4069 4669	100 100
9	Male Female	2 1	779 825	5780 6575	100 100
10	Male Female	2 1	817 782	6747 7570	100 100
11	Male Female	0 1	----- 789	----- 7095	----- 100
12	Male Female	0 1	----- 830	----- 6245	----- 100
18	Male Female	0 1	----- 810	----- 6875	----- 100
19	Male Female	1 0	971 -----	12005 -----	100 -----
25	Male Female	1 0	900 -----	8905 -----	100 -----
28	Male Female	1 0	902 -----	5455 -----	100 -----

B) Klondike Strain

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (grams)	PERCENT MATURE
4	Male Female	86 26	568 577	2085 2246	99 75
5	Male Female	14 12	587 622	2342 2813	100 100
6	Male Female	5 4	625 617	2940 2810	100 100
8	Male Female	4 1	624 711	2877 4610	100 100

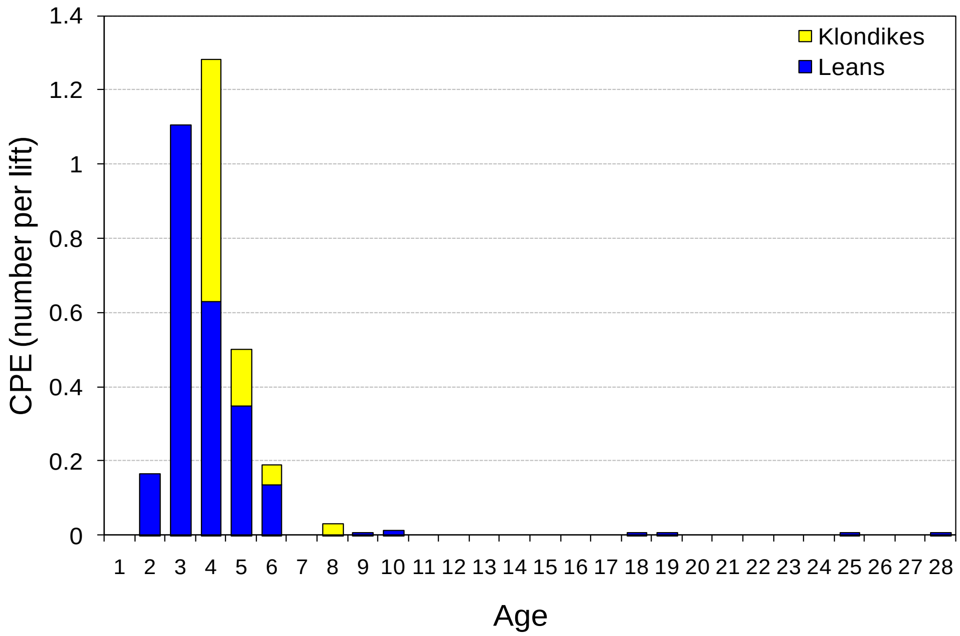


FIGURE 1.3. Relative abundance (number per lift) at age of Lean strain and Klondike strain lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie 2012.

The overall trend in area-weighted mean CPE of lake trout caught in standard nets in the eastern basin decreased in 2012 to 2.9 fish per lift (Figure 1.4). Despite the decline, this was the sixth highest adult abundance in the series. Decreases were observed in both NY and ON waters in 2012. Abundance estimates also declined in PA waters since their previous sampling effort in 2009. Basin-wide abundance remains well below the rehabilitation target of 8.0 fish/lift (Markham *et al.* 2008).

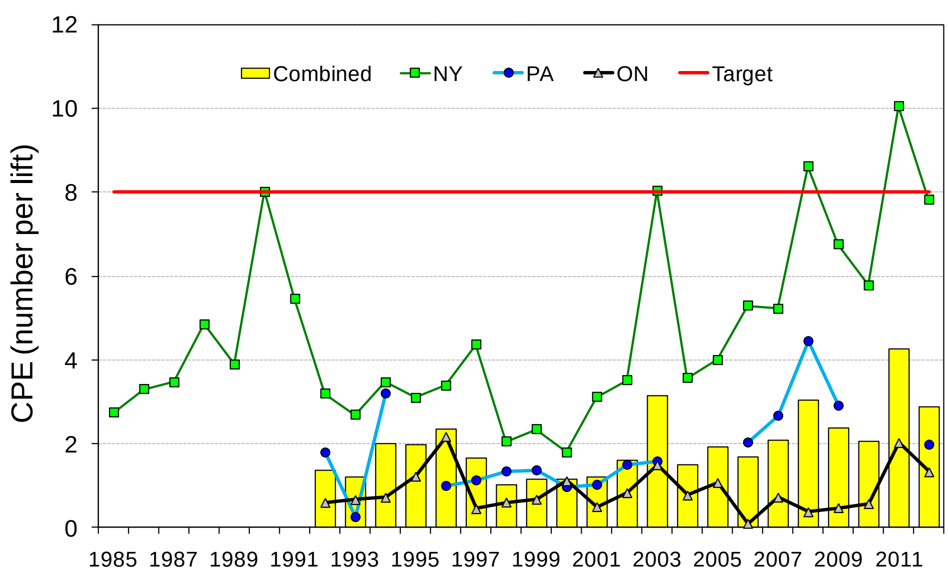


FIGURE 1.4. Mean CPE (number per lift) by jurisdiction and combined (weighted by area) for lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1985-2012.

A total of 111 lake trout were caught in the East Basin and Pennsylvania Ridge areas during the OMNR Partnership Index Fishing Program in 2012; no lake trout were caught in the East-Central basin. The lake trout index in the East Basin was the highest observed in the series but was near average in the Pennsylvania Ridge (Figure 1.5). The increase in the East basin 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 Slate Island strain fish stocked in Ontario waters. Variability of abundance estimates in this survey is high due to low sample sizes, especially in the Pennsylvania Ridge, and to a broad spatial sampling that may have extended outside the preferred habitat of lake trout.

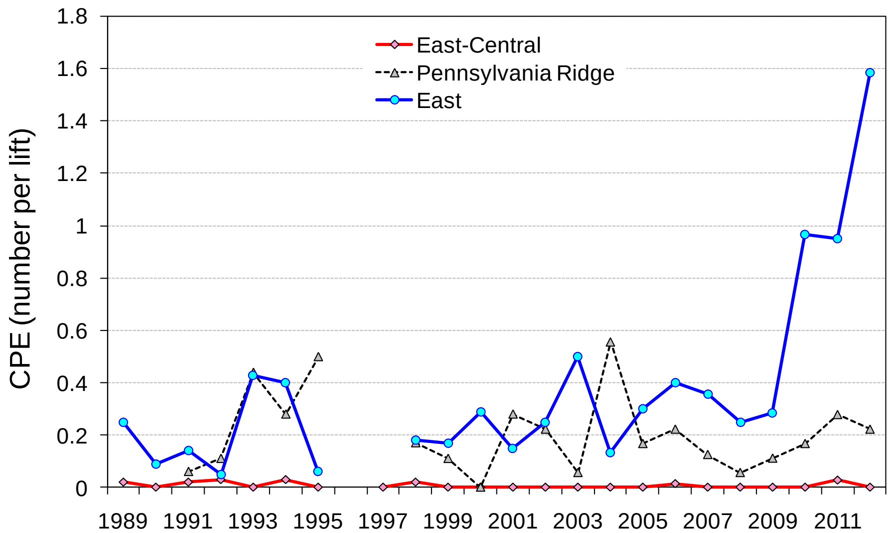


FIGURE 1.5. Lake trout CPE (number per lift) by basin from the OMNR Partnership Index Fishing Program, 1989-2012. Includes canned (suspended) and bottom gill net sets, excluding thermocline sets.

The relative abundance of adult (age-5 and older) lake trout caught in standard assessment gill nets (weighted by area) serves as an indicator of the size of the lake trout spawning stock in Lake Erie. Adult abundance decreased in 2012 to 0.56 fish per lift following a sharp increase in 2011 (Figure 1.6). Despite the decline, this was the fourth 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).

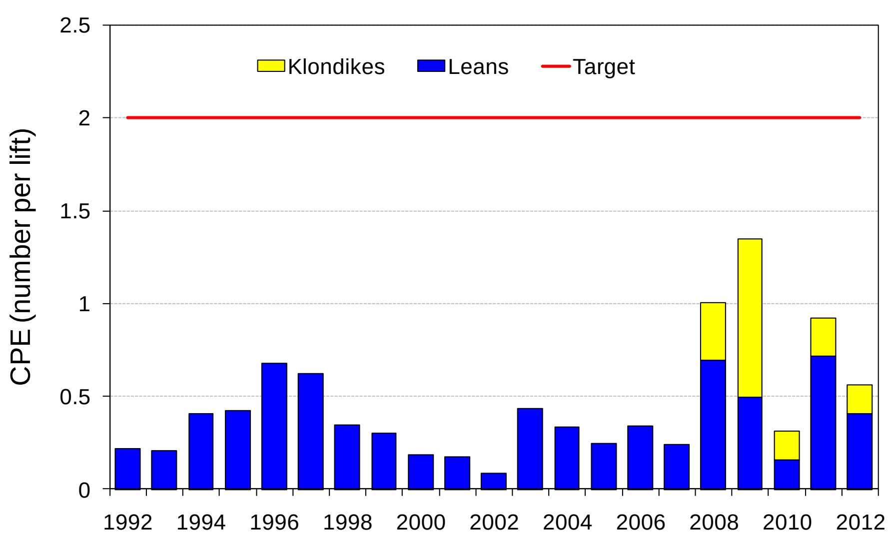


FIGURE 1.6. Relative abundance (number per lift) weighted by area of age 5 and older Lean strain and Klondike strain lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2012.

The relative abundance of mature females over 4500g, an index of repeat-spawning for females ages six and older, also decreased in 2012 to 0.08 fish per lift (Figure 1.7). This index value remains well below the rehabilitation plan basin-wide target of 0.50 adult females per lift (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.

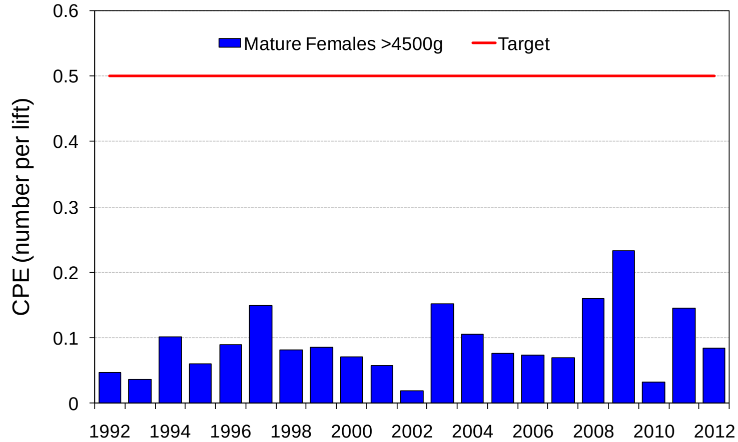


FIGURE 1.7. Relative abundance (all strains, number per lift, weighted by area) of mature female lake trout greater than 4500g in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2012.

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 in that year-class stocked. 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 increased 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 2012 SP index was 0.07, which was below average for the time series and the lowest value since 2007 (Figure 1.8). Actual age-2 abundances, which had been high over the past four years due to increased levels of stocking, also dropped to their lowest levels since 2007.

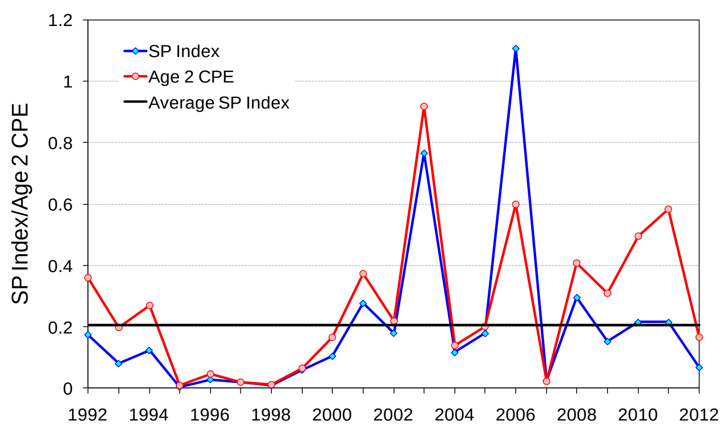


FIGURE 1.8. Stocking Performance (SP) index and age-2 CPE (number per lift) for lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2012. The SP index is equal to the number of age-2 fish caught per lift for every 100,000 yearling lake trout stocked.

Strain Performance

Eight different lake trout strains were found in the 569 fish caught with either hatchery-implanted coded-wire tags (CWTs) or fin-clips in 2012 (Table 1.2). Lake Champlain (LC; 39%), Finger Lakes (FL; 25%) and Klondike (KL; 27%) strain lake trout remain the most prevalent strains in the Lake Erie lake trout population. Finger Lakes have been the most prevalent strain stocked in Lake Erie while Klondikes have only been stocked in five of the past nine years. Lake Champlain is a recently stocked strain, being stocked in three of the past four years. Slate Island (SI; 3%), Traverse Island (TI; <1%), Apostle Island (AI; 4%), Lewis Lake (LL; <1%), and Michipicoten (MIC; <1%) strains represented the remainder of the lake trout catch. Superior (SUP) strain lake trout, stocked extensively in Lake Erie in the 1980s and again from 1997-2002, was absent from the catches in 2012. Only one SUP strain lake trout has been caught in assessment netting in the last three years. The FL strain continues to show the most consistent returns at older ages; all but five of 18 lake trout age-7 and older were FL strain fish.

TABLE 1.2. Number of lake trout per stocking strain by age collected in gill nets from the eastern basin of Lake Erie, August 2012. Stocking strain codes are: FL = Finger Lakes, SUP = Superior, 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	SUP	LL	KL	SI	TI	AI	LC	MIC
1									
2					4			22	
3					6			168	5
4	46		2	113	9		25	30	
5	59			26					
6	22			9		5			
7									
8				5					
9	3								
10	4								
11	1								
12	1								
13									
14									
15									
16									
17									
18	1								
19	1								
25	1								
28	1								
TOTAL	**140**	**0**	**2**	**153**	**19**	**5**	**25**	**220**	**5**

Survival

Estimates of annual survival (S) for individual cohorts were calculated by strain and year class using a 3-year running average of CPE with ages 4 through 11. A running average was used due to the high year-to-year variability in catches. Mean overall adult survival estimates varied by strain and year. Survival estimates prior to 1986 are low due to excessive mortality from a large, untreated sea lamprey population. Dramatic 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 0.79 for the Superior (SUP) strain to 0.83 for the Finger Lakes (FL) strain (Table 1.3).

More recent estimates indicate that survival has declined 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 from the 1996, 1997, and 1999-2002 FL strain are much higher, but are generated from very low returns. More recent estimates from the 2003 year class of FL strain indicate lower survival rates. All recent survival estimates are below the ranges previously observed for these strains during the period of successful lamprey control. Preliminary estimates of the 2003 and 2004 year classes of Klondike (KL) strain fish indicate very low survival rates at adult ages that are comparable to survival rates of SUP strain lake trout from the 1997-2001 year classes. Mean overall survival estimates were above the target of 60% or higher (Lake Trout Task Group 1985; Markham *et al.* 2008) for Lake Erie (LE), Lake Ontario (LO), and FL strains but below target for the Lewis Lake (LL), SUP, and KL strains. The Finger Lakes strain, the most consistently stocked lake trout strain in Lake Erie, had an overall mean survival estimate of 0.74.

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, 1985–2012. 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. Asterisks (*) indicates years where straight CPE's were used for ages 5-10 (FL 2002), 5-9 (FL 2003, KL 2003), or 4-8 (KL 2004).

	STRAIN					
Year Class	**LE**	**LO**	**LL**	**SUP**	**FL**	**KL**
1983				0.687		
1984				0.619	0.502	
1985				0.543	0.594	
1986				0.678		
1987				0.712	0.928	
1988		0.784		0.726	0.818	
1989		0.852		0.914	0.945	
1990		0.840		0.789	0.634	
1991		0.763	0.616			
1992	0.719		0.568			
1993	0.857				0.850	
1994						
1995						
1996					0.780	
1997				0.404	0.850	
1998				0.414		
1999				0.323	0.76	
2000				0.438	0.769	
2001				0.225	0.696	
2002*					0.712	
2003*					0.495	0.293
2004*						0.311
MEAN	**0.788**	**0.810**	**0.592**	**0.575**	**0.738**	**0.302**

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 (2002-2011) through age 12 (Figures 1.9 and 1.10). Variations in both mean length and weight compared to the ten-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 4-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.

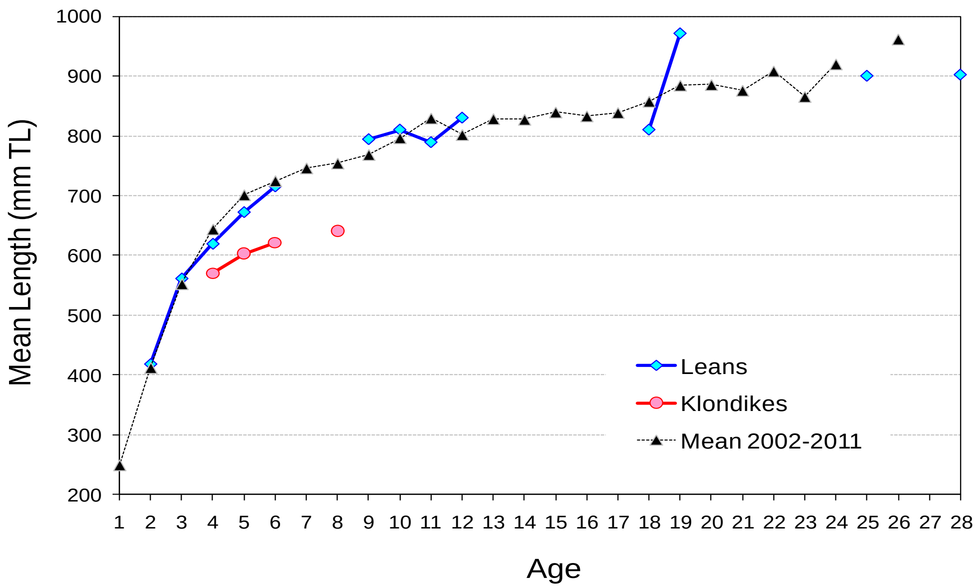


FIGURE 1.9. Mean length-at-age of Lean strain and Klondike strain lake trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2012. The previous 10-year average (2002-2011) from New York waters is shown for current growth rate comparison.

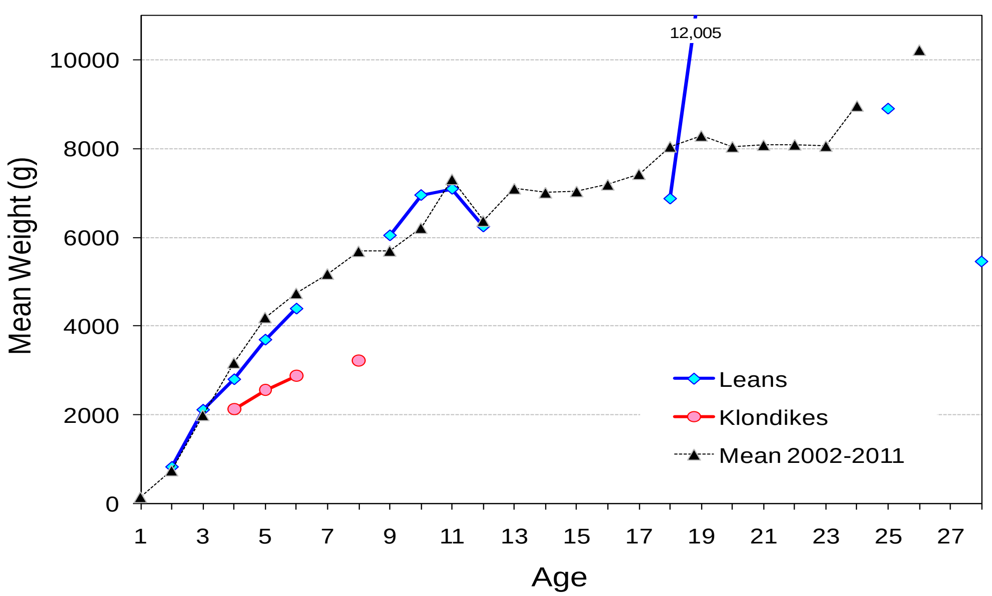


FIGURE 1.10. Mean weight-at-age of Lean strain and Klondike strain lake trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2012. The previous 10-year average (2002-2011) from New York waters is shown for current growth rate comparison.

Mean coefficients of condition (K; 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. Female condition began to decline in 2004 and male condition in 2001, but both increased again in 2007 and 2008. Both male and female condition of Lean strain lake trout has shown a slight decline since 2008. 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.

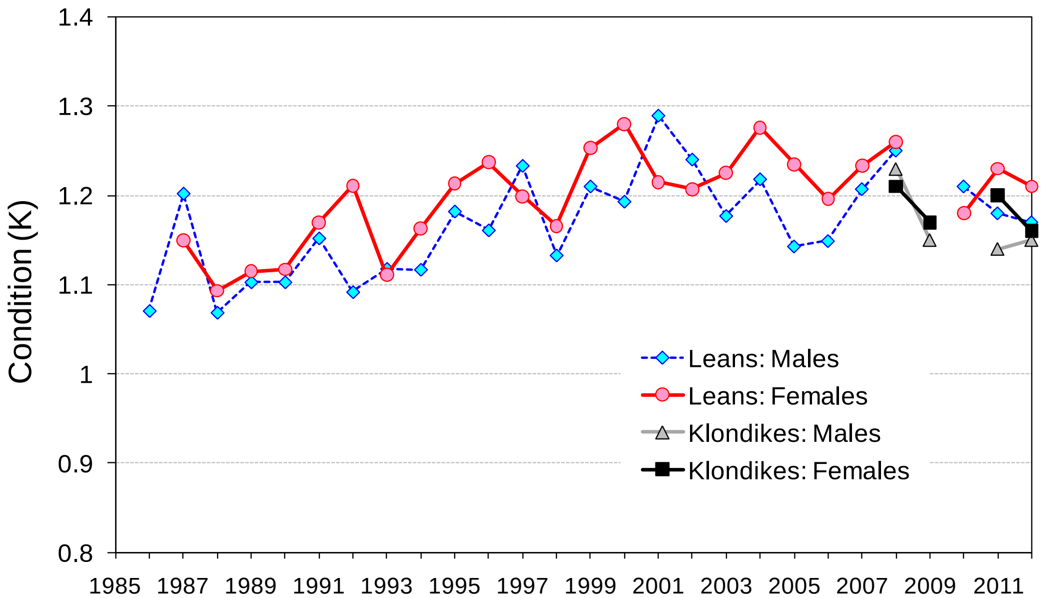


FIGURE 1.11. Mean coefficients of condition for age-5 Lean strain and Klondike strain lake trout, by sex, collected in eastern basin assessment gill nets in Lake Erie, August 1985-2012.

Maturity

Maturity rates of Lean strain lake trout remain consistent with past years where males are nearly 100% 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 528 lake trout were harvested in New York waters out of an estimated catch of 1,345 in 2012 (Figure 1.12). This was the highest estimated harvest of lake trout in New York waters of Lake Erie since 1996. No lake trout were reported as caught or harvested in Pennsylvania waters in 2012.

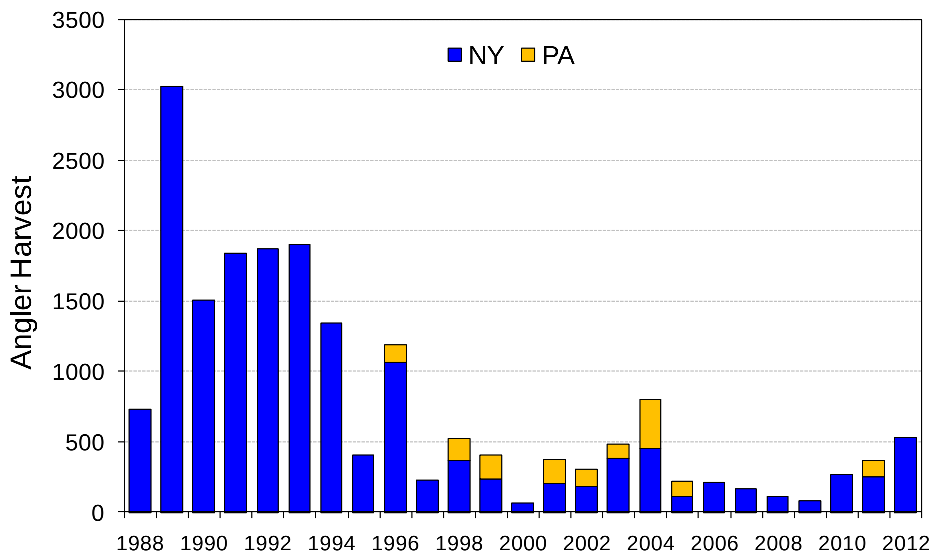


FIGURE 1.12. Estimated lake trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2012.

Natural Reproduction

Three potentially wild fish (no fin clips; no CWT's) were caught in eastern basin coldwater gill net surveys in 2012, making a total of 57 potentially wild lake trout recorded over the past twelve years. Otoliths are collected from lake trout found without CWTs or fin-clips and will be used in future stock discrimination studies. Despite more than 30 years of lake trout stocking in Lake Erie, no naturally-reproduced lake trout have been documented.

A GIS project was conducted by the USGS (Sandusky) and Ohio Division of Wildlife to determine potential lake trout spawning sites within Lake Erie (Habitat Task Group 2006). The goal of this exercise was to identify areas with suitable physical habitat for lake trout spawning within Lake Erie so that future stocking efforts may be directed at those sites. Side-scan sonar work was also accomplished during 2007, 2008 and 2009 on several of the identified sites in the eastern basin of Lake Erie near Port Maitland, Ontario, and at Brocton Shoal near Dunkirk, New York (Habitat Task Group 2011). Additional funding received in 2007 and 2008 (Canada-Ontario Agreement; USFWS Restoration Funds) enabled the further examination of the sites identified in the GIS-phase of this exercise using side-scan sonar and underwater video imaging. Results of the data analysis of the side-scan mosaics and underwater video indicate potential spawning habitat on Brocton Shoal, Presque Isle Bay, Nanticoke Shoal, Hoover Point, and Tecumseh Reef. However, underwater video indicates that the quality of the habitat has undergone considerable deterioration, especially at Brocton Shoal, mainly due to dreissenid colonization and extensive sedimentation. Nearshore areas in Presque Isle Bay and Nanticoke Shoal do not exhibit extensive dreissenid colonization, and appear to hold more favorable spawning substrate.

For the fifth consecutive year, a gill net survey was conducted by the NYSDEC during November to determine if lake trout were using any local spawning areas. Underwater bottom video work conducted during the summer months revealed a large area of rocks off the mouth of Eighteen Mile Creek near Hamburg, NY. Rock formations at this site appeared to be favorable for spawning lake trout: cobble-sized rocks in piles with open interstitial spaces (Figure 1.13). Furthermore, the rocks did not appear to be as heavily encrusted with dreissenids as areas on Brocton Shoal. Despite being far from lake trout stocking locations (25 miles), the quality and quantity of suitable habitat in this area made it a candidate for lake trout spawning assessment. November 2011 gill net sampling at this location caught 18 lake trout (Coldwater Task Group 2012), an indication that lake trout were possibly using this as a spawning location.

Surveys in 2012 in the same locations off Eighteen Mile Creek were conducted to confirm the continued presence of lake trout at this possible spawning area. A total of four gangs (1000 gill net feet total) were fished overnight on 14 November 2012 in locations similar to the previous year (Figure 1.14). Two sets were made at the east end of the rocky area in 6-16 feet deep, and two at the west end at 7-18 foot depths. Bottom water temperature during all sampling was 44F, which was six degrees colder than the previous year. Underwater bottom video of the site prior to setting the nets revealed that much of the *Cladophora* that was present in the July 2011 video was gone. However, the rocks in the area were still partially encrusted in dreissenids.

A total of 22 lake trout were caught in the four nets. The fish were generally scattered over the site with twelve fish caught in the two western nets and ten fish in the two eastern nets. Eight of the lake trout were females and fourteen males. All of the lake trout were mature and five of the females had ripe, flowing eggs. Nearly all the lake trout were Finger Lakes (FL) strain, with the exception of two 3-year-old Lake Champlain (LC) strain fish. Ages ranged from 3-22 years old with ages 4, 5, and 10 years old the most common (Figure 1.15). Seventeen of the lake trout caught were stocked offshore of Dunkirk and the remaining fish had been stocked offshore at Barcelona.

FIGURE 1.13. Underwater photo of bottom habitat off Eighteen Mile Creek Shoal in Lake Erie, July 2011.

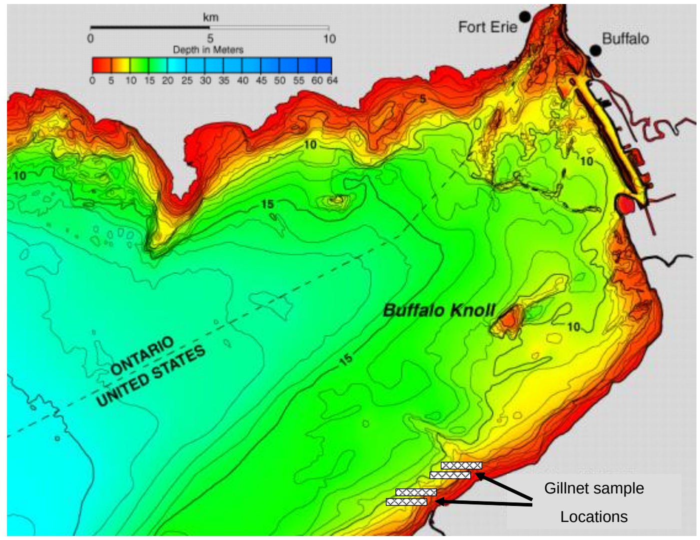


FIGURE 1.14. Gill net survey locations sampled for spawning lake trout in the New York waters of Lake Erie, November 2011 and 2012.

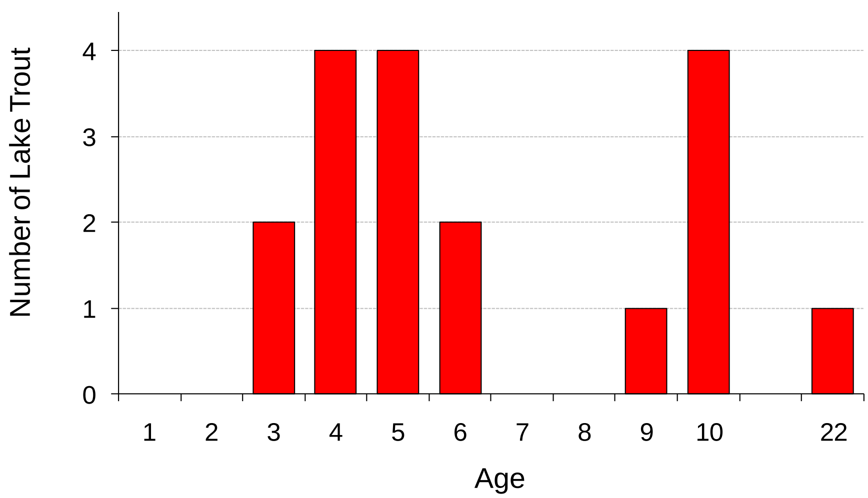


FIGURE 1.15. Age distribution of lake trout sampled in the New York waters of Lake Erie, November, 2012.

In 2010, 2011, and 2012, OMNR conducted November gillnet surveys, similar to those conducted on the south shore in NY waters, targeting Nanticoke Shoal, Ontario. The area is significant as a key site identified during previous spawning habitat assessments (above) and as a newly established stocking location; annual stocking commenced there in 2008. Survey design took advantage of previously mapped substrate and video evidence to surround cobble substrate areas deemed to have the highest potential for successful spawning. Four gangs of monofilament gill net, each 381 m (1250 ft) in length, with mesh sizes ranging from 1.25 to 6 inches (50 or 100 ft panels), were set in water depths of 4-6 m. Lake trout were caught for the first time on November 15, 2012 (10 fish) and subsequently on November 21 (2 fish). Lake trout were caught in all nets, but primarily in those associated with the south and west sides of the shoal. The lake trout caught ranged in age from 1 to 6 years (Figure 1.16).

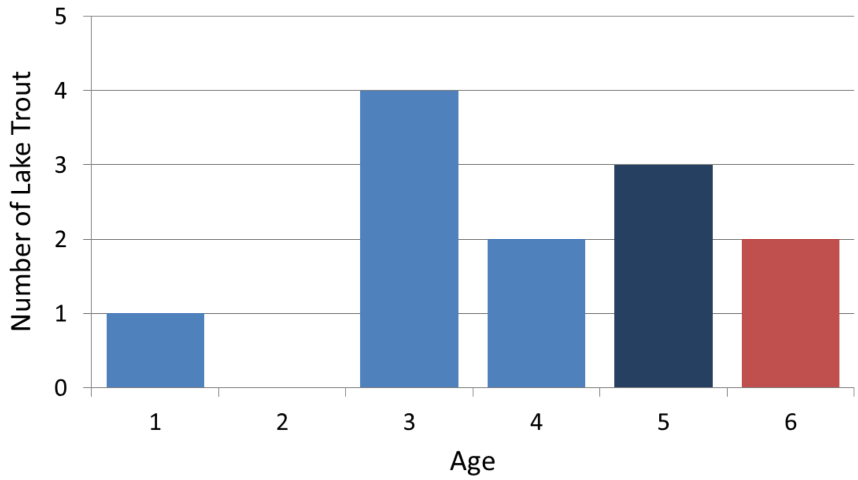


FIGURE 1.16. Age distribution of lake trout sampled in the Ontario waters of Lake Erie, November 2012. Colors represent strain/original stocking location: Red - Finger Lakes / NY waters; Dark Blue – Lake Manitou / Nanticoke Shoal; Light Blue – Slate Island/ Nanticoke Shoal.

The two oldest fish were mature females of Finger Lakes strain originally stocked off of Dunkirk, NY, while the rest were all originally stocked on Nanticoke Shoal. Lake trout caught on November 15th (water temperature 9-10.6° C) were all pre-spawning, while the two male fish caught on November 21st (9-9.5° C) were in spawning condition. The absence of older fish, and the predominance of Ontario-stocked fish at this location are likely related to: 1) the short history of stocking at this site (first lake trout stocked were in the 2007 year class); 2) the previously identified tendency of Lake Erie stocked lake trout to not disperse far from the stocking location, and 3) the absence of larger mesh sizes in the assessment gear. It is worth noting that although mussel-free cobble substrate was noted at Nanticoke Shoal in 2012, the presence of considerable coverage by *Cladophora* algae, even late in November, may compromise successful spawning at this location.

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-type accounting 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 2012 lake trout model estimated the Lake Erie population at 232,919 fish and the age-5 and older population at 47,561 fish, less than half of what it was a decade ago when the lake trout population was at its peak (Figure 1.17). 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 lamprey 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.

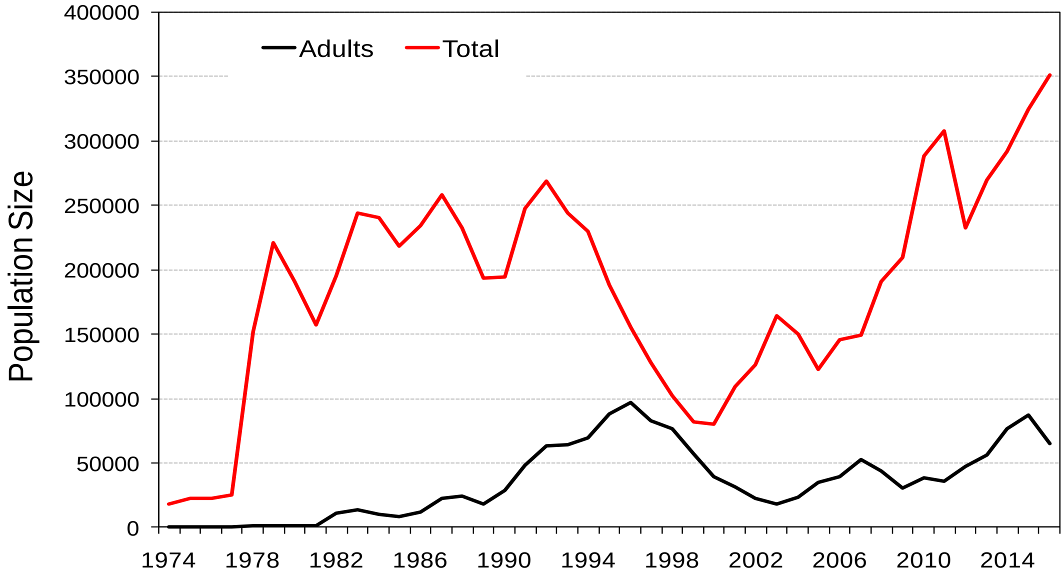


FIGURE 1.17. Projections of the Lake Erie total and adult (ages 5+) lake trout population using the CWTG lake trout model. Projections for 2013-2016 were made using low rates of sea lamprey mortality with proposed stocking rates. The model estimated the lakewide lake trout population in 2012 at 232,919 and the adult population at 47,561.

Diet

Based on current sampling protocols, lake trout diet information was limited to fish caught during August 2012 in the coldwater gill net assessment surveys in the eastern basin of Lake Erie. Analysis of the stomach contents revealed a diversity of prey fish species in the diets of both Lean and Klondike strain lake trout. Rainbow smelt was most prevalent diet item, occurring in 93% of Lean and 79% of Klondike lake trout stomachs (Table 1.4). Round goby was the second most commonly encountered prey item (Leans = 7%; Klondikes = 16%), but it occurred in lower percentages than in past years. When smelt are in good supply, they appear to be the preferred prey item for all lake trout. However, in years of lower adult smelt abundance, lake trout appear to prey more on round gobies. Klondike strain lake trout consistently have higher percentages of round goby in their diets compared to lean strain lake trout (Coldwater Task Group 2011). Gizzard shad and alewife were also present in lake trout diets in 2012. These forage fish rarely show up in lake trout diets, and their presence is indicative of their higher abundance in eastern basin forage fish surveys in 2012 (Forage Task Group 2013). Emerald shiners were the only other identified prey species that were encountered in 2012.

TABLE 1.4. Frequency of occurrence of diet items from non-empty stomachs of Lean and Klondike strain lake trout collected in gill nets from eastern basin waters of Lake Erie, August 2012.

PREY SPECIES	Lean Lake Trout (N = 242)	Klondike Lake Trout (N = 68)
Smelt	225 (93%)	54 (79%)
Round Goby	16 (7%)	11 (16%)
Alewife	1 (<1%)	1 (1%)
Gizzard Shad	11 (5%)	7 (10%)
Emerald Shiner	1 (<1%)	4 (6%)
Unknown Fish	5 (2%)	2 (3%)
Number of Empty Stomachs	163	44

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Charge 2: Continue to assess the lake whitefish fishery, 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 2012 was 341,374 pounds (Figure 2.1). Ontario accounted for 63% of the total, harvesting 215,051 pounds, followed by Ohio (35%; 119,887 lbs.), with 2% of the harvest in Michigan (6,436 lbs.) and none in Pennsylvania or New York (Figure 2.2). Total harvest in 2012 was 45% lower than the total harvest in 2011. Lake whitefish harvest in 2012 declined 59% in Ontario but increased 45% in Ohio and 55% in Michigan waters from 2011.

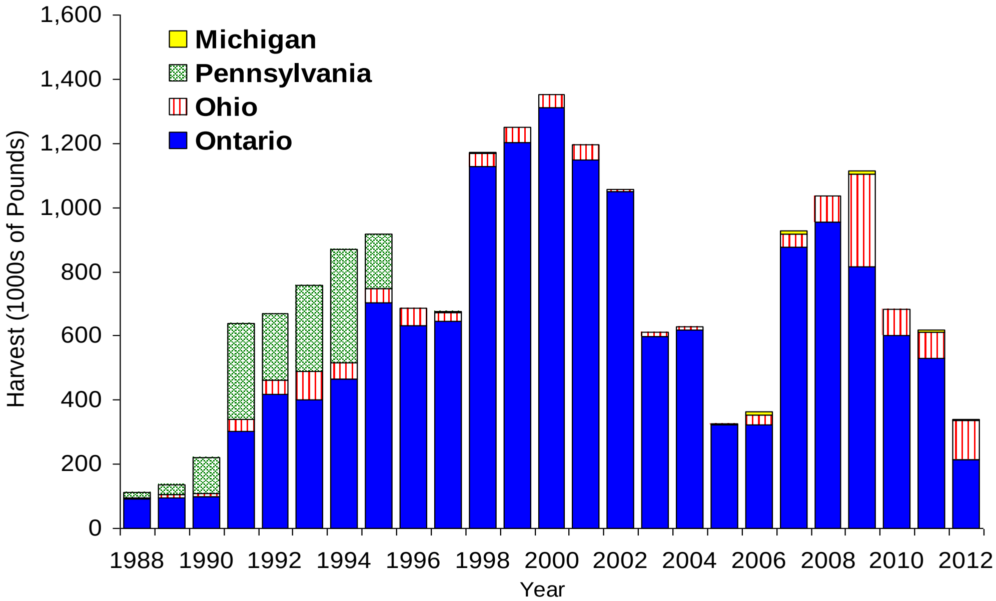

FIGURE 2.1. Total Lake Erie commercial whitefish harvest from 1987-2012 by jurisdiction. Pennsylvania ceased gill netting in 1996, and Michigan resumed commercial fishing in 2006, excluding 2008.

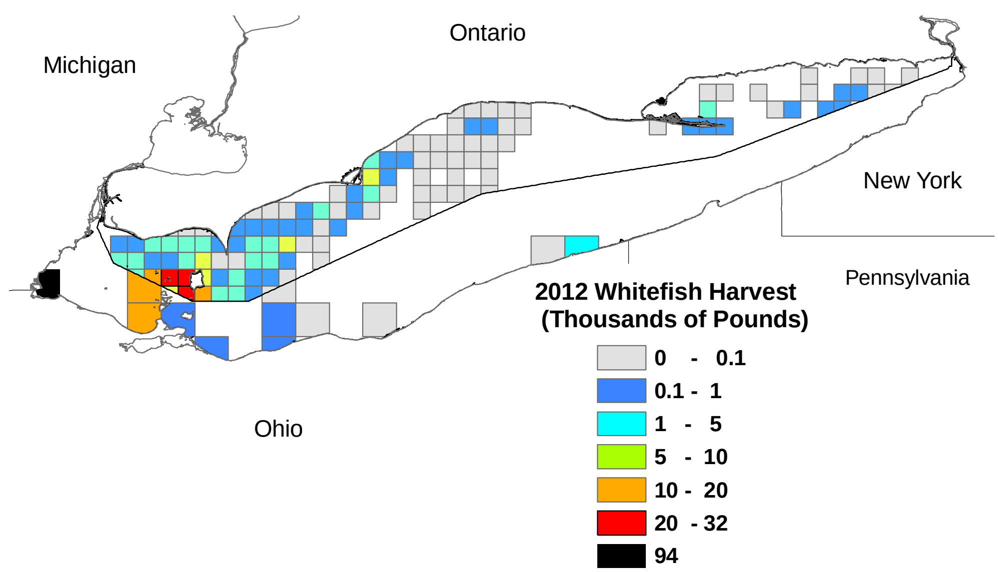

FIGURE 2.2. Lake whitefish harvest among all Lake Erie jurisdictions during 2012 by 5-minute (Ontario) and 10-minute (Michigan, Ohio) grids. No lake whitefish harvest was reported in Pennsylvania and New York.

The majority (98%) of Ontario's 2012 lake whitefish harvest was taken in gill nets. The remainder was caught in smelt trawls (2%), and harvest in impoundment gear (24 lbs.) was negligible. The largest fraction of Ontario's whitefish harvest (77%) was caught in the west basin (Ontario Unit OE1) followed by OE2 (21%), with the remaining harvest distributed eastward among units OE4, OE5 and OE3. Harvest in OE1 occurred primarily from October to December (98%), peaking in November, whereas OE2 harvest peaked during March and April (88%). The majority of the lake whitefish harvest in OE4 (80%) occurred in August and September, while OE3 and OE5 whitefish harvest was distributed between spring and fall. In Ontario, 40% of lake whitefish were harvested from gill nets targeting whitefish, followed by fisheries targeting walleye (39%), white bass (18%), and rainbow smelt (trawls; 2%), with the remaining whitefish harvest from white perch and yellow perch fisheries.

In Ohio waters during 2012, 99% of the whitefish harvest occurred in the west basin. Whitefish were harvested from 1,273 trap net lifts in 2012, with lifts distributed among District 1 (45%), District 2 (30%) and District 3 (25%) respectively. The majority of Ohio's whitefish harvest occurred during November (94%) and December (5%) in the western basin. Whitefish yield in 2012 was greatest near the mouth of the Maumee River, attributed mostly to harvest in Ohio waters (87,101 pounds) and to a lesser extent in Michigan waters (6,436 pounds, Figure 2.2).

Ontario annual commercial catch rates targeting lake whitefish dropped by more than half in all quota areas from 2011 (Figure 2.3). From 1998 to 2012, fall (Oct-Dec) catch rates in the west basin (quota zone 1) ranged from 66 to 211 kg / km but was 87 kg/km in 2012, representing the third lowest catch rate in 15 years. The 2012 mean catch rate across quota zones was the lowest observed in 15 years. West basin monthly catch rates in 2012 were highest during spawning in November, followed by October and December (Figure 2.4A). Fall (Oct-Dec) gill net effort targeting whitefish in the west basin (OE1) was 333 km or the 7th lowest in 15 years (Figure 2.4B). OE1 fall harvest (28,970 kg) was fourth lowest since 1998 (Figure 2.4C). In contrast, Ohio commercial trap net catch rates in 2012 were second highest since 1996 (Figure 2.5).

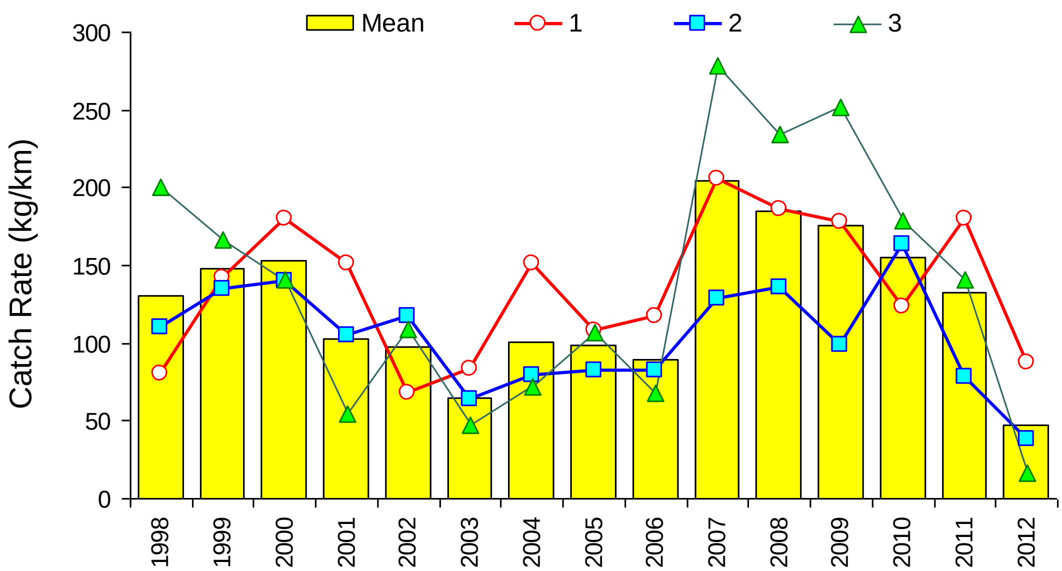

FIGURE 2.3. Ontario annual commercial large mesh gill net catch rates targeting lake whitefish by quota zone, 1998 - 2012. Bars represent averages of catch rates across quota zones. Quota zone 1 refers to the west basin, zone 2 extends eastward to the middle of the central basin. The eastern portion remaining is quota zone 3.

The landed weight of roe from Ontario's 2012 lake whitefish fishery was 3,956 pounds, most of which came from OE1 during November (70%) and October (28%). The remaining fraction of roe was collected from OE2 (1%) during October with negligible amounts from other areas. The approximate landed value of the roe was CDN $14,960.

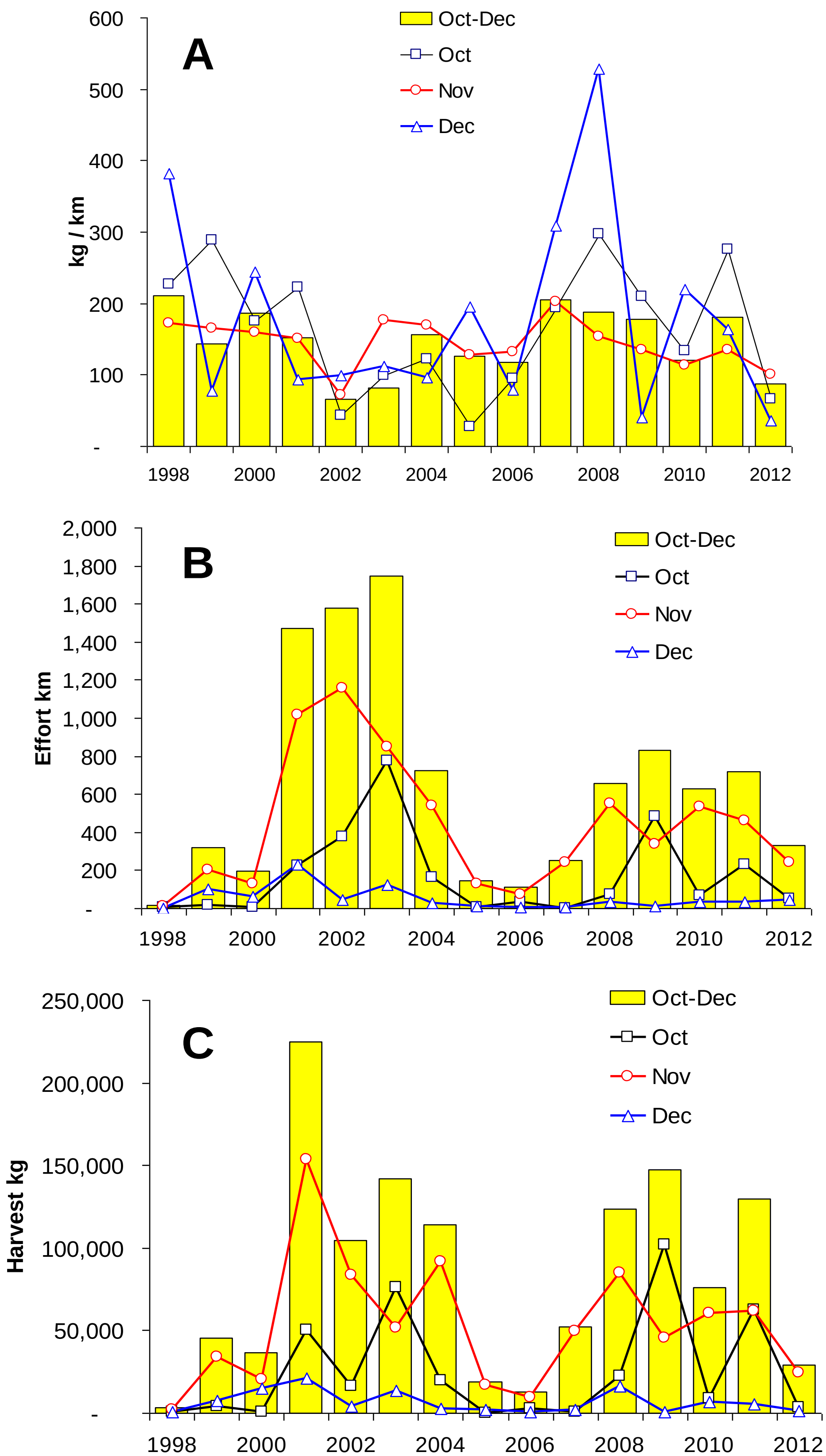

FIGURE 2.4. Targeted large mesh gill net catch rate (A), gill net effort (B) and harvest (C) for lake whitefish in the west basin for October, November, December and pooled (Oct-Dec) 1998-2012.

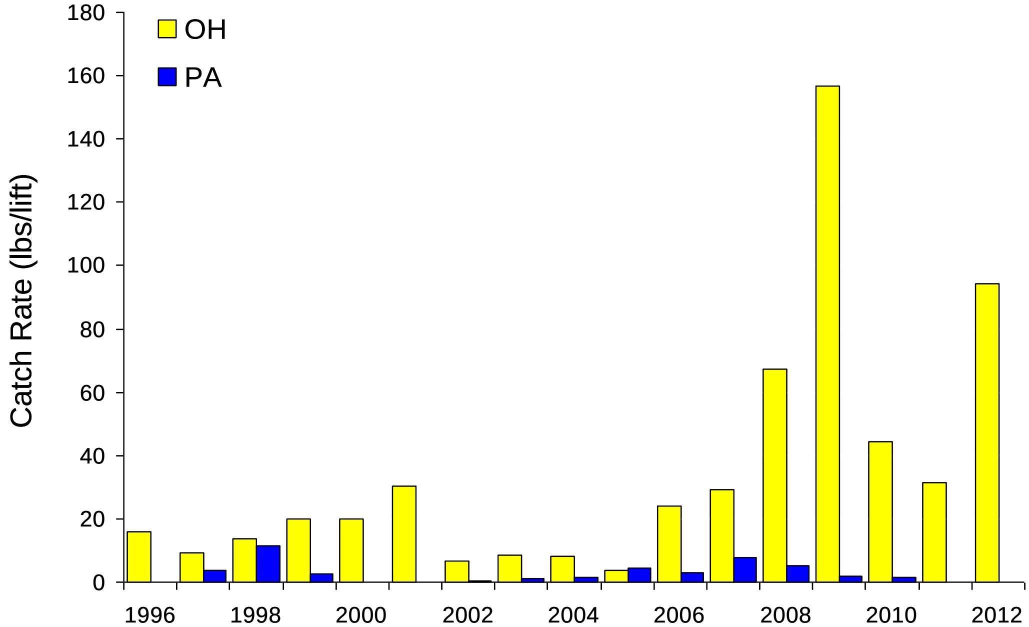

FIGURE 2.5. Ohio and Pennsylvania lake whitefish commercial trap net catch rates (pounds per lift), 1996-2012. There was no lake whitefish harvest in Pennsylvania in 2011 and 2012.

Ontario's west basin fall lake whitefish fishery was dominated by older fish (Figure 2.6). The strong 2003 cohort (age 9) dominated 2012 catches in targeted and non-targeted (walleye) fisheries (Figure 2.7). Age 7 was the next most abundant year class (2005) and the oldest lake whitefish in Ontario's harvest was 23 (Figure 2.7). There was no characterization of the lake whitefish commercial fishery by age in Ohio in 2012.

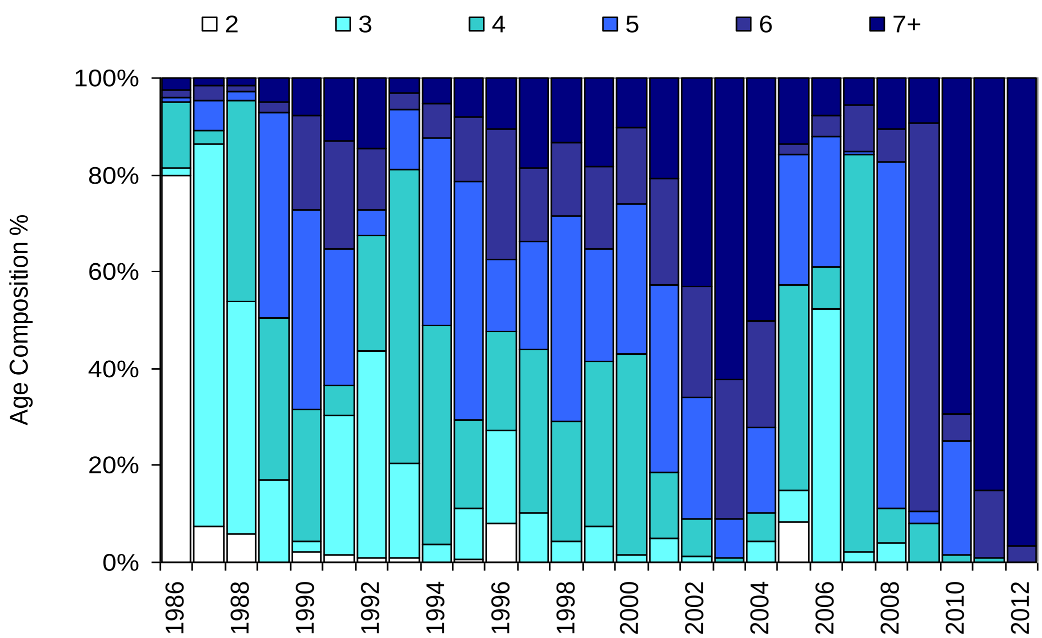

FIGURE 2.6. Ontario fall commercial whitefish harvest age composition in statistical district 1, 1986-2012, from effort with gill nets mesh ≥3 inches with lake whitefish in the catch from October to December.

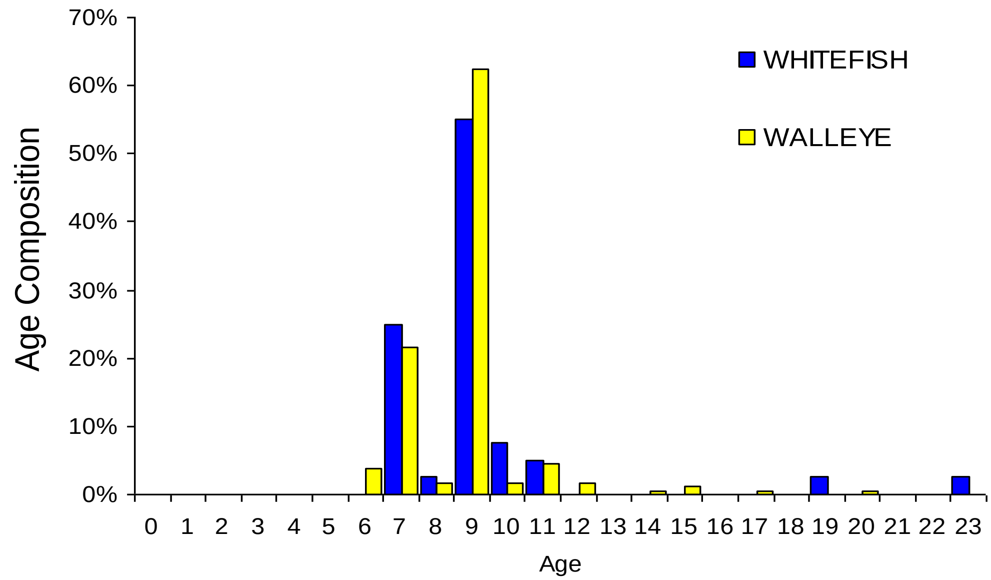

FIGURE 2.7. Age composition of lake whitefish caught commercially in Ontario waters of Lake Erie in 2012 by target species fisheries. Otoliths and scales were used to age lake whitefish samples (N=221).

Assessment Surveys

Lake whitefish abundance indices in the 2012 gill net assessments varied from low to moderate (Figures 2.8 and 2.9). Relative to the time series, catch rate percentiles were 0, 5, 0, 26 and 38 in the Ontario west, west-central, east-central, Pennsylvania Ridge, and east basin surveys, respectively (Figure 2.8). In contrast, New York's coldwater assessment survey catch rates more than doubled from 2011 (3.2 whitefish per lift; Figure 2.9); and the catch rate is at the 67th percentile in the time series.

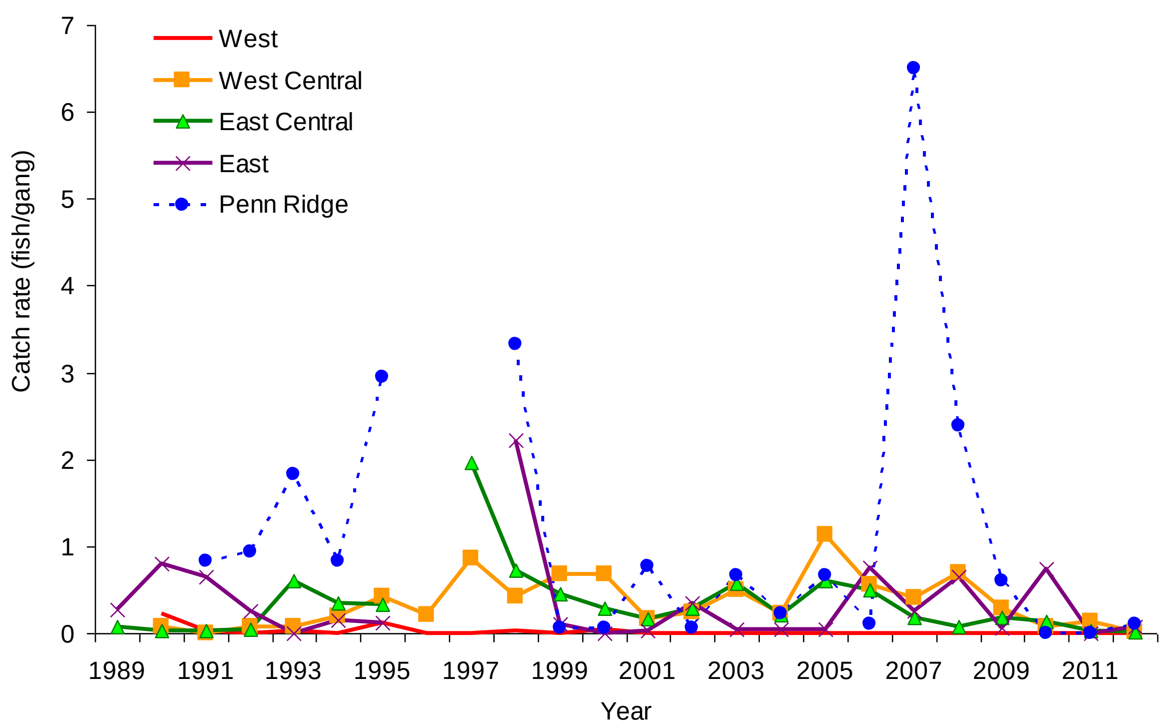

FIGURE 2.8. Catch rate (number per gang) of lake whitefish from Ontario partnership index gill netting by basin, Lake Erie, 1989 - 2012.

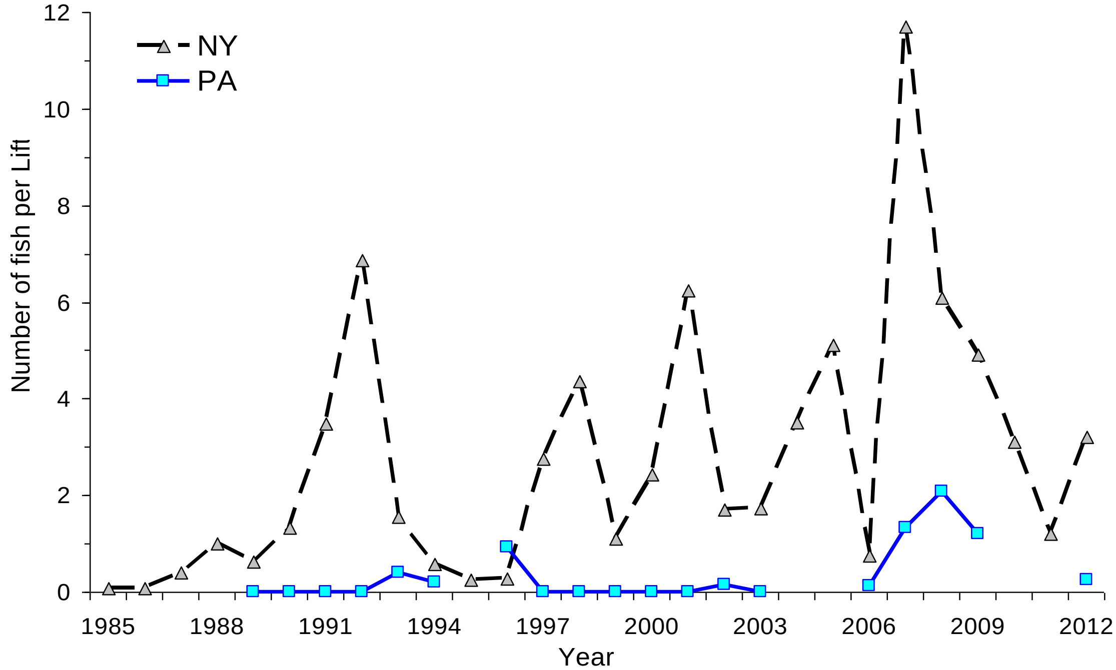

FIGURE 2.9. Catch per effort (number fish/lift) of lake whitefish caught in standard assessment gill nets from New York, August 1985-2012 (triangles), and August assessment gill nets from Pennsylvania, 1989-2009 (squares). No sampling took place in Pennsylvania waters in 1995, 2004, 2005, 2010-2011.

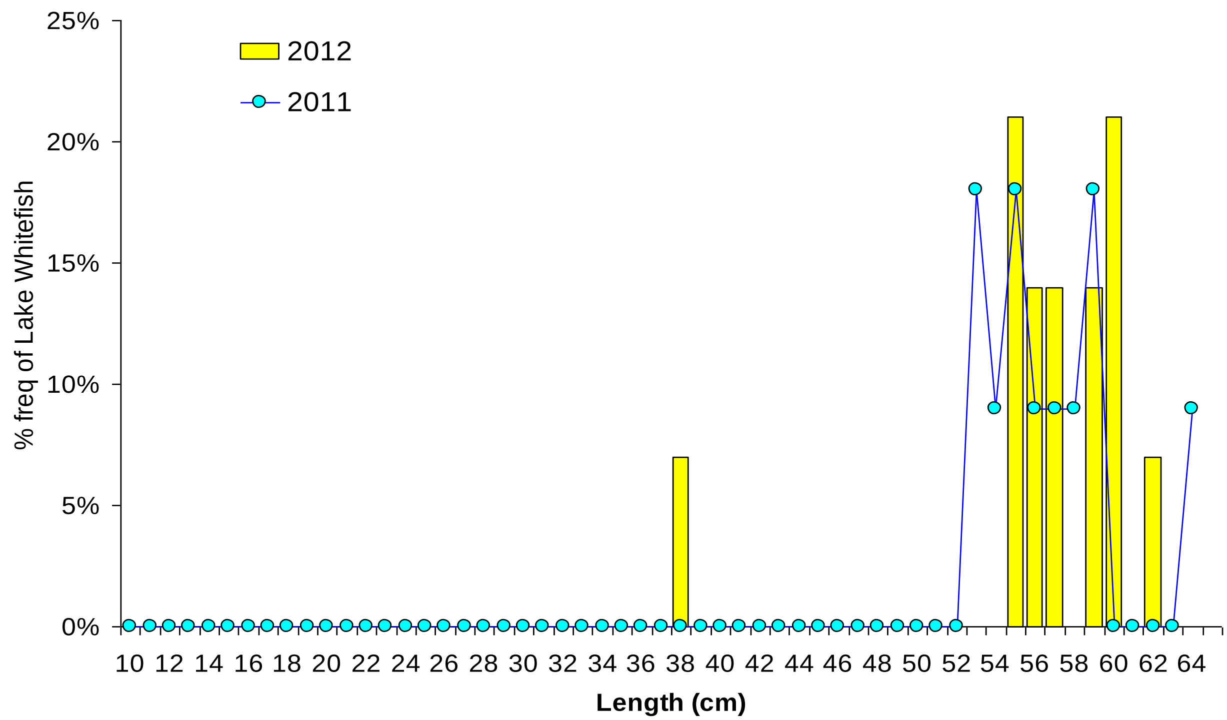

FIGURE 2.10. Length (cm) frequency distributions of lake whitefish collected during lake-wide Ontario partnership index fishing, 2011 and 2012. Standardized to equal effort among mesh sizes.

Length-frequency distributions of lake whitefish captured in Ontario partnership index gill netting reflected the dominance of older whitefish (Figure 2.10). The majority (36%) of lake whitefish sampled in the Ontario surveys were from the 2003 cohort, with the 2005, 2002, 2002, 2009 and 1990 year classes present (Figure 2.11). The youngest whitefish caught during Ontario Partnership surveys was age 3.

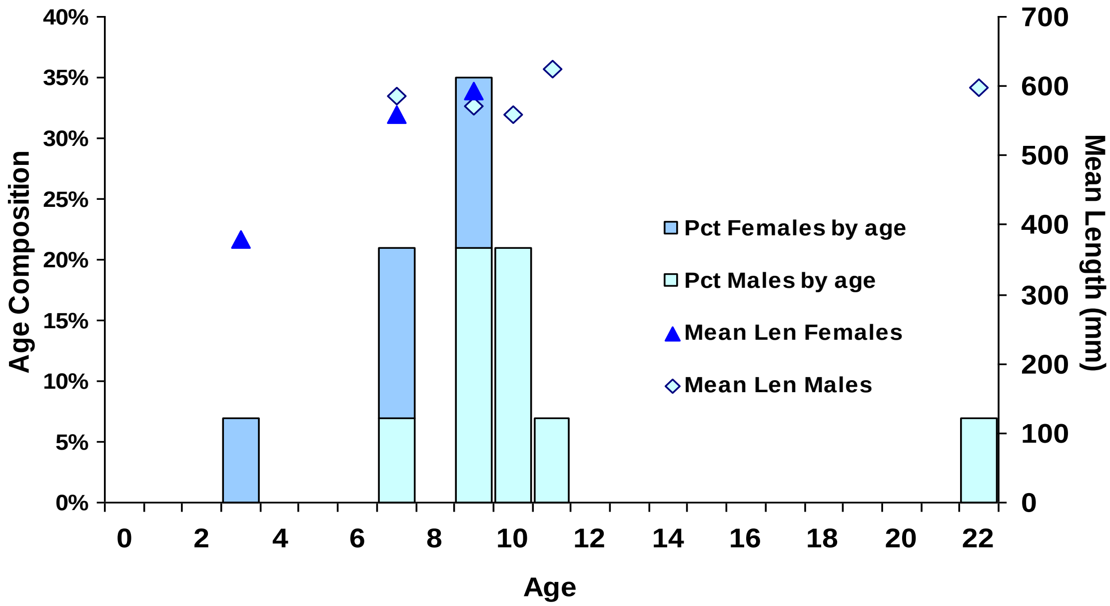

FIGURE 2.11. Age frequency distributions and mean length by sex of lake whitefish collected during Ontario lake-wide partnership index fishing, 2012. Standardized to equal effort among mesh sizes.

Length-frequencies and distribution of lengths at age by sex for lake whitefish from the New York coldwater gill net assessments also showed the dominance of older, larger fish in these surveys (Figure 2.12). The majority of fish were age 9, comprising 47% of the catch, followed by ages10, 11, and 16. The oldest fish observed in the New York surveys was age 23.

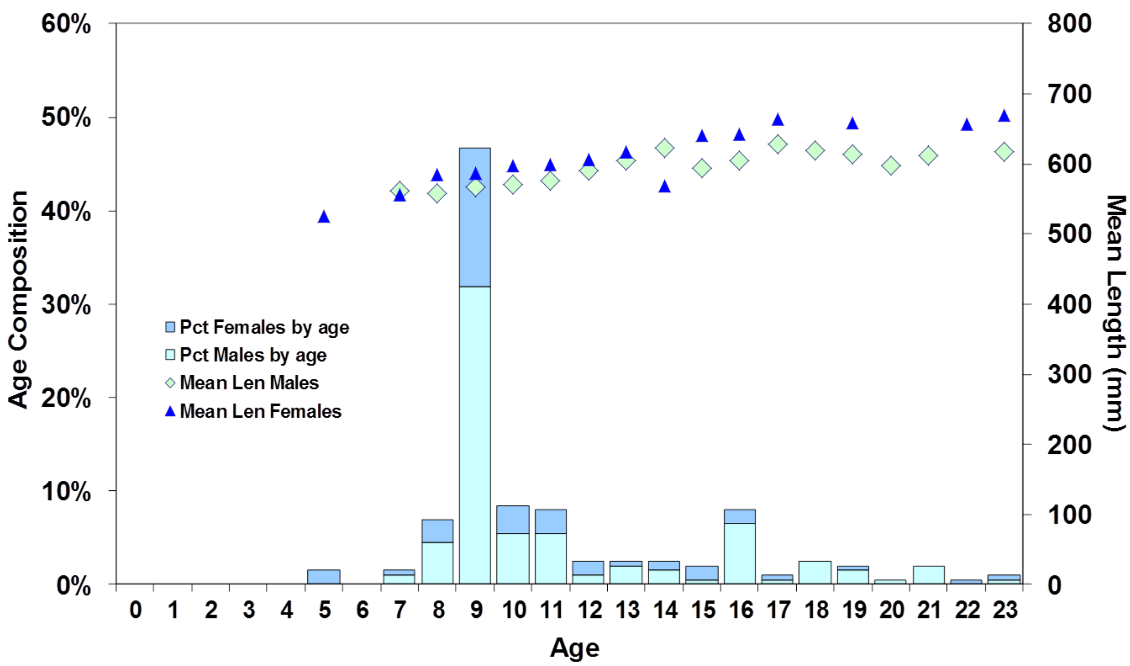

FIGURE 2.12. Age distribution and mean length-at-age of lake whitefish collected during coldwater gill net assessment surveys in New York waters of Lake Erie during 2012 (N=201).

Adult lake whitefish captured and aged from Ohio DNR assessment surveys (N=9) included the 2003 year class (age 9), and the 2006, 2005, 2001 and 2009 year classes (Figure 2.13). Length frequencies and length-at-age were comparable to recent Ohio assessment survey catches and to other agencies' results.

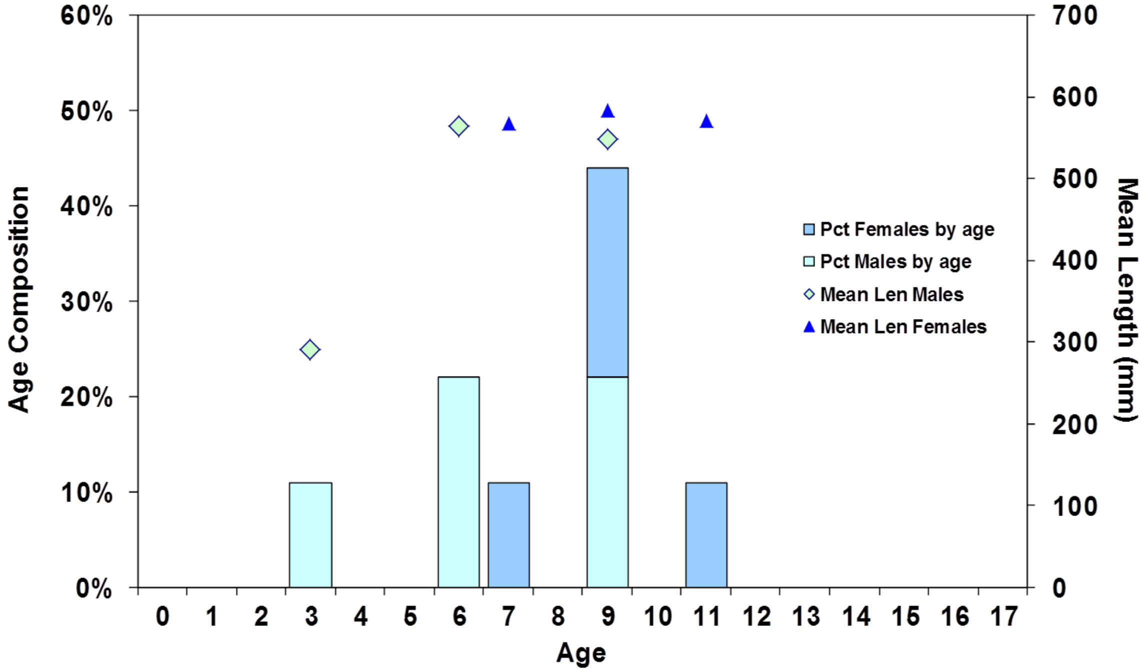

FIGURE 2.13. Age distribution and mean length-at-age of lake whitefish collected during trawl and gill net assessment surveys in Ohio waters of Lake Erie during 2012 (N=9).

USGS-Sandusky personnel captured 29 lake whitefish during late fall surveys in the western basin. Of the otolith-aged fish (N=21), the mean age was 13.62 years, with an age range of 8-24 years (Figure 2.14).

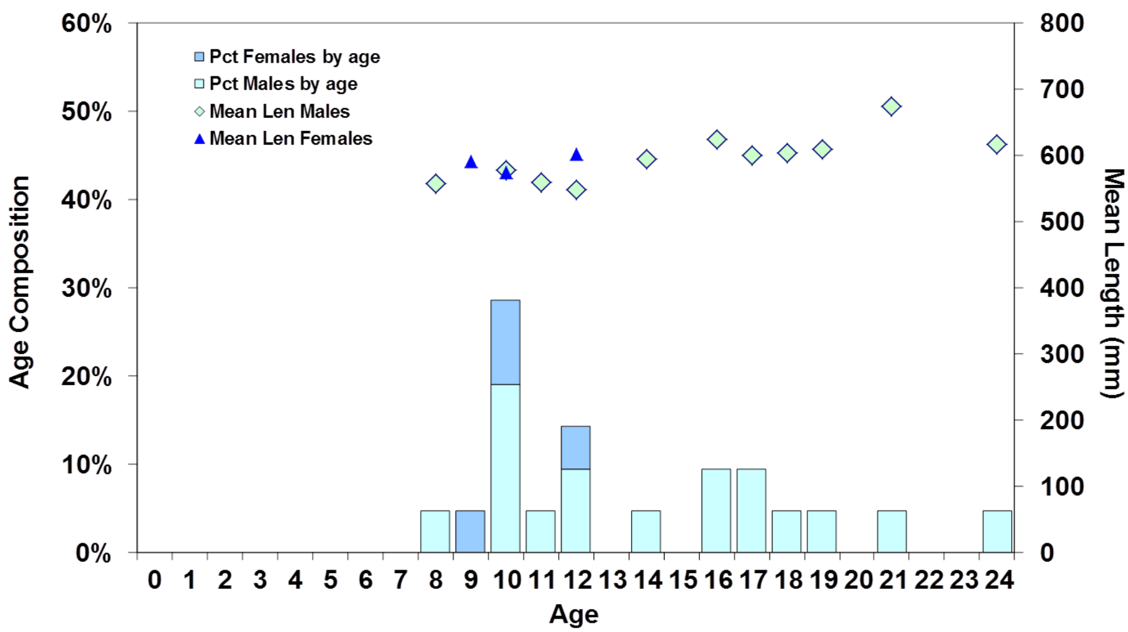

FIGURE 2.14. Age distribution and mean length-at-age of lake whitefish collected during USGS fall gill net surveys in Lake Erie's western basin during 2012 (N=21).

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. Also, yearlings were sampled in Ohio bottom trawl surveys in 2005, 2006 and 2011. During 2012, YOY and yearlings were not caught in Ohio assessment surveys. Low recruitment indices from assessment programs predict decreasing future performance of Lake Erie's lake whitefish fisheries.

Growth and Diet

Lake whitefish sampled in Ohio assessment trawl and gillnet surveys in 2012 indicated that condition of age 4 and older males (mean K= 1.03) and females (mean K= 1.15) were above Van Oosten and Hile's (1947) historic condition reference values of 1927-1929 (Figure 2.15). In 2012, condition (K) values of female (mean = 1.125) and male (1.084) lake whitefish assessed using Ontario fall commercial fishery and partnership gillnet survey data were above the historic average for each sex: 1.131 for females and 1.015 for males, respectively (Van Oosten and Hile 1947; Figure 2.16). Ontario lake whitefish assessed for condition analyses only included age-4 and older fish that were not spent or running, and were collected from October to December.

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 2012 were 1.135 for males and 1.229 for females.

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.

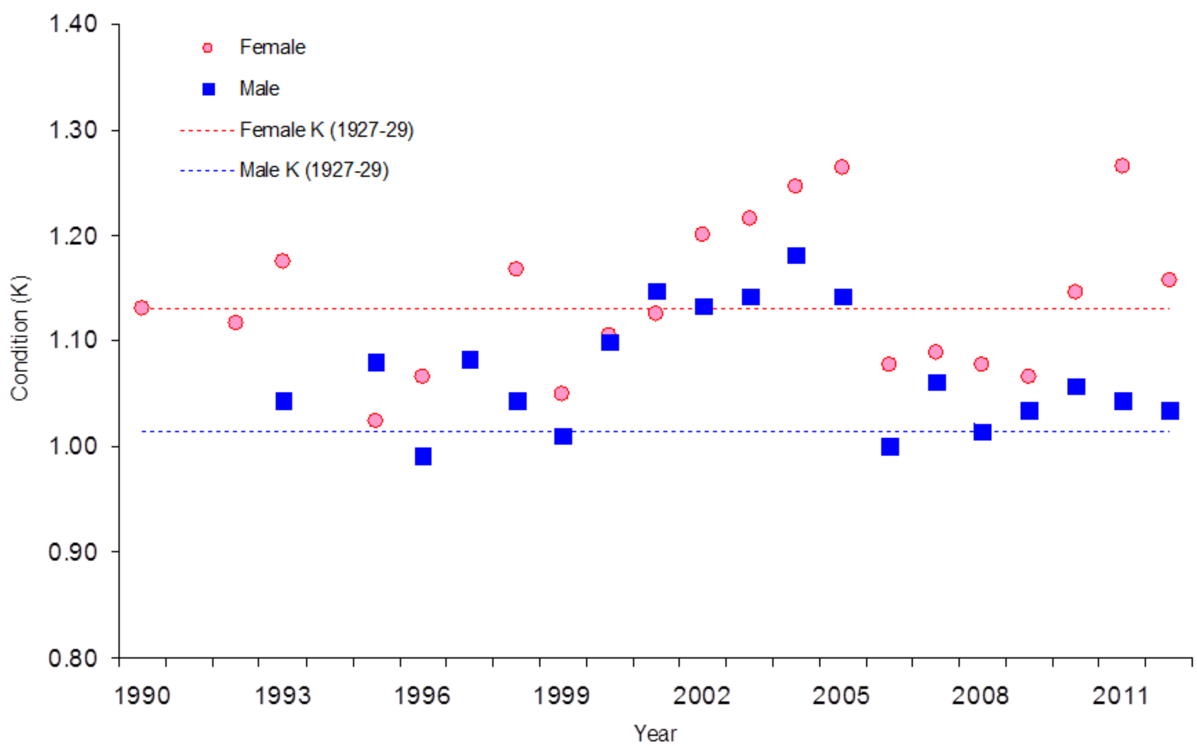

FIGURE 2.15. Mean condition (K) factor values of age 4 and older lake whitefish obtained from Ohio survey data (Aug-Dec) by sex from 1990-2012. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

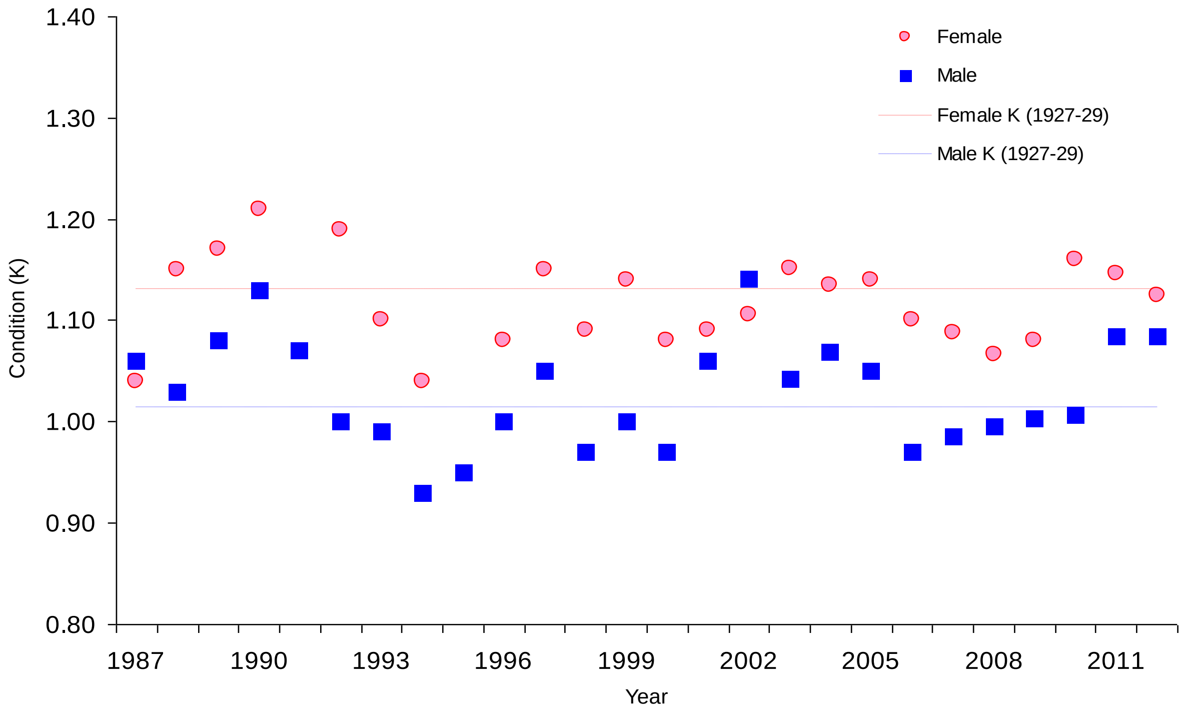

FIGURE 2.16. Mean condition (K) factor values of age 4 and older lake whitefish obtained from Ontario commercial and partnership survey data (Oct.-Dec.) by sex from 1987-2012. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

References

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

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 Elizabeth Trometer (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 2012 was 1,308 pounds (1,313 kg); a 55% decrease from 2011 (Table 3.1). All jurisdictions recorded less than 1000 lbs of commercial burbot harvest. In addition, about 109 pounds (49.4 kg) were discarded by Ontario commercial fishers in 2012. The Ontario harvest is now from by-catch in other fisheries. Most of the burbot caught by the Ontario commercial fishing industry in 2012 was by-catch in trawls from the rainbow smelt fishery (54%), followed by the lake whitefish fishery (36%).

Harvest has decreased in Pennsylvania waters after 1995 following a shift from a gill net to a trap net commercial fishery, resulting in a substantial decrease of commercial effort (CWTG 1997). Harvest of burbot in New York is from one commercial fisher. In 1999, a market was developed for burbot in Ontario, leading the industry to actively target this species. As a result, the commercial harvest in Ontario increased dramatically (Table 3.1). However, this opportunistic market did not persist, resulting in declining annual harvests.

Abundance and Distribution

Burbot are seasonally found in all the major basins of Lake Erie; however, the summer distribution of adult fish is restricted primarily to the 20-m and deeper thermally stratified regions of the eastern basin (Figure 3.1). The Ontario Partnership Index Fishing Program is an annual lakewide gill net survey of the Canadian waters of Lake Erie and it has provided an additional, spatially robust assessment of fish species abundance and distribution since 1989. During the early 1990s, burbot abundance was low throughout the lake; catch rates in the Partnership index gill nets averaged less than 0.5 burbot per 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 per lift in 1998.

Burbot numbers in the central basin also peaked in 1998, but at a much lower catch rate of 0.5 burbot per lift. Catch rates in the Pennsylvania Ridge area during 1998 to 2004 remained high, but variable, ranging between 2.0 and 4.2 burbot per lift, and then decreased to about 0.5 burbot per lift in 2005-2006. Catch rates in the eastern basin since 1998 have been variable but exhibit an overall decreasing trend. In 2012, zero burbot were captured in the central basin. Abundance in the east basin and Pennsylvania Ridge decreased sharply, reversing the temporary uptick observed in 2011. Burbot numbers in 2012 were the lowest observed during the 24-year time series of the Ontario Partnership Survey (Figure 3.2).

An examination of bottom sets from combined sample locations in the east basin and Pennsylvania Ridge of the Ontario Partnership assessment data shows that the abundance of burbot (CPE; number of fish per 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 2012, both abundance measures were at or near their respective time-series minima (Figure 3.3).

Numeric abundance of burbot, as determined from interagency coldwater gill net assessments, 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 less than one burbot per lift across all jurisdictions in 2012 (Figure 3.4).

TABLE 3.1. Total burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2012.

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	2.894
2012	0.7	0.2	0.2	0.2	1.308

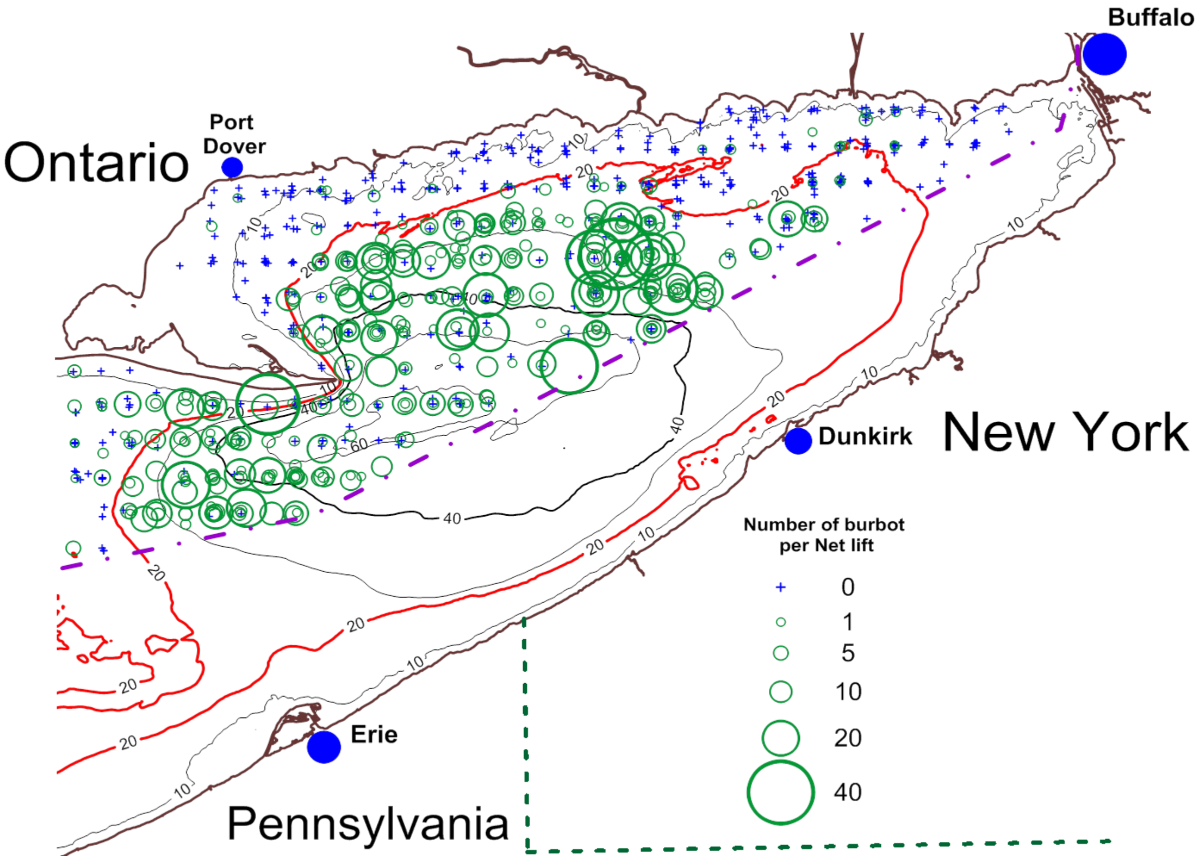

FIGURE 3.1. Distribution of burbot catches (number per lift) in Ontario Partnership gill nets during August surveys of eastern Lake Erie, 1989-2012.

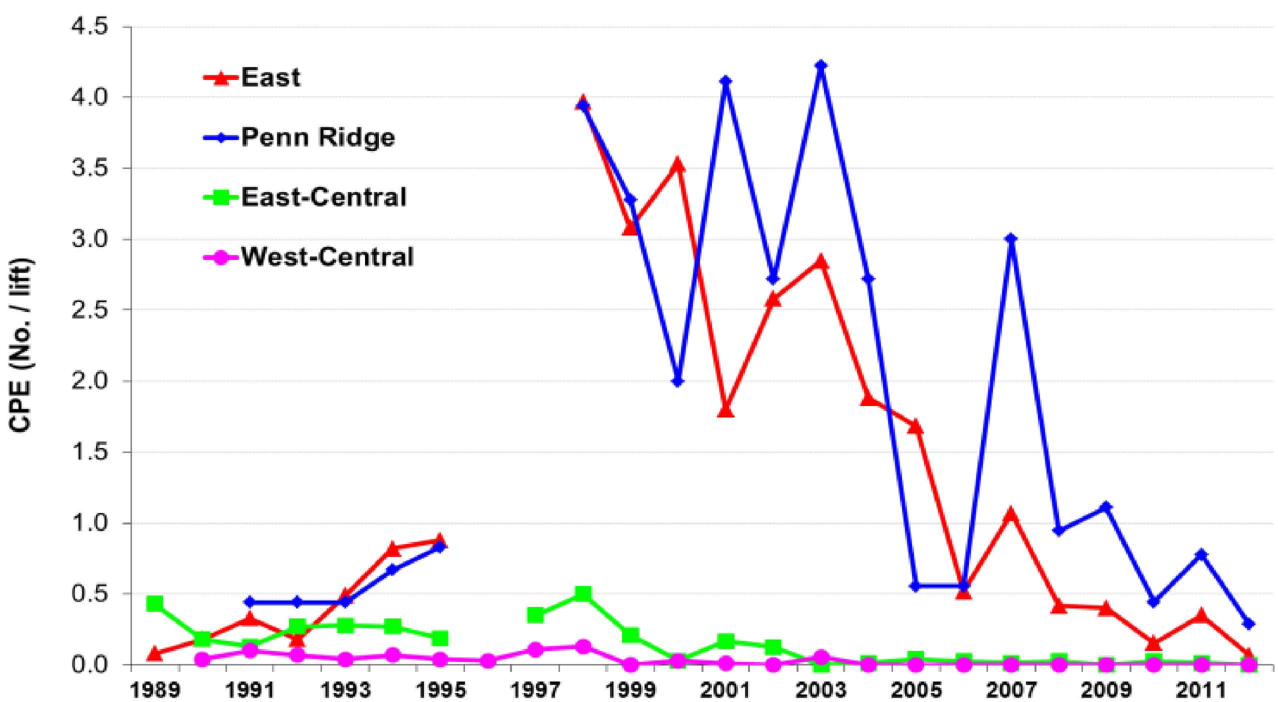

FIGURE 3.2. Burbot CPE (number of fish/lift) by basin from the Ontario Partnership surveys, 1989–2012 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets).

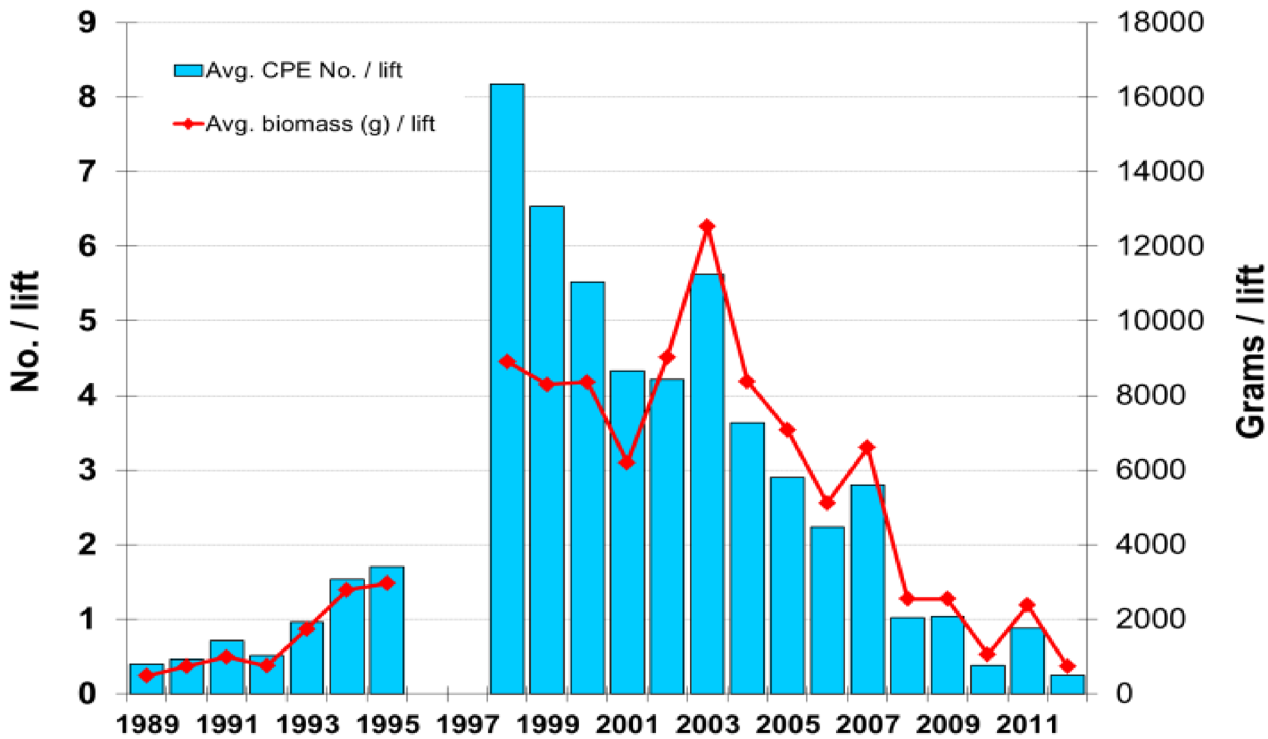

FIGURE 3.3. Average catch rate (CPE as number of fish/lift) and biomass (CPE as grams/lift) of burbot in Ontario waters of eastern Lake Erie, Ontario Partnership gillnet survey, 1989–2012 (includes only bottom sets, all mesh sizes; PA-ridge and east basin sample sites).

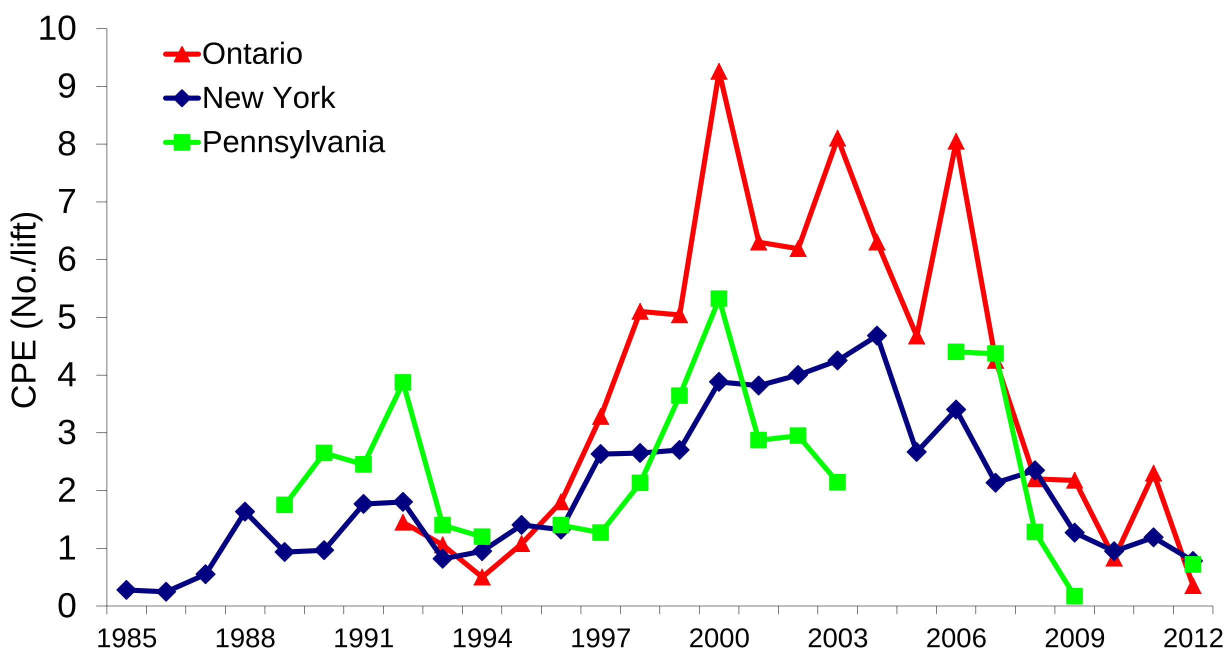

FIGURE 3.4. Average burbot catch rate (number of fish/lift) from summer coldwater gill net assessment by jurisdiction, 1985-2012. Note: Pennsylvania waters were not surveyed in 2010 and 2011.

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, and the 2012 burbot catch rates in these two regions decreased into the below-6th percentile range of the respective time-series (Figure 3.5). In Pennsylvania, the 2009 burbot biomass estimate was the lowest in their time series; however, following two years of no assessment effort in 2010 and 2011, the 2012 burbot biomass ranked as third-lowest (15th percentile) in that survey.

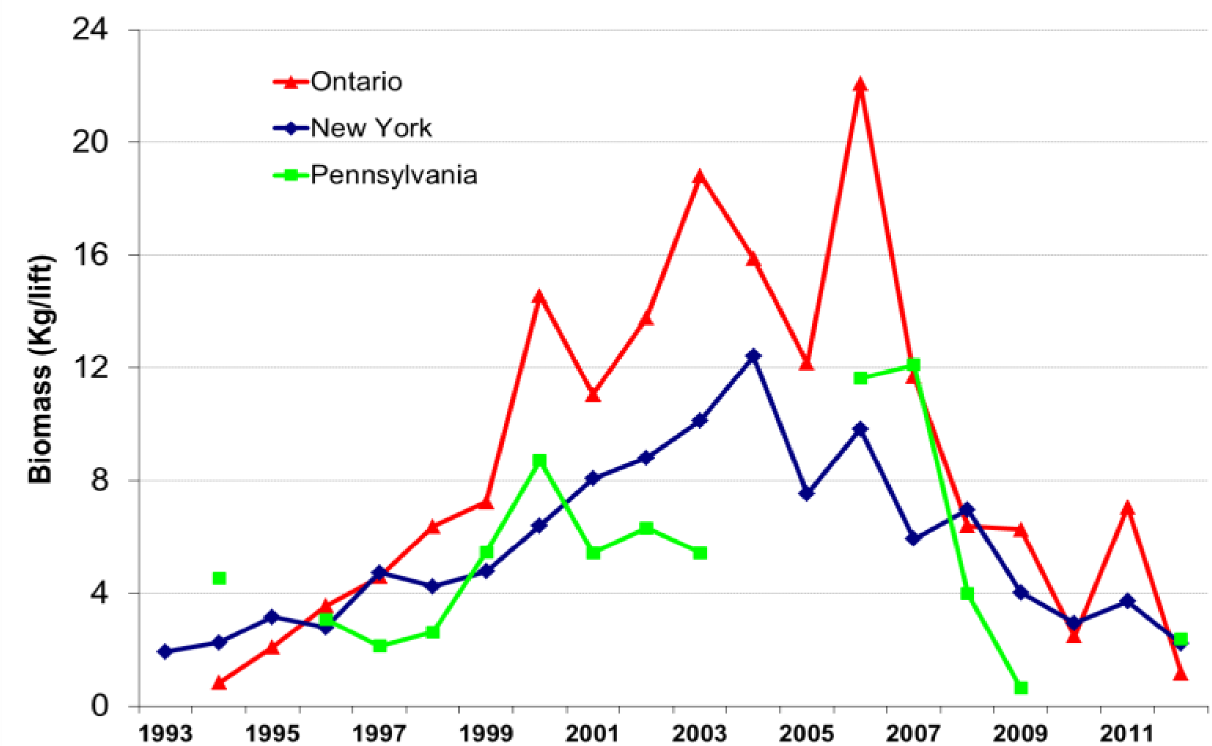

FIGURE 3.5. Average burbot biomass (kg/lift) from summer coldwater gill net assessment by jurisdiction, 1993-2012. Note: Pennsylvania waters were not surveyed in 2010 and 2011.

In a recent analysis applying GIS techniques to burbot catches in the Ontario Partnership survey of eastern Lake Erie, Stapanian et al. (in review) 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 when 2007-2011 catches were compared to 1994-2001 catches. Median depth of burbot distribution remained the same (at about 30 m) between sexes and across analysis periods. The overlap in capture areas of adult male and female burbot was measured at greater than 20% maximum yearly catch, and decreased some 36% and 74% from 1994-2001 to 2002-2006 to 2007-2011, respectively.

Age and Recruitment

Burbot ages (from examinations of otoliths) have been estimated for fish caught in coldwater assessment gill nets in Ontario waters since 1997 and for the entire east basin survey area in 2011. The burbot catch ranged in age from 3 to 20 years in 2011 and from 4 to 22 years in 2012 (Figure 3.6). Burbot older than 12 years represented 74% and 54% of the 2011 and 2012 aged fish, respectively, with age 15 and 16 as the dominant age group in both years. Mean age of burbot has increased since 1998, and this trend continued in 2011 (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 2012 (Figure 3.7). Four of the six age-4 burbot shown in Figure 3.6 for 2012 were captured in Ontario, and while this appears to represent a significant increase in number from 2011 (two age-4 burbot were captured in Ontario), the age-4 recruitment index remained unchanged because twice as many gill net lifts were completed during 2012 than the previous year. A recently published analysis (Stapanian et al. 2010) suggested that recruitment during 1997-2007 was associated with abundance of yearling and older yellow perch when the burbot were age-0, and beneficial winter water temperatures supported the spawning and egg development phases of burbot. Burbot have the highest reproductive success at water temperatures between 0 and 2^{o} C, and are susceptible during early life to predation by yellow perch. Despite an increased number of age-4 burbot in the recent survey, a sustained downward trend in catch rates, an increasing trend in mean age, and persistent low recruitment signal continuing troubles for this population. For accurate assessment of this aging population, the use of otolith thin-sections is recommended as the best approach for accurate age determination (Edwards et al. 2011). 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.

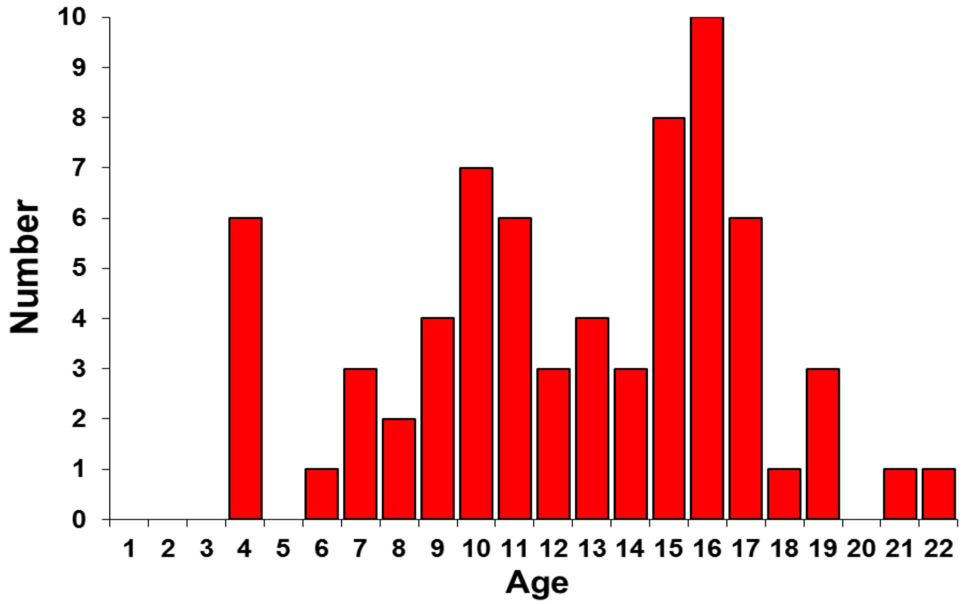

FIGURE 3.6. Age distribution of burbot caught in summer coldwater gill net assessment in eastern Lake Erie, 2012 (N=69).

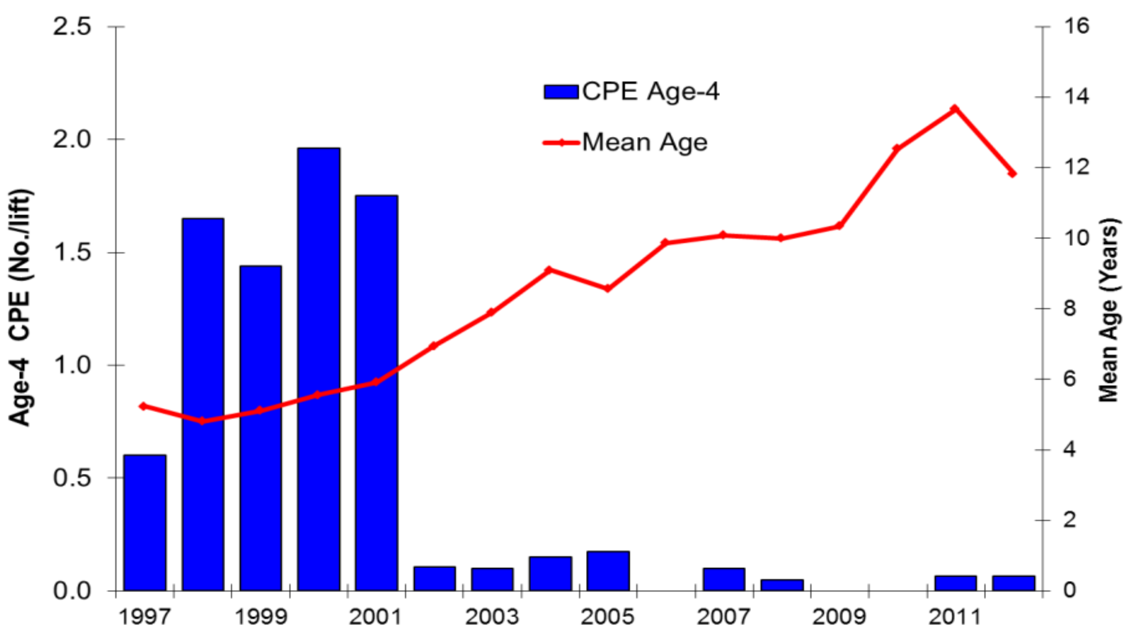

FIGURE 3.7. Mean age and average CPE of age-4 burbot caught in summer gill net assessment in Ontario waters of eastern Lake Erie during 1997-2012.

Growth

Mean total length of burbot continued to increase in Ontario, a trend prevalent across all jurisdictions since the late 1990's, and it reached a time-series maximum in Pennsylvania during 2012 coldwater assessment surveys (Figure 3.8). In contrast, burbot length deceased in 2012 for the first time in some 12 years in New York. The change in average weight of burbot from 2011 to 2012 followed a similar pattern across jurisdictions, with increases observed in Ontario and Pennsylvania and a decrease in New York (Figure 3.9). Increasing average size remains the dominant trend since about 1998. These results reflected the increasing mean age of the burbot population.

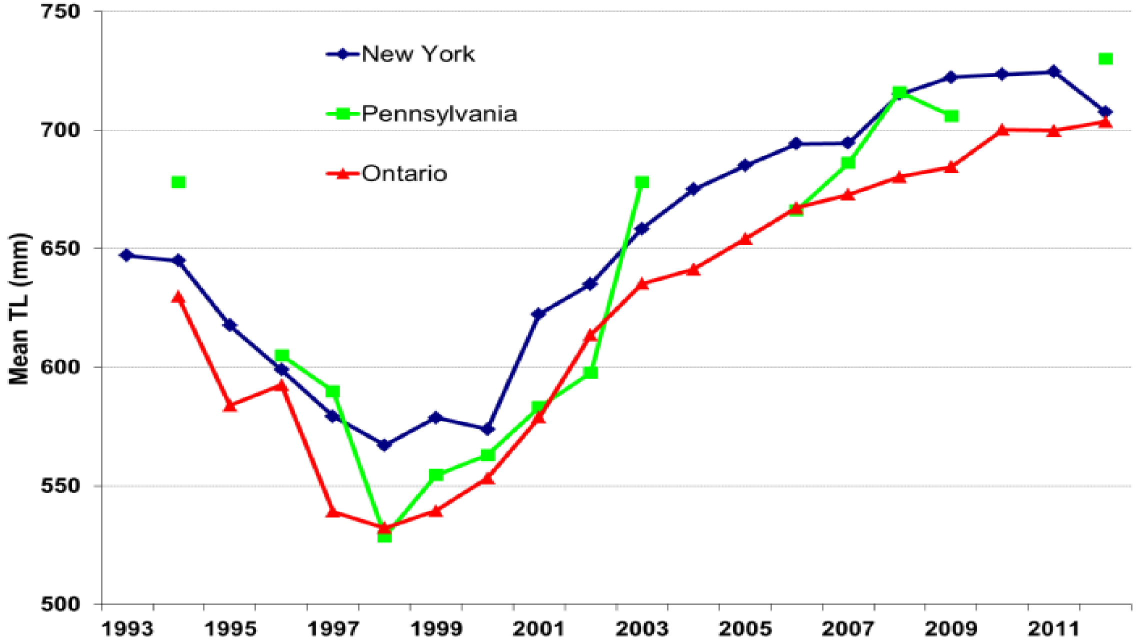

FIGURE 3.8. Average total length (TL) of burbot caught in summer gill net assessments by jurisdiction during 1993-2012. Note: Pennsylvania waters were not surveyed in 2010 and 2011.

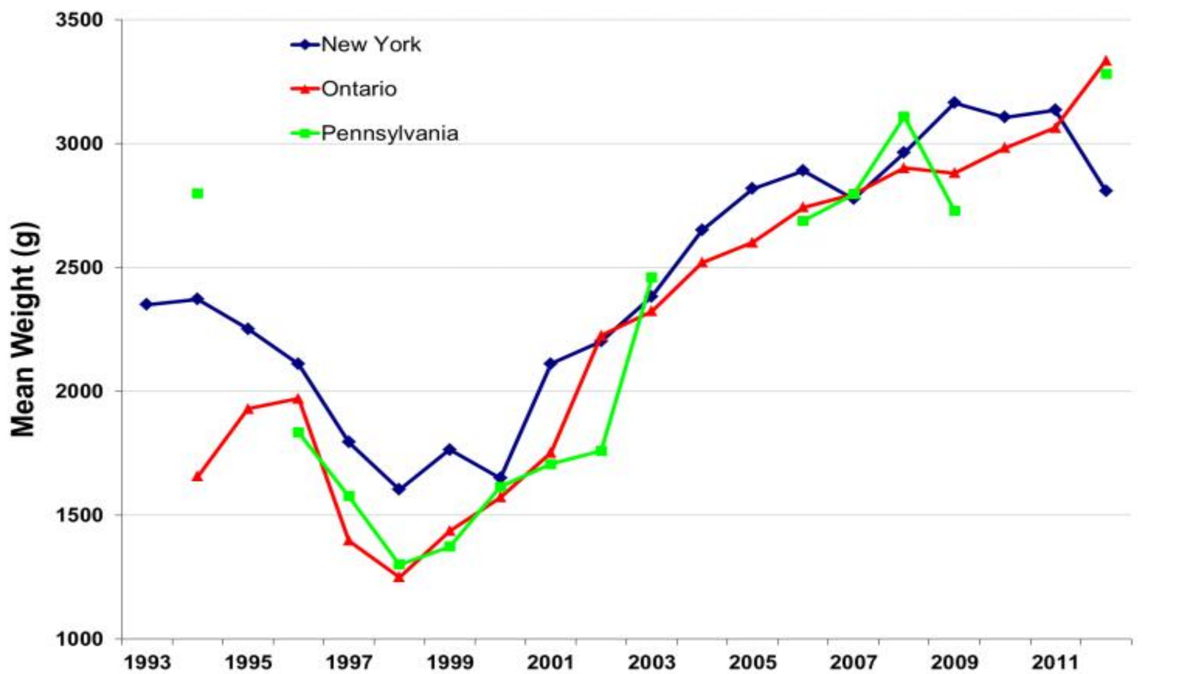

FIGURE 3.9. Average weight of burbot (g) caught in summer gill net assessments by jurisdiction during 1993-2012. Note: Pennsylvania waters were not surveyed in 2010 and 2011.

Diet

Burbot diet information was limited to fish caught during August 2012 coldwater gill net assessment surveys in the eastern basin of Lake Erie. Analysis of burbot stomach contents revealed a diet made up mostly of fish (Figure 3.10). Burbot diets continued to be diverse, with six different identifiable fish species and one invertebrate species found in stomach samples. Rainbow smelt were the dominant prey item, occurring in 55% of the burbot stomachs, followed by round goby (45% occurrence). Two clupeid species, alewife and gizzard shad, were collectively found in 17% of burbot stomachs. Other identifiable taxa were found in 5% or less of the stomachs, and included yellow perch, emerald shiners, and dreissenid mussels.

Round gobies have increased in the diet of burbot since they first appeared in the eastern basin in 1999 (Figure 3.11). They were the main diet item for burbot in seven of the last 10 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 gobies became a significant component of the burbot diet (Stapanian et al. in review). This increase in size is thought to be associated with reduced competition for food among juvenile burbot during low recruitment years.

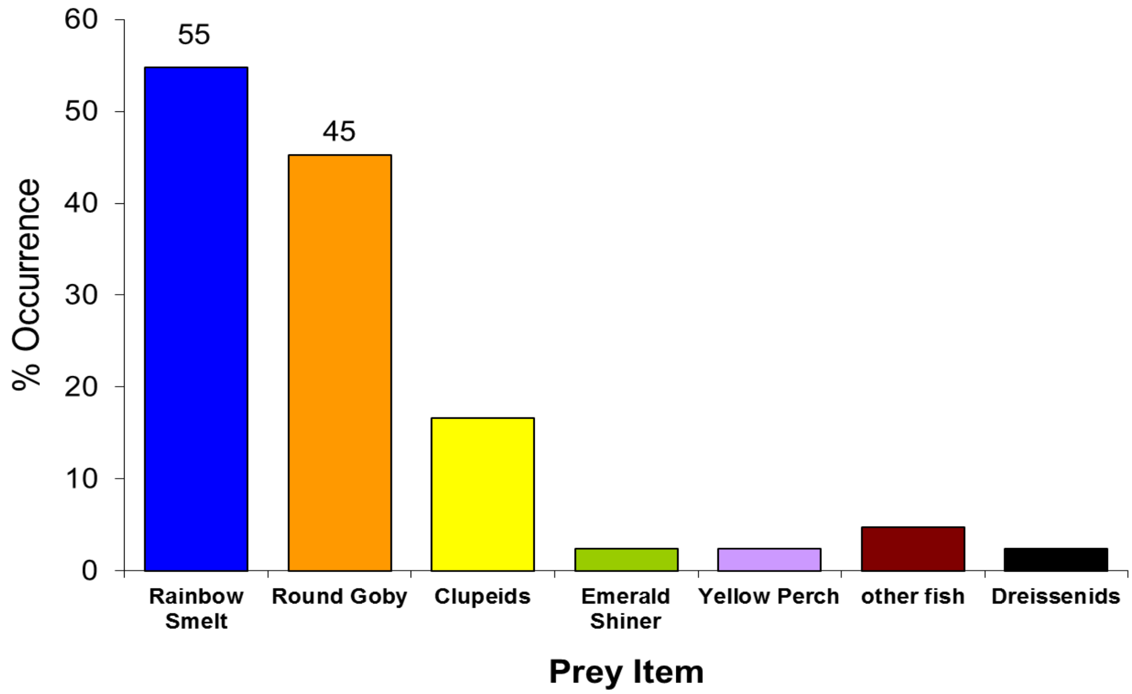

FIGURE 3.10. Frequency of occurrence of diet items from non-empty stomachs of burbot sampled in gill nets from the eastern basin of Lake Erie, August 2012. Other fish includes fish remains that could not be identified to species. Sample size is 42 stomachs.

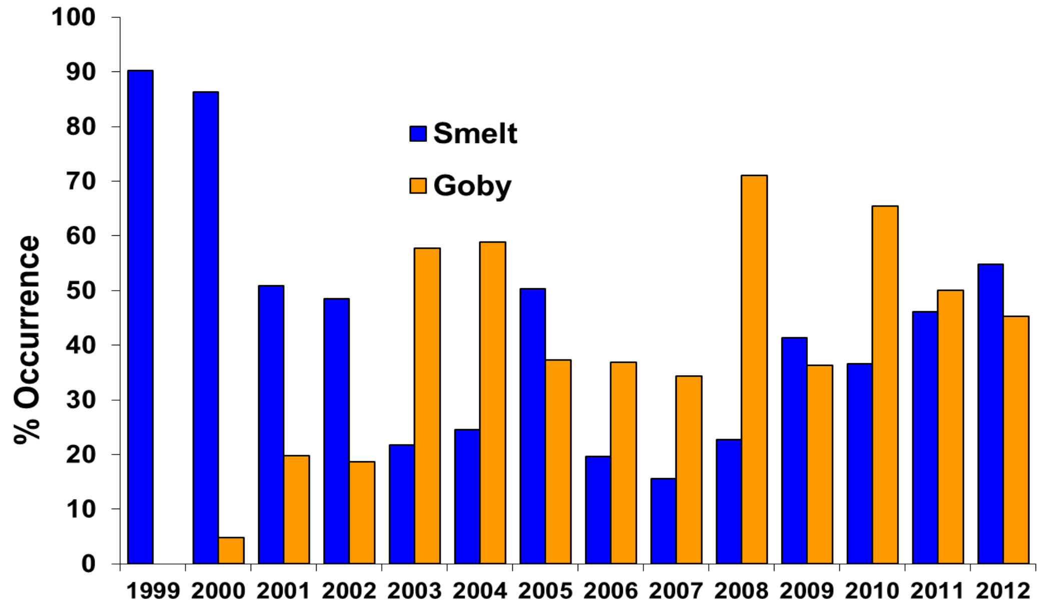

FIGURE 3.11. Frequency of occurrence of rainbow smelt and round goby in the diet of burbot caught in gill nets set during August in the eastern basin of Lake Erie, 1999-2012.

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

Tim Sullivan (USFWS), 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 60 A1-A3 wounds were found on 595 lake trout greater than 532 mm (21 inches) total length in 2012, equaling a wounding rate of 10.1 wounds per 100 fish (Table 4.1; Figure 4.1). This was a 23% increase from the 2011 wounding rate of 8.2 wounds per 100 fish and the first increase in wounding rates since 2009. The current wounding rate still exceeds 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 17 of the past 18 years following reduced sea lamprey control measures in the mid-1990's (Sullivan *et al.* 2003). Lake trout larger than 736 mm (29 inches) total length (TL) continue to be the preferred targets for sea lamprey with A1-A3 wounding rates almost three times as high as any other length group (Table 4.1). Conversely, small lake trout in the 432-532 mm (17-21 inch) size category only received one fresh wound in 63 fish examined (1.6 wounds/100 fish) in 2012.

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 2011 was 2.4 wounds per adult lake trout greater than 532 mm, which was the highest A1 wounding rate since 2007 and above the series average of 2.0 wounds per 100 fish (Table 4.1; Figure 4.2). A total of 14 A1 wounds were spread across all size categories greater than 532 mm.

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 2012.

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	63	1	0	0	5	1.6	7.9
533-634	428	9	4	27	79	9.3	18.5
635-736	138	3	2	7	66	8.7	47.8
>736	29	2	2	4	43	27.6	148.3
>532	595	14	8	38	188	10.1	31.6

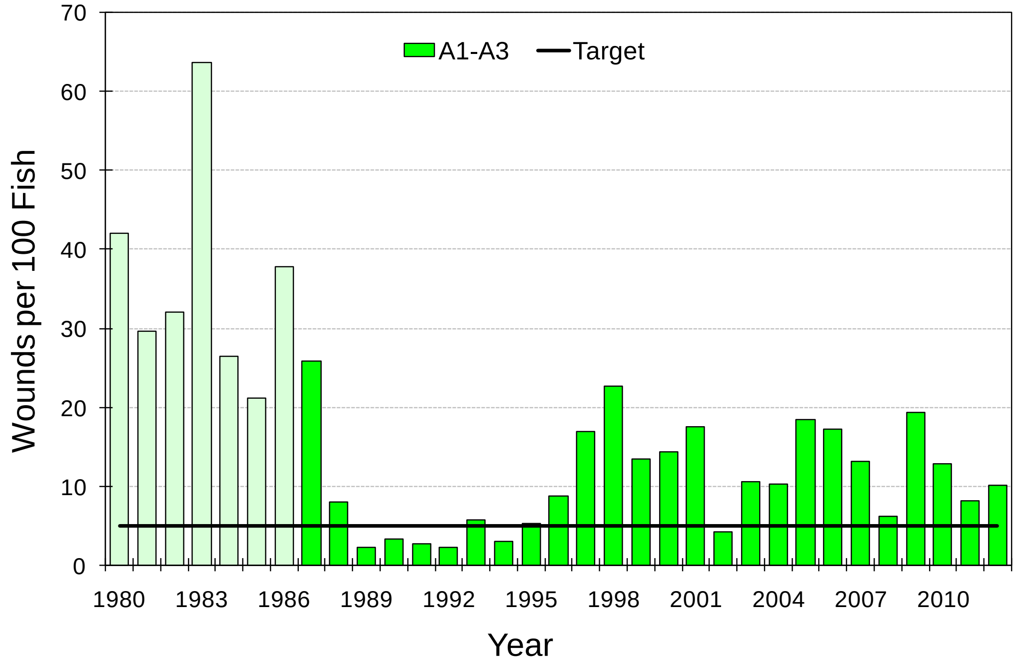

FIGURE 4.1. Number of fresh (A1-A3) sea lamprey wounds per 100 lake trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2012. The target rate is 5 wounds per 100 fish. Lighter shading indicates pre-treatment years.

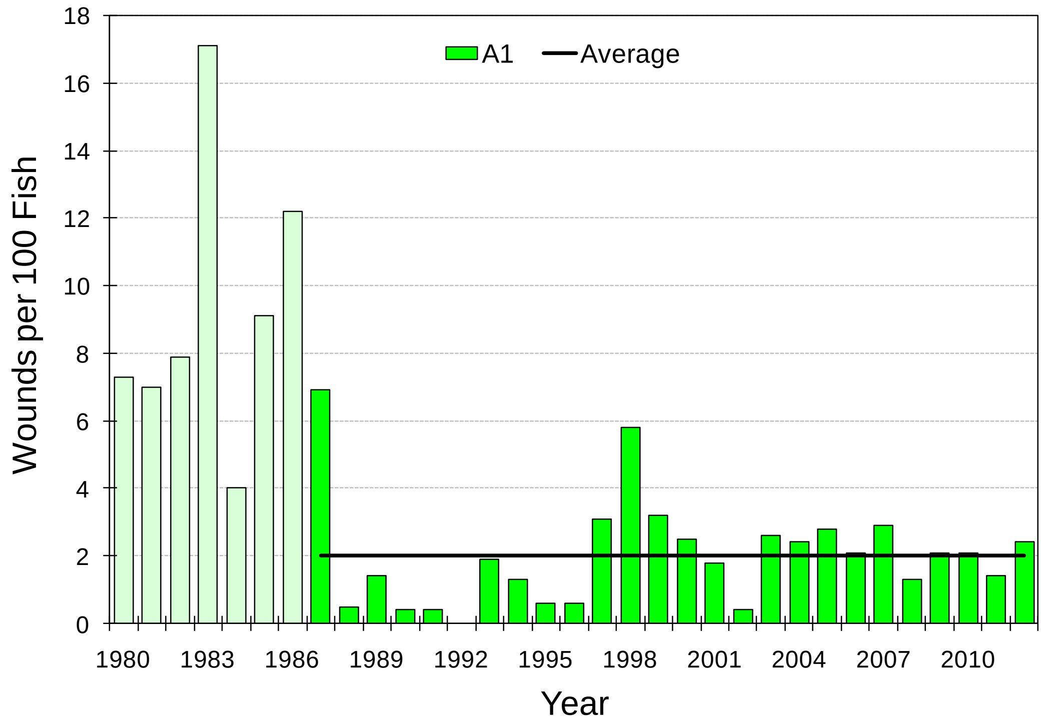

FIGURE 4.2. Number of A1 sea lamprey wounds per 100 lake trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2012. The post-treatment average includes 1987-2011. Lighter shading indicates pre-treatment years.

The past year's cumulative attacks are indicated by A4 wounds. A4 wounding rates decreased in 2012 to 31.6 wounds per 100 fish (Figure 4.3). This was second lowest A4 wounding rate in the past eight years but remained above the series average of 25.4 wounds per 100 fish. Similar to last year, A4 wounds were observed across all length categories, increased in frequency with lake trout size and was an alarming 148.3 wounds per 100 fish in lake trout larger than 736 mm (29 inches) with many fish possessing multiple wounds (Table 4.1).

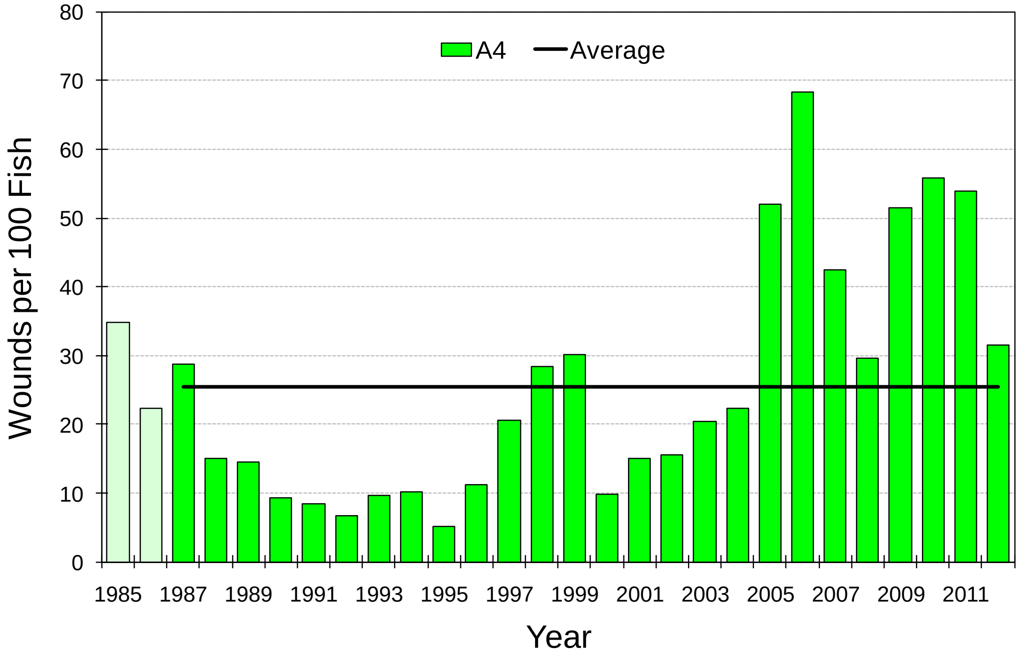

FIGURE 4.3. Number of A4 sea lamprey wounds per 100 lake trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1985-2012. The post-treatment average includes 1987-2011. Lighter shading indicates pre-treatment years.

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 strain lake trout, while A4 wounds were over twice as high 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) 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 three years, and they have not yet reached the size ranges that are especially vulnerable to sea lamprey.

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 2012. AI=Apostle Island, FL=Finger Lakes, KL=Klondike, LC=Lake Champlain, SI = Slate Island, LL=Lewis Lake, MIC = Michipicoten, 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	25	5	0	4	13	36.0	52
FL	140	3	1	7	74	7.9	52.9
KL	141	2	3	17	33	15.6	23.4
LC	172	2	1	2	30	2.9	17.4
SI	13	0	0	2	2	15.4	15.4
LL	2	0	0	0	2	0.0	100.0
MIC	5	0	0	0	2	0.0	40.0
TI	5	0	1	2	7	60.0	140.0

Burbot Wounding Rates

The burbot population, once the most prevalent coldwater predator in the eastern basin of Lake Erie, has declined over 80% (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 decreased in 2012; A1-A3 wounds decreased to 1.9 per 100 burbot while A4 wounds decreased to 6.6 per 100 burbot. This was the lowest A1-A3 wounding rate since 2006, but the third highest A4 wounding rate in the twelve year series.

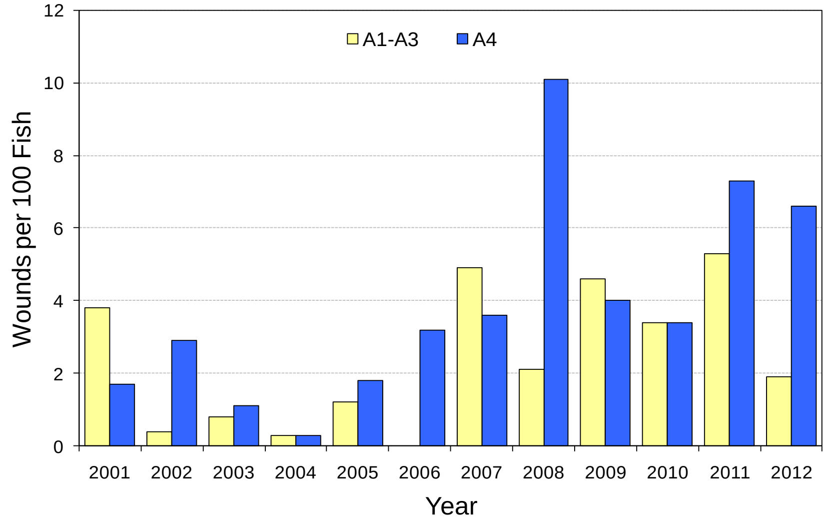

FIGURE 4.4. Number of A1-A3 and A4 sea lamprey wounds per 100 burbot (all sizes) sampled in assessment gill nets in the eastern basin of Lake Erie, August, 2001-2012.

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 5 fresh (A1-A3) and 12 healed (A4) wounds were observed on lake whitefish in 2012 assessment netting, equalling an A1-A3 wounding rate of 2.3 wounds/100 whitefish and an A4 wounding rate of 5.5 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.

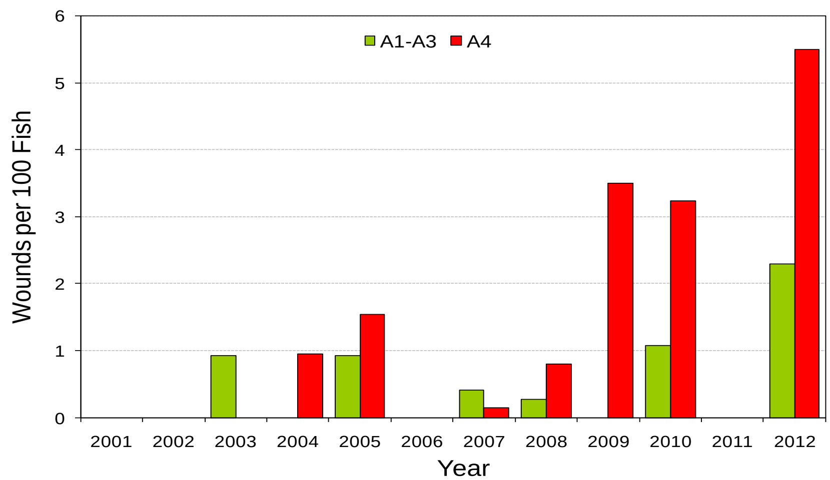

FIGURE 4.5. Number of A1-A3 and A4 sea lamprey wounds per 100 lake whitefish (all sizes) sampled in assessment gill nets in the New York waters of Lake Erie, August, 2001-2012.

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 contaminate collections. Wounding rates on these surveys vary. In 2010, Pennsylvania began a more directed survey during their annual fall steelhead run to address this shortfall and this survey continued in 2012. A total of ten A1-A3 wounds and nine A4 wounds were found on 405 adult steelhead in 2012, yielding wounding rates of 2.5 A1-A3 wounds per 100 fish and 2.2 A4 wounds per 100 fish, respectively (Table 4.3). An additional 21 B-type wounds were also found, which normally are not used in wounding rate calculations. Sea lamprey wounds were also recorded in a collection of steelhead for disease screening by the NYSDEC in Chautauqua and Cattaraugus Creeks during Fall 2012. A total of three A1-A3 wounds, eleven A4, and seven B-type wounds were found in a sample of 41 fish. A sample of 130 steelhead was also observed for wounds during an angler creel survey on the NY tributaries from September 2011 – May 2012. A total of nine A1-A3 wounds and five A4 wounds were observed.

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 lampreys 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 108 lake trout were examined for wounds in 2012. Four trout (4) had A1-A3 wounds while 8 lake trout had scars. There were 94 lake trout greater than 532 mm caught and examined, and this size range included all wounded and scarred lake trout. Wounding and scarring rates for this size range were 4.3 and 8.5 per 100 fish, respectively. 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.

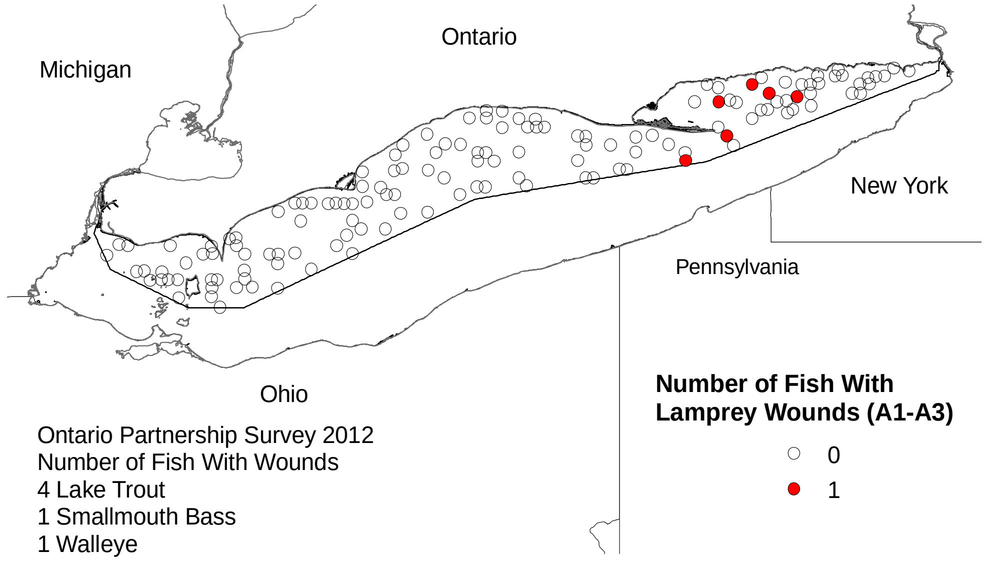

FIGURE 4.6. Number of fresh wounds (A1-A3) on fish examined for lamprey wounds by site during Partnership Index gillnetting, 2012. Includes all index and auxiliary gear.

2012 Sea Lamprey Control Actions

Following the back-to-back treatments of all known producers in 2008-2010, no streams were treated in 2012. Assessments for larval sea lamprey were conducted in 86 tributaries (61 U.S., 25 Canada) and offshore of 1 U.S. tributary (Table 4.4). Surveys to detect new populations were conducted in 45 tributaries (30 U.S, 15 Canada). One new population was found in Buffalo Creek, a tributary to the Buffalo River. Buffalo Creek is scheduled for treatment in 2013. The estimated number of spawning adult sea lampreys decreased from 20,638 in 2011 to 17,211 in 2012 (Figure 4.7), a decrease of 17%. A total of 3,015 spawning-phase sea lamprey were trapped at seven sites in five tributaries (2 U.S., 3 Canada).

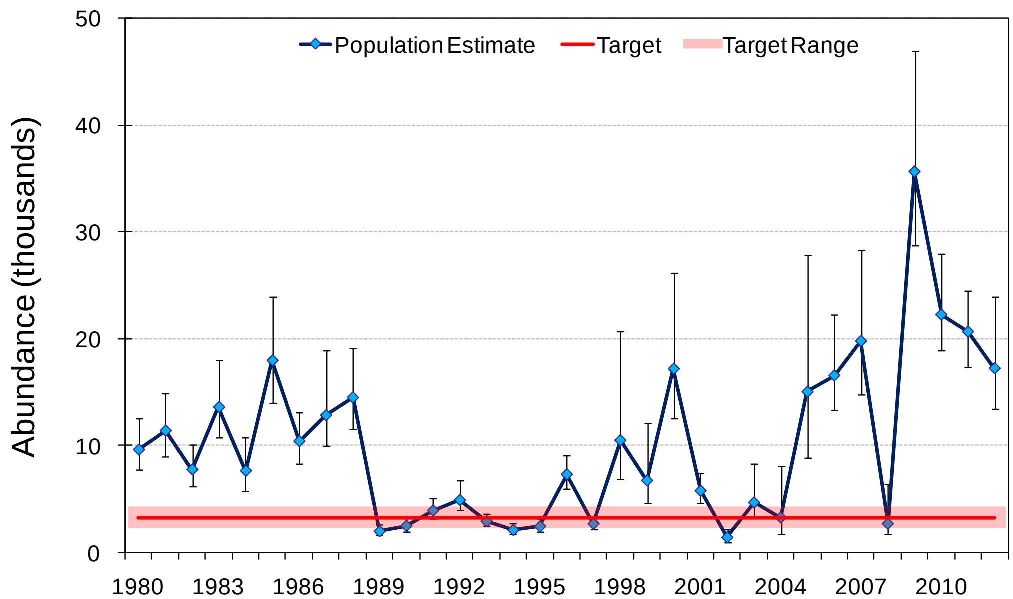

FIGURE 4.7. Lake-wide population estimates of adult sea lampreys in Lake Erie during 1980-2012 with 95% confidence intervals (black vertical lines). The target population level of 3,244 spawning adults (red horizontal line) with 95% confidence bounds (pink shading) is also shown.

The Army Corps of Engineers recently completed a ground penetrating radar survey of the Harpersfield Dam on the Grand River, which confirmed suspicions that the dam itself was hollow and that it was in much worse shape than originally assumed. These new findings suggest that repair of the barrier is not a likely option so the discussion has returned to the original alternatives: status quo, rebuild onsite, or rebuild further downstream. Construction of the sea lamprey trap at Scoby Hill Dam on Cattaraugus Creek was continued during late summer and fall.

A mark-recapture study was conducted to 1) determine whether juvenile sea lamprey released in the St. Clair River can migrate successfully through the Huron-Erie Corridor (HEC) and survive to be recaptured in the eastern basin in Lake Erie and 2) compare recovery rates for juveniles released in the HEC and eastern Lake Erie tributaries. Releases occurred in the St. Clair River (417), Big Creek (46), Big Otter (46), Cattaraugus Creek (44), Conneaut Creek (44), Crooked Creek (44), Grand River (67), Raccoon Creek (43), Silver Creek (44), South Otter Creek (44), and Youngs Creek (43). Recapture effort was conducted during fall fyke netting in the HEC and will occur again in spring 2014 when adults are vulnerable to assessment traps. Juvenile sea lamprey trapping was conducted at three locations within the HEC between November 27th and December 14th. This work continued the efforts started in the lower Detroit River during 2011, but expanded to include more stations further upstream in the system (Belle Isle and the lower St. Clair River). A total of 31 floating fyke nets were deployed in U.S. waters during the course of the survey. Nets were fished on a near continuous basis and checked every 48 hours. Eighteen juvenile sea lampreys were collected during the nearly 9900 hours of sampling effort put forth by Service field crews, two with coded wire tags.

The Sea Lamprey Control Plan for the Great Lakes was drafted and adopted by the Great Lakes Fishery Commission. Technical editors were identified and the Plan was edited. Bob O'Gorman edited the Erie chapter.

2013 Sea Lamprey Control Plans

The following streams are scheduled for treatment in 2013: Cattaraugus Creek, Conneaut Creek, Raccoon Creek, Crooked Creek, Grand River, Delaware Creek, and Buffalo Creek (U.S.); and Big Otter Creek, Big Creek, Youngs Creek and Bradley Creek, a tributary to Catfish Creek (Canada).

Larval assessment surveys are scheduled for 65 streams (52 U.S., 13 Canada; Table 4.4) to continue to detect and monitor larval sea lamprey populations and to prepare for potential 2014 treatments. Adult assessment traps will be operated on five streams (2 U.S. and 3 Canada) to estimate lake-wide spawning-phase abundance. Detection and distribution sampling in the Huron-Erie Corridor will be expanded in 2013. The plan is to sample 11.8 hectares of the St. Clair River; 3.6 hectares of Lake St. Clair; and 1.1 hectares of the Detroit River with granular Bayluscide. The objective of this additional sampling in the St. Clair River is to prepare for potential future larval lamprey control measures.

Upon learning that repair of the Harpersfield Dam (Grand River, Ohio) is not a likely option, the U.S. Army Corps of Engineers is considering other alternatives including: maintaining status quo, rebuilding onsite, or rebuilding further downstream. The Corps is currently working with a private engineering firm (Tetra Tech) to determine the cost and feasibility of each option.

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TABLE 4.4. Larval sea lamprey assessments of Lake Erie tributaries during 2012 and plans for 2013.

Stream	Detection History	Surveyed in 2012	Survey Type[1]	Results	Plans for 2013
Canada					
St. Clair R.	Positive	Yes	Evaluation	Positive	Evaluation
Baby Cr.	Negative	Yes	Detection	Negative	
Bowers Cr.	Negative	Yes	Detection	Negative	
Clay Cr.	Negative	Yes	Detection	Negative	
Marshy Cr.	Negative	Yes	Detection	Negative	
Sydenham R.	Negative	Yes	Detection	Negative	
Maxwell Cr.	Negative	Yes	Detection	Negative	
Little Bear Cr.	Negative	Yes	Detection	Negative	
Rankin Cr.	Negative	Yes	Detection	Negative	
Unnamed (C-8)	Negative	Yes	Detection	Negative	
Boyle Drain	Negative	Yes	Detection	Negative	
Unnamed (C-10)	Negative	Yes	Detection	Negative	
Thames R.	Positive	Yes	Detection	Negative	Evaluation
Tremblay Cr.	Negative	Yes	Detection	Negative	
Ruscom R.	Negative	Yes	Detection	Negative	
Moison Cr.	Negative	Yes	Detection	Negative	
Duck Cr.	Negative	Yes	Detection	Negative	
Detroit R.	Negative	No		Negative	Detection
Cedar Cr.	Negative	No			Detection
East Cr.	Positive	No			Evaluation
Catfish Cr.	Positive	Yes	Evaluation	Positive	
Silver Cr.	Positive	No			Evaluation
Big Otter Cr.	Positive	Yes		Positive	Trt. Evaluation
South Otter Cr.	Positive	Yes	Evaluation	Negative	
Clear Cr.	Positive	Yes	Evaluation	Negative	
Big Cr.	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Dedrich Cr.	Negative	No			Detection
Forestville Cr.	Positive	No			Evaluation
Normandale Cr.	Positive	Yes	Evaluation	Negative	
Fishers Cr.	Positive	No			Evaluation
Unnamed (E-116)	Negative	No			Detection
Youngs Cr.	Positive	Yes	Evaluation	Positive	
Lynn Cr.	Negative	Yes	Evaluation	Negative	
Grand R.	Negative	No			Detection

continued

Stream	Detection History	Surveyed in 2012	Survey Type[1]	Results	Plans for 2013
United States					
Buffalo R. (NY)	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Delaware Cr.	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Cattaraugus Cr.	Positive	Yes	Evaluation	Positive	Trt. Evaluation
" (estuary)	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Van Buren Cr. # 1	Negative	Yes	Detection	Negative	
Van Buren Cr. # 2	Negative	Yes	Detection	Negative	
Hall Road Cr.	Negative	Yes	Detection	Negative	
Lake Erie Park Cr. #1	Negative	Yes	Detection	Negative	
Corell Cr.	Negative	Yes	Detection	Negative	
Pratt Rd. Cr.	Negative	Yes	Detection	Negative	
Bournes Cr.	Negative	Yes	Detection	Negative	
Chautauqua Cr.	Positive	Yes	Evaluation	Positive	Evaluation
Rogerville Rd. Cr.	Negative	Yes	Detection	Negative	
Shore Haven Cr. #2	Negative	Yes	Detection	Negative	
Forsyth Rd. Cr.	Negative	Yes	Detection	Negative	
N. Brockway Rd. Cr.	Negative	Yes	Detection	Negative	
Ripley Cr. (NY)	Negative	Yes	Detection	Negative	
Crooked Cr. (PA)	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Raccoon Cr. (PA)	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Conneaut Cr.(PA/OH)	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Grand R. (OH)	Positive	Yes	Evaluation	Positive	Trt. Evaluation
Chagrin R. (OH)	Positive	Yes	Evaluation	Positive	Evaluation
Black R. (OH)	Negative	Yes	Detection	Negative	
Vermilion R.	Negative	Yes	Detection	Negative	
Sugar Cr.	Negative	Yes	Detection	Negative	
Cold Cr.	Negative	Yes	Detection	Negative	
Little Pickerel Cr.	Negative	Yes	Detection	Negative	
Sandusky R. (lentic)	Negative	Yes	Detection	Negative	
Muddy Cr. (lentic)	Negative	Yes	Detection	Negative	
Turtle Cr.	Negative	Yes	Detection	Negative	
Crane Cr.	Negative	Yes	Detection	Negative	
Maumee R. (OH)	Negative	Yes	Detection	Negative	
Bay Cr. (MI)	Negative	Yes	Detection	Negative	
Whitewood Cr.	Negative	Yes	Detection	Negative	
River Raisin	Negative	Yes	Barrier Eval.	Negative	Barrier Eval.
Swan Cr.	Negative	Yes	Detection	Negative	
Mouillee Cr.	Negative	Yes	Detection	Negative	

continued

Stream	Detection History	Surveyed in 2012	Survey Type[1]	Results	Plans for 2013
Huron R.	Negative	Yes	Detection	Negative	
Black R.	Positive	Yes	Evaluation	Negative	Evaluation
Pine R.	Positive	Yes	Evaluation	Negative	Evaluation
Belle R.	Positive	Yes	Evaluation	Negative	Evaluation
Clinton R.	Positive	Yes	Barrier Eval.	Positive	Evaluation
River Rouge	Negative	Yes	Detection	Negative	
St. Clair R.	Positive	Yes	Evaluation	Positive	Evaluation
Detroit R.	Negative	Yes	Detection	Negative	Detection
Muddy Cr. (NY)	Negative	No			Detection
Halfway Br.	Positive	No			Evaluation
Van Buren Cr. #3	Negative	No			Detection
West Forest Ave Cr.	Negative	No			Detection
Ripley Cr. #2	Negative	No			Detection
Barden Rd. Cr. #1	Negative	No			Detection
N. Brockway Rd. Cr. #2	Negative	No			Detection
Wiley Rd. Cr. #1	Negative	No			Detection
Wiley Rd. Cr. #2	Negative	No			Detection
Barnes Rd. Cr.	Negative	No			Detection
Ripley Airport Cr. #1	Negative	No			Detection
Shortman Rd. Cr.	Negative	No			Detection
State Line Cr. (NY)	Unknown	No			Detection
Gannondale Acad. Cr. (PA)	Negative	No			Detection
Great Lakes Camp Cr.	Unknown	No			Detection
Camp Lambec #2 Cr.	Unknown	No			Detection
Camp Lambec #3 Cr.	Unknown	No			Detection
Conneaut Park Cr. (OH)	Unknown	No			Detection
Kingsville on the Lake	Unknown	No			Detection
North Kingsville Cr.	Unknown	No			Detection
Ashtabula R.	Positive	No			Evaluation

continued

Stream	Detection History	Surveyed in 2012	Survey Type[1]	Results	Plans for 2013
Geneva on the Lake Cr.	Unknown	No			Detection
Cowles Cr.	Negative	No			Detection
Madison on the Lake Cr. #1	Unknown	No			Detection
Madison on the Lake Cr. #2	Unknown	No			Detection
Camp Wingfoot Cr.	Unknown	No			Detection
N. Perry Park Cr.	Unknown	No			Detection
Camp Roosevelt Cr. #1	Unknown	No			Detection
Camp Roosevelt Cr. #2	Unknown	No			Detection
McKinley Cr.	Unknown	No			Detection
Nine Mile Cr.	Unknown	No			Detection
Doan Brook	Unknown	No			Detection
Swan Cr. (MI)	Negative	No			Detection
Marsac Cr.	Negative	No			Detection

[1] *Evaluation survey* – conducted to detect larval recruitment in streams with a history of sea lamprey infestation.
Detection survey – conducted to detect larval recruitment in streams with no history of sea lamprey infestation.
Distribution survey – conducted to determine instream geographic distribution or to determine lampricide treatment application points.
Treatment (Trt) 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 greater than 100 mm total length to provide a ranking against other Great Lakes tributaries for 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 for the STC, GLFC and Lake Erie agency data depositories.

Chuck Murray (PFBC) and James Markham (NYSDEC)

Lake Trout Stocking

The current CWTG lake trout stocking goal for Lake Erie (160,000 yearlings) was not met for the first time since 2007. In 2012, 55,300 yearlings and 123,700 fall fingerling (17,142 yearling-equivalent) lake trout were stocked into Lake Erie waters (Figure 5.1). The combined 72,442 yearling equivalents stocked in 2012 were the second lowest number of lake trout stocked into Lake Erie in a single year since directed stocking efforts began in 1982.

No yearling lake trout from the 2011 year class were available for stocking into the U.S. portion of Lake Erie in 2012. Lake trout planned for Lake Erie were reared at the White River National Fish Hatchery, a USFWS facility located in Vermont; however, in late August 2011 the hatchery experienced severe damage from flooding following tropical storm Irene. The USFWS decided to depopulate the hatchery over serious concerns of contamination of raceway water with didymo (*Didymosphenia geminate*) from the adjacent White River. Subsequently, all lake trout being held in the facility were destroyed to avoid the risk of spreading didymo to Great Lakes waters.

While no yearling lake trout were stocked in U.S. waters in 2012, a total of 55,330 yearlings were stocked by the Ontario Ministry of Natural Resources on Nanticoke Shoal in April 2012 (Figure 5.1). These fish were Slate Island strain and boat stocked on Nanticoke Shoal. This was the sixth lake trout stocking in Ontario waters in the last seven years.

In fall 2012, 123,700 surplus fall fingerlings became available from the recently renovated USFWS Allegheny National Fish Hatchery. All of these lake trout were Finger Lakes strain. A total of 82,400 were shore-stocked at Miller's Ferry Docks in Catawba, Ohio, in the west basin of Lake Erie on 5 November and 7 November, 2012. An additional 41,300 fall fingerlings were-shore stocked on 6 November 2012 at Fairport Harbor, Ohio, in the central basin. These were the first lake trout stocked recent history in the western and central basins of Lake Erie.

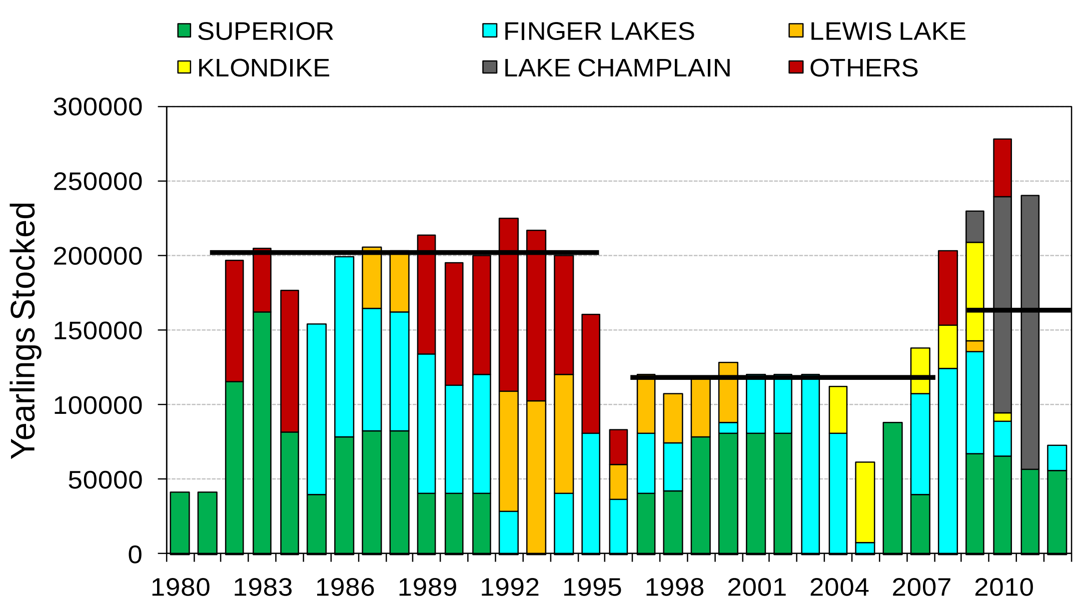

FIGURE 5.1. Yearling and fall fingerling (in yearling equivalents) lake trout stocked by all jurisdictions in Lake Erie, 1980-2012, by strain. Stocking goals through time are shown by dark lines. "Superior" includes Superior, Apostle Island, Traverse Island, and Slate Island strains. "Others" include Clearwater Lake, Lake Ontario, Lake Erie, Lake Manitou, and Michipicoten strains. The current stocking goal, 160,000 yearlings per year, is represented by the horizontal line on the right of the graph; other stocking goals for previous time periods are represented by other horizontal lines.

Stocking of Other Salmonids

In 2012, over 1.9 million yearling trout were stocked in Lake Erie, including rainbow/steelhead trout, brown trout and lake trout (Figure 5.2). Pacific salmon (Coho and Chinook) stocking was discontinued by all Lake Erie agencies by 2003.

Total salmonid stocking decreased 3% from 2011 and 14% from the long-term average (1989-2011). 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 U.S. 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 1,788,839 yearling rainbow/steelhead trout were stocked in 2012, accounting for 91% of all salmonids stocked. This was a 2% increase from 2011, and 2% decrease from the long-term average. Rainbow trout/steelhead stocking increased 60% in Ohio waters and 5% in Michigan waters from 2011, and decreased 43% in Ontario waters, 15% in New York waters and 7% in Pennsylvania waters from 2011. A full account of rainbow/steelhead trout stocked in Lake Erie by jurisdiction for 2012 can be found under Charge 6 of this CWTG report, which details the locations and strains of rainbow trout stocked across Lake Erie.

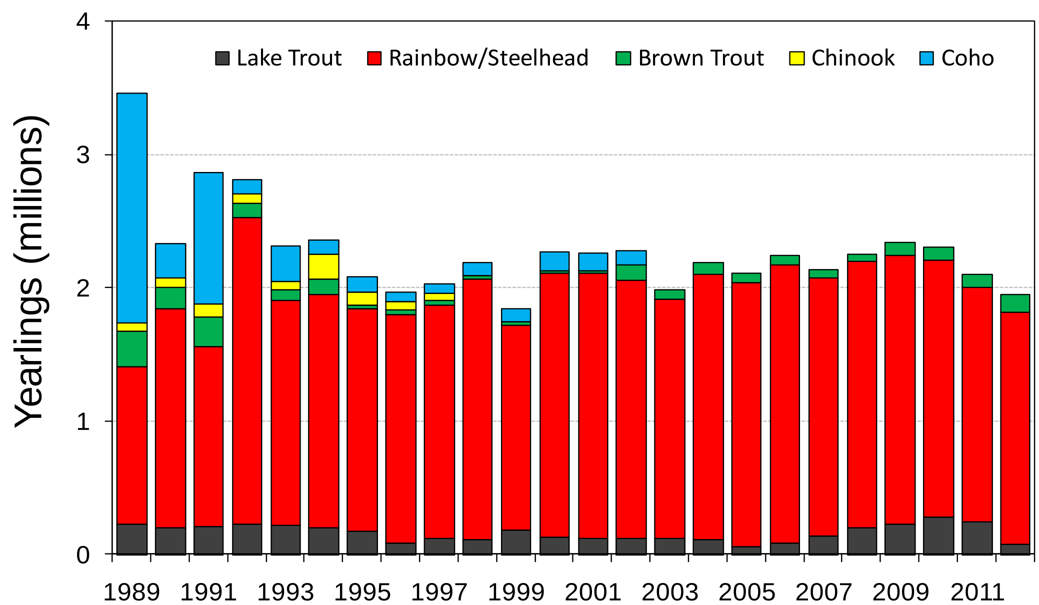

FIGURE 5.2. Annual stocking of all salmonid species (in yearling equivalents) in Lake Erie by all agencies, 1990-2012.

Brown trout stocking in Lake Erie totaled 101,204 yearlings in 2012, which was a 36% increase from 2011 and a 20% increase over the long-term average. Recent increases in the last decade are 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. Pennsylvania also stocked 34,700 adult brown trout (34% of total) to provide "catchable" trout for the opening day of trout season in Pennsylvania.

Between 2 April and 27 April, 2012 the NYSDEC stocked 35,480 yearling brown trout in Cattaraugus Creek, Barcelona Harbor, Point Breeze and Dunkirk Harbor. 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. Brown trout stockings are expected to continue at these levels for 2013 in both New York and Pennsylvania waters.

TABLE 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1990-2012.

	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, 1990-2012.

	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**

Charge 6. Continue to assess the steelhead and other salmonid fisheries, age structure, growth, diet, seasonal distribution and other population parameters

Chuck Murray (PFBC), Kevin Kayle (ODW), and James Markham (NYSDEC)

Stocking

All Lake Erie jurisdictions stocked lake-run rainbow trout (or steelhead) in 2012 (Table 6.1). Based on these efforts, a total of 1,788,839 yearling steelhead/rainbow trout were stocked in 2012, representing a 2% increase from 2011 and a 2% decrease from the long-term (1990-2011) average. Nearly all of the rainbow trout stocked in Lake Erie originated from naturalized Great Lakes strains. A Lake Erie strain accounted for 57% of the strain composition, followed by a Lake Michigan strain (27%) and a Lake Ontario strain (15%); Lake Erie strains were collected from Trout Run in Pennsylvania; Lake Michigan strains were collected from the Manistee River in Michigan, and the Lake Ontario strains were collected from the Salmon River in New York and the Ganaraska River in Ontario.

TABLE 6.1. Rainbow trout/steelhead stocking by jurisdiction and location for 2012.

Jurisdiction	Location	Strain	Number	Life Stage	Yearling Equivalents	
Michigan	Huron River	Manistee River, L. Michigan	64,500	Yearling	**64,500**	**Sub-Total**
Ontario	Mill Creek	Ganaraska River, L. Ontario	16,000	Adult	16,000	
	Lake Erie at Erieau Harbour	Ganaraska River, L. Ontario	2,600	Adult	2,600	
	Lake Erie at Port Stanley Harbour	Ganaraska River, L. Ontario	2,450	Adult	2,450	
					21,050	**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	240,501	Yearling	240,501	
	Fourmile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Godfrey Run	Trout Run, L. Erie	18,500	Yearling	18,500	
	Presque Isle Bay	Trout Run, L. Erie	83,350	Yearling	83,350	
	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	64,250	Yearling	64,250	
	Twelvemile Creek	Trout Run, L. Erie	37,000	Yearling	37,000	
	Twentymile Creek	Trout Run, L. Erie	111,000	Yearling	111,000	
	Walnut Creek	Trout Run, L. Erie	185,000	Yearling	185,000	
					1,018,101	**Sub-Total**
Ohio	Chagrin River	Manistee River, L. Michigan	92,461	Yearling	92,461	
	Conneaut Creek	Manistee River, L. Michigan	75,086	Yearling	75,086	
	Grand River	Manistee River, L. Michigan	91,288	Yearling	91,288	
	Rocky River	Manistee River, L. Michigan	106,875	Yearling	106,875	
	Vermilion River	Manistee River, L. Michigan	55,077	Yearling	55,077	
	Lake Erie at Ashtabula	Manistee River, L. Michigan	31,564	Fingerling	1,114	
	Lake Erie at Avon	Manistee River, L. Michigan	32,907	Fingerling	1,162	
	Lake Erie at Geneva	Manistee River, L. Michigan	60,202	Fingerling	2,125	
					425,188	**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**
					1,788,839	**Grand Total**

U.S. state fisheries management agencies are responsible for 98% of all stocking efforts in Lake Erie. Approximately 2% of the steelhead stocking is through sportsman's organizations in Pennsylvania (18,000 yearlings) and Ontario (21,050 yearlings). Fisheries agency stocking of spring yearlings took place between February and May, when smolts averaged about 163 mm in length (Table 6.2).

TABLE 6.2. Stocking summaries of yearling steelhead by fisheries agency for 2012.

Agency	Range of Dates Stocked	mean length (mm)	N of yearlings stocked
Michigan Dept. of Natural Resources	12 April 2012	190	64,500
New York Dept. of Environmental Conservation	13 March - 4 April 2012	127	255,000
Ohio Division of Wildlife	27 April - 5 May 2012	165	420,787
Pennsylvania Fish and Boat Commission	24 February - 16 May 2012	169	1,000,101

No tagging and only a limited amount clipping have been conducted on Lake Erie steelhead since 2000. There were no fin clipped rainbow trout stocked in 2012 (Table 6.3). A mass marking / coded wire tag study on steelhead is being implemented on Lakes Michigan, Superior and Huron beginning in 2013. In response to this initiative on the upper Great Lakes, the Lake Erie Committee has asked the Coldwater Task Group (CWTG) to draft a proposal for tagging Lake Erie steelhead. Many of the logistical issues to tagging have been identified by the CWTG in a previous document in 2004. An updated proposal will include a range of tagging strategies to evaluate natural reproduction, stocking methodologies, straying, exploitation and survival. Critical to this evaluation is the ability to collect an adequate amount of post tagging data (heads) from adult steelhead.

TABLE 6.3. Rainbow trout (steelhead) fin-clip summary for Lake Erie, 2000-2012.

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	-	-	-	-	-

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

Assessment

In 2012, the Pennsylvania Fish and Boat Commission began an assessment of adult steelhead returns at Godfrey Run, a nursery stream utilized for collection of feral brood stock in support of Pennsylvania's steelhead hatchery program. Godfrey Run is infrequently used as a secondary source of adult steelhead broodstock by hatchery personnel and is closed to angling, making it an excellent site for enumeration and examination of spawning run adult fish. This study was initiated in September 2012, will continue through the end of May 2013, and is expected to continue as part of a routine assessment program into the future. This first season's activity, 2012-2013, is considered a pilot study as methods are developed and refined.

In this survey, the numbers of adult steelhead retained at a collection weir over a 24-hour period are counted on 10 randomly selected weekdays (Tuesday-Friday) each month. Weather and other field assessment commitments precluded a full complement (10 days) of monthly sampling, especially in September and October.

All fish retained in the collection basin were counted and marked (caudal fin, hole-punched) and released below the collection weir. Marking fish allowed for identification of recaptured fish on subsequent collection dates. Between 14 September and 31 December, 2012, the total catch was 606 adult steelhead, with 151 recaptures. The first 100 steelhead captured each month were measured for total length (mm), identified by sex, and examined for incidence of sea lamprey wounds, fin clips, and infestation of parasitic copepods (*Salmincola sp.).*

In addition to the fish count and biological data collected from fish, daily temperature, stream flow and discharge was also recorded at the fish collection site. Supplemental data important to the study included daily hydrographic data supplied by a USGS gaging station at Walnut Creek (USGS 04213152), approximately 4.25 miles east of Godfrey Run, Pennsylvania.

Hurricane Sandy (October 22-29) changed the stream characteristics considerably below the study site, but did not appear to limit the ability of steelhead to traverse newly exposed obstacles. The first significant run of the season took place on 10 October and was associated with increased stream flows and decreased temperatures (Figure 6.1).

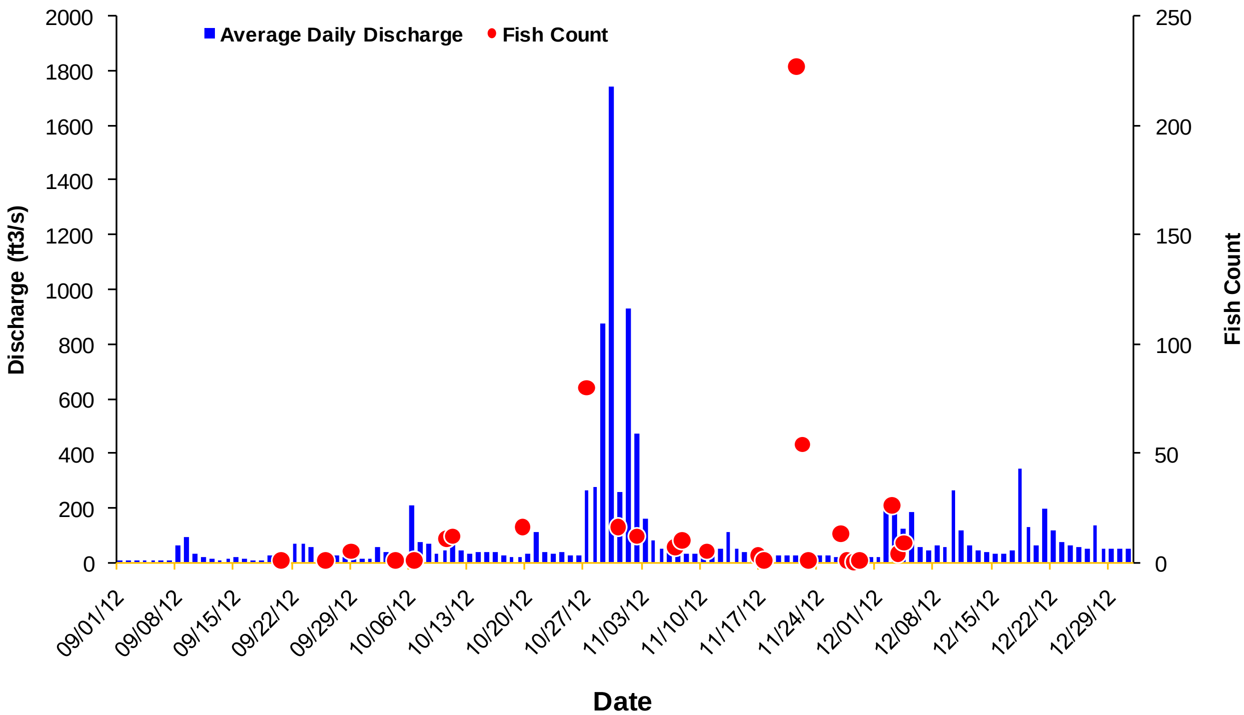

FIGURE 6.1. Adult steelhead counts at Godfrey Run Pennsylvania and average daily discharge from USGS Gaging Station 04213152 at Walnut Creek, PA.

The average daily steelhead count by month in the assessment basin increased from September through December (Table 6.4). High average monthly counts in November and December were greatly influenced by a few very large migration events on 1 November (80 fish), 4 December (227 fish) and 5 December (54 fish).

Mean length of steelhead (sexes combined) was 588 mm, with males averaging 564 mm and females averaging 610 mm (Figure 6.2). Average length of males was decreased by the prominence (~14%) of precocious males (“jacks”) in the sample (Figure 6.2). The largest steelhead measured was a female at 810 mm

TABLE 6.4. Monthly summary of sample days, mean daily fish count, and average temperature at Godfrey Run, PA, and corresponding discharge at Walnut Creek, PA (USGS Station 04213152).

Month	N of Sample days	Mean Fish Count	Mean Temperature (°C)	Mean daily discharge (cfs) @ Walnut Creek
September	3	2.3	14.6	20
October	5	8.2	12.5	147
November	8	16.8	8.6	80
December	10	32.7	6.7	94

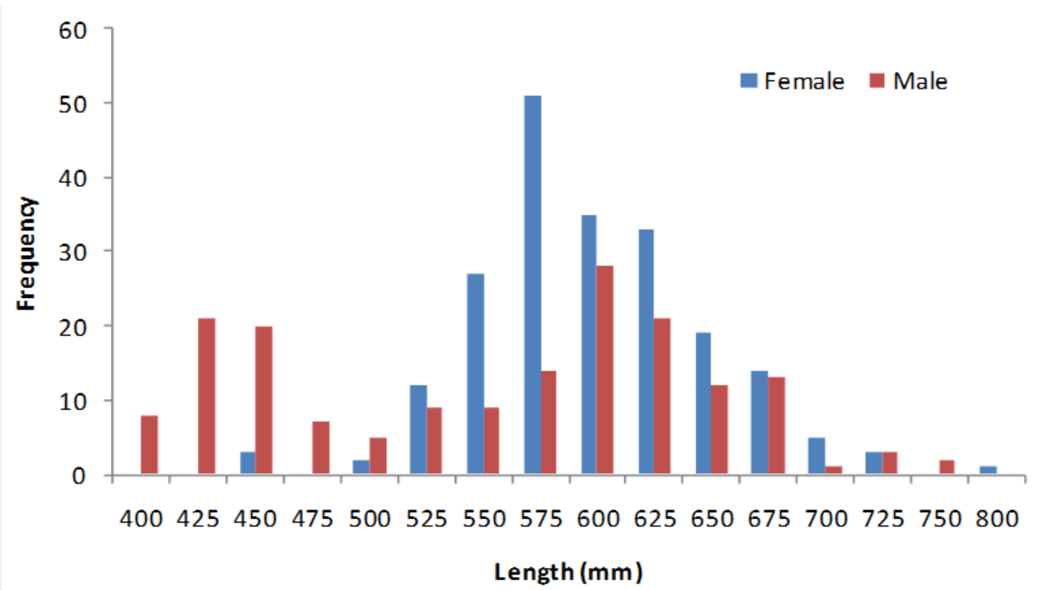

FIGURE 6.2. Length frequency of male and female adult steelhead captured at Godfrey Run, PA, between 14 September and 31 December, 2012.

Sea lamprey wounding rates from steelhead in this survey are summarized under Charge 4 of this CWTG report. Parasitic copepod (*Salmincola sp.*) attachment was observed on 47% of all fish examined. Copepod attachment was usually on the gills, but was also noted on the inside of the opercula and in the buccal cavity. Infestation ranged from mild (a few individuals attached) to severe (hundreds attached).

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 harvest from the summer open-water boat angler fishery in 2012 was 10,165 steelhead in U.S. waters; a 127% increase from the 2011 estimated steelhead harvest (Table 6.5). This was the largest open lake harvest in the last four years. Rainbow trout harvest by open lake boat anglers varied greatly across jurisdictions. Low directed effort at rainbow trout in the open water fishery can lead to wide variations in annual estimates. Harvest increased significantly in New York (307%), Ohio (129%) and Pennsylvania (110%). Ohio and Pennsylvania accounted for 96% of all open lake steelhead harvest. Michigan's open lake harvest remains insignificant, with an estimated harvest of 9 fish. Although steelhead harvest increased from 2011, all reporting jurisdictions showed a decrease in harvest from the long-term (13 year) average; Ohio's harvest was 57% below average, New York's harvest was 47% below average and Pennsylvania's harvest was 28% below average. Among US jurisdictions, over half (53%) of the reported harvest was concentrated in central basin waters of Ohio (41%) and Pennsylvania (12%). The west-central basin waters of Ohio accounted for 27% the harvest. The east basin accounted for 20% of the harvest, mostly in Pennsylvania waters (16%). The eastern basin waters in New York accounted for 4% of the open lake steelhead harvest. Very few (0.3%) rainbow trout were harvested in the western basin.

TABLE 6.5. Estimated harvest by open lake boat anglers in Lake Erie, 1999-2012.

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
1999-2011 mean	16,102	4,055	707	33,025	44	31,070

* no creel data collected by OMNR in 2003, 2005-2012.

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

Trends in open lake steelhead angler harvest rates were contrasting across the lake (Figure 6.3). Small amounts of targeted effort for steelhead, and small numbers of interviews contributing to the catch rate statistics, confound these results. Compared to 2011, the 2012 open-lake steelhead harvest rates declined in Ohio and New York, remained stable in Ontario, and increased in Pennsylvania. Steelhead boat angler harvest rates in 2012 were highest in Ohio waters (0.37 steelhead per angler hour, or 0.37 f/hr); although they decreased 14% from 2011, they were more than double the long-term average of 0.16 f/hr. Pennsylvania ranked second in steelhead boat angler harvest rate, with nearly a five-fold increase in harvest rate from 2011 and 43% higher than the long-term average (0.12 f/hr). Harvest rates in Ontario (0.07 f/hr) and New York (0.06 f/hr) were similar, but the declines in harvest rates in New York waters were much greater relative to 2011, as well as their long-term average. Anglers fishing New York waters saw a 77% decrease in harvest rate from 2011 and a 48% decrease from the long-term average of 0.11 f/hr. Ontario anglers realized a 2% increase in harvest rate from 2011, but the catch rate was 34% below the long-term average of 0.10 f/hr. The combined harvest rate in 2012 across all reporting agencies of 0.17 f/hr for steelhead was 44% above the long-term average of 0.12 f/hr.

The Ontario Ministry of Natural Resources did not conduct open water angler surveys during 2012 that would provide comprehensive estimates of rainbow trout harvest, effort or catch rates in open lake Ontario waters of Lake Erie. However, they collected angler diary reports that detail trends over time across the various areas of the lake. In 2012, Ontario diarists reported 74 targeted rainbow trout trips in west-central basin and 30 targeted trips in the east-central basin waters of Lake Erie. Only two trips targeting rainbow trout were recorded through the diary program in the east basin for 2012 and only one rainbow trout was caught.

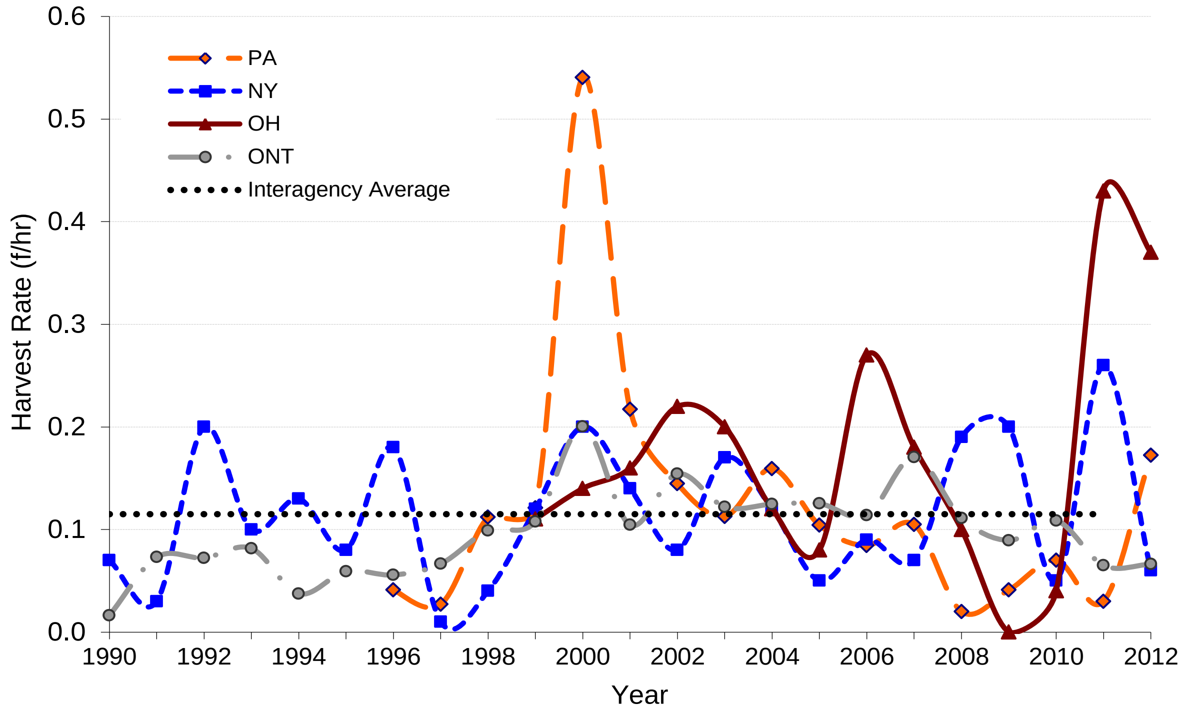

FIGURE 6.3: Targeted steelhead catch rates (fish/angler hour) in Lake Erie by open lake boat anglers in Ohio, Pennsylvania, New York and Ontario, and the interagency average value for 1990-2011.

Angler diary reports from Ontario in west-central basin waters show that rod-hours for rainbow trout declined 32% from 2011 and were 18% below the 22-year (1990-2011) mean. The 2,284 rod hours reported by diarists in 2012 was the lowest since 1996 (Figure 6.4). Steelhead catch rates in the west-central basin (0.12 fish/rod-hour) were 8% lower than 2011, and17% lower than the long-term average of 0.146 fish/rod-hour.

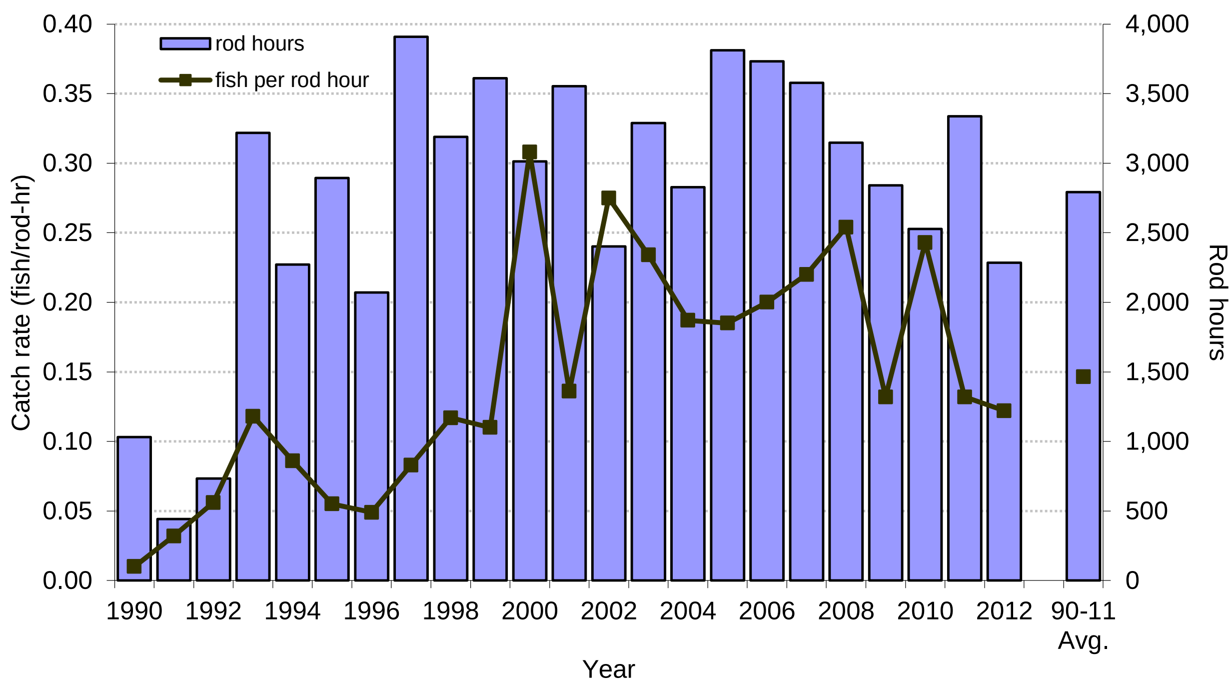

FIGURE 6.4. Targeted steelhead effort and catch rates in Lake Erie's west-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2012.

The 819 rod hours recorded by Ontario anglers fishing in the east-central basin for rainbow trout was a significant decrease (43%) from 2011, as well, and was 45% below the 22-year average of 1,480 hours (Figure 6.5). The rainbow trout catch rate of 0.029 fish per rod-hour was the lowest catch rate since 1994 (0.007 f/rod-hour) and the third lowest in the 22-year time series.

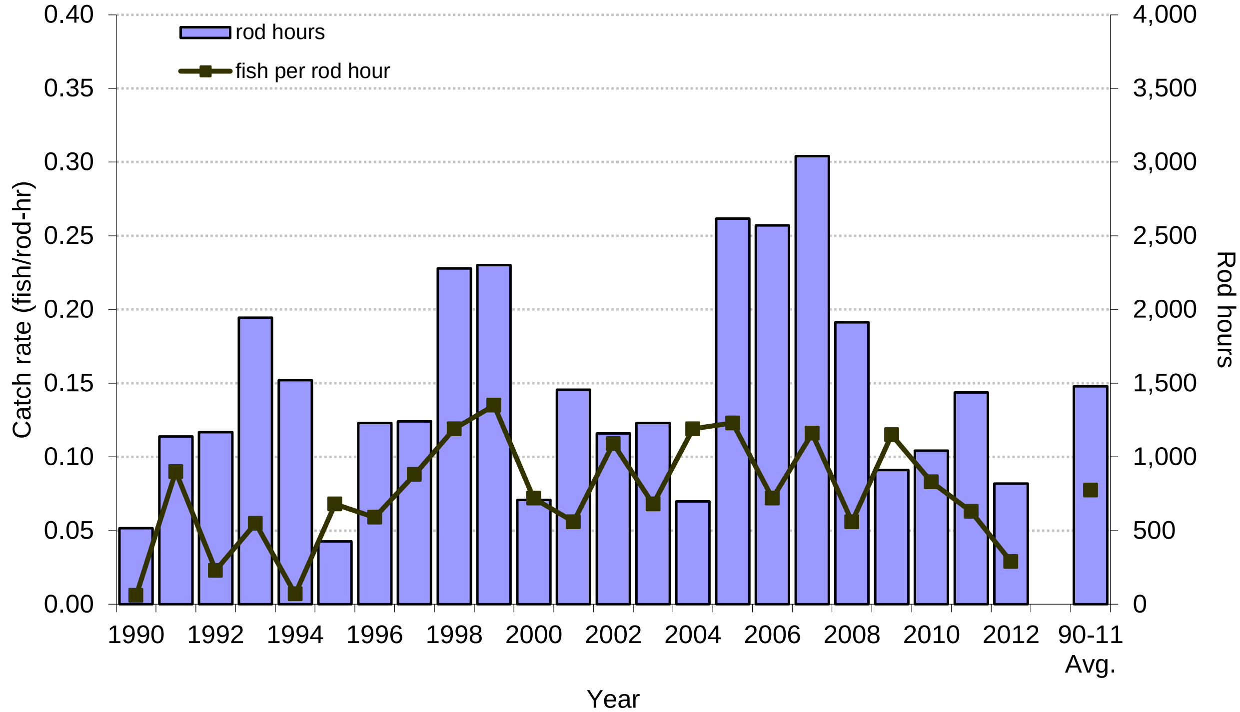

FIGURE 6.5. Targeted steelhead effort and catch rates in Lake Erie's west-central basin as reported in angler diaries by open lake boat anglers in Ontario from 1990-2012.

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 2011. 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 (Figure 6.6). Catch rates remained high through 2008, but sharply declined in 2009 and 2010, and those rose again in 2011. Diary cooperator catch rates in 2011 were 0.68 steelhead per angler hour, which was nearly identical to the 2009 catch rate and well above the long-term series average of 0.48 steelhead per angler hour (Figure 6.6).

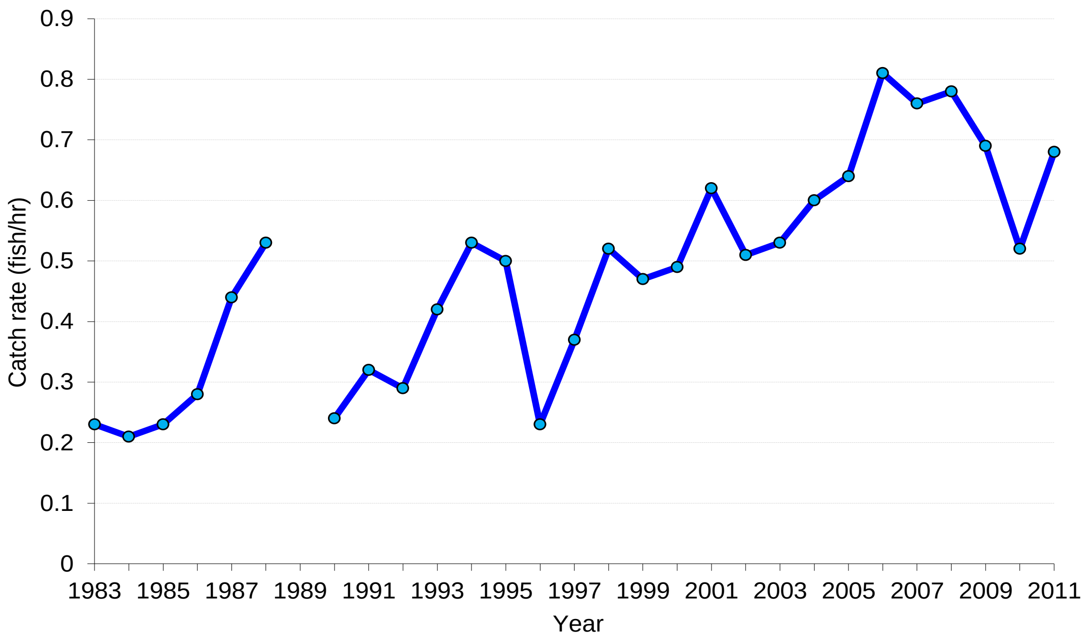

FIGURE 6.6. Targeted steelhead catch rates (fish per angler hour) in Lake Erie tributaries by New York angler diary cooperators, 1987-2011.

An angler survey was implemented by the NYSDEC on the New York tributaries to Lake Erie from 15 September 2011 - 15 May 2012 to estimate effort, catch, and harvest in the salmonid fishery (Markham 2012). This was the fourth angler survey conducted by the NYSDEC since 2003. The survey covered eight Lake Erie tributaries in New York stocked with steelhead (Chautauqua, Canadaway, Silver, Walnut, Cattaraugus, Eighteen Mile, Buffalo, and Cayuga Creeks). A total of 1,779 interviews were conducted on five routes to estimate catch, harvest, and obtain demographic and angler opinion information. Seventy-three access sites were visited to estimate overall angler effort.

The majority of the anglers interviewed (89%) were targeting steelhead. Total tributary effort was estimated at 181,985 angler-hours, which was a 10% decline from the previous survey conducted in 2007-2008. Cattaraugus Creek received the most effort followed by Eighteen Mile, Chautauqua, and Canadaway creeks. The months of October, November, and March experienced the highest angler effort. Targeted salmonid catch rate and harvest rate was 0.35 and 0.06 fish per angler hour, respectively. The overall catch rate declined 42% from the previous angler survey in 2007-2008. Similar to other surveys, catch rates varied between streams and generally declined from west to east. Peak catch rates occurred in November 2011 and March 2012. Overall tributary catch was estimated at 66,009 salmonids, a 47% decline from the previous survey. Overall harvest was estimated at 9,720 fish. The majority of the catch (97%) and harvest (98%) was steelhead. Four tributaries (Chautauqua, Canadaway, Eighteen Mile, and Cattaraugus creeks) contributed over 90% of the total catch and 93% of the total harvest. The detailed report on this angler survey can be found at: www.dec.ny.gov/outdoor/32286.html.

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Charge 7: Prepare Lake Erie Cisco Management Plan. Review ecology and history of this species and assess potential for recovery.

Elizabeth Trometer (USFWS), Tom MacDougall (OMNR), Kurt Oldenburg (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 are considered extirpated in Lake Erie, although commercial fishermen report them periodically (Table 7.1, Figure 7.1). 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 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 (*C. clupeaformis;* Oldenburg et al. 2007), although recent declines in lake whitefish abundance and recruitment (Section 2) muddy the issue. Cisco could be favored by these conditions. Rainbow smelt abundance declined sharply in the 1990's in Lake Erie and continues to remain low relative to the 1980s (Ryan et al. 1999 and Forage Task Group 2012). Alewife have never been very abundant in Lake Erie due to overwinter temperatures that frequently prove lethal (Ryan et al. 1999). The 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, recruitment problems identified in both lake whitefish and burbot over the past 10+ years have called into question the success of their recovery and qualifies the potential for cisco recovery. It should be recognized that although rainbow smelt abundance in Lake Erie has declined from past decades, and densities of this offshore pelagic feeder are still relatively high compared to other predator species (Forage Task Group 2012).

Current Status of Cisco

Commercial fishermen have reported cisco in 11 of the last 16 years. It is difficult to assess relative abundance from these reports, however, as they represent the passive surrendering of by-catch by two commercial fishers who recognize the importance of their appearance. Recent reports and collections are summarized in Table 7.1 with locations shown in Figure 7.1. While young cisco (age 1 and 2) were observed in the early part of the 2000's, none have been observed lately. One three-year-old cisco, captured in commercial gill nets targeting yellow perch in the central basin, was reported in 2012.

Recent fish surveys in 2010, 2011, and 2012 in the Huron-Erie corridor collected young coregonids (Figure 7.1). Two larvae (12.0 mm TL) were collected on 11-12 May 2010 and one on 16 June 2011 in the St. Clair River (Edward Roseman, USGS-GLSC, pers. comm.) (Figure 7.1, Table 7.2). Two of those coregonids were assessed using DNA barcoding techniques and determined not to be lake whitefish (Wendylee Stott, USGS, pers. comm.). 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 Chiotti, USFWS, pers. comm.). Five of those were subsequently verified as most likely being cisco (Wendylee Stott, USGS, pers. comm.). In December 2012, another juvenile coregonid was collected in the Detroit River (Table 7.2).

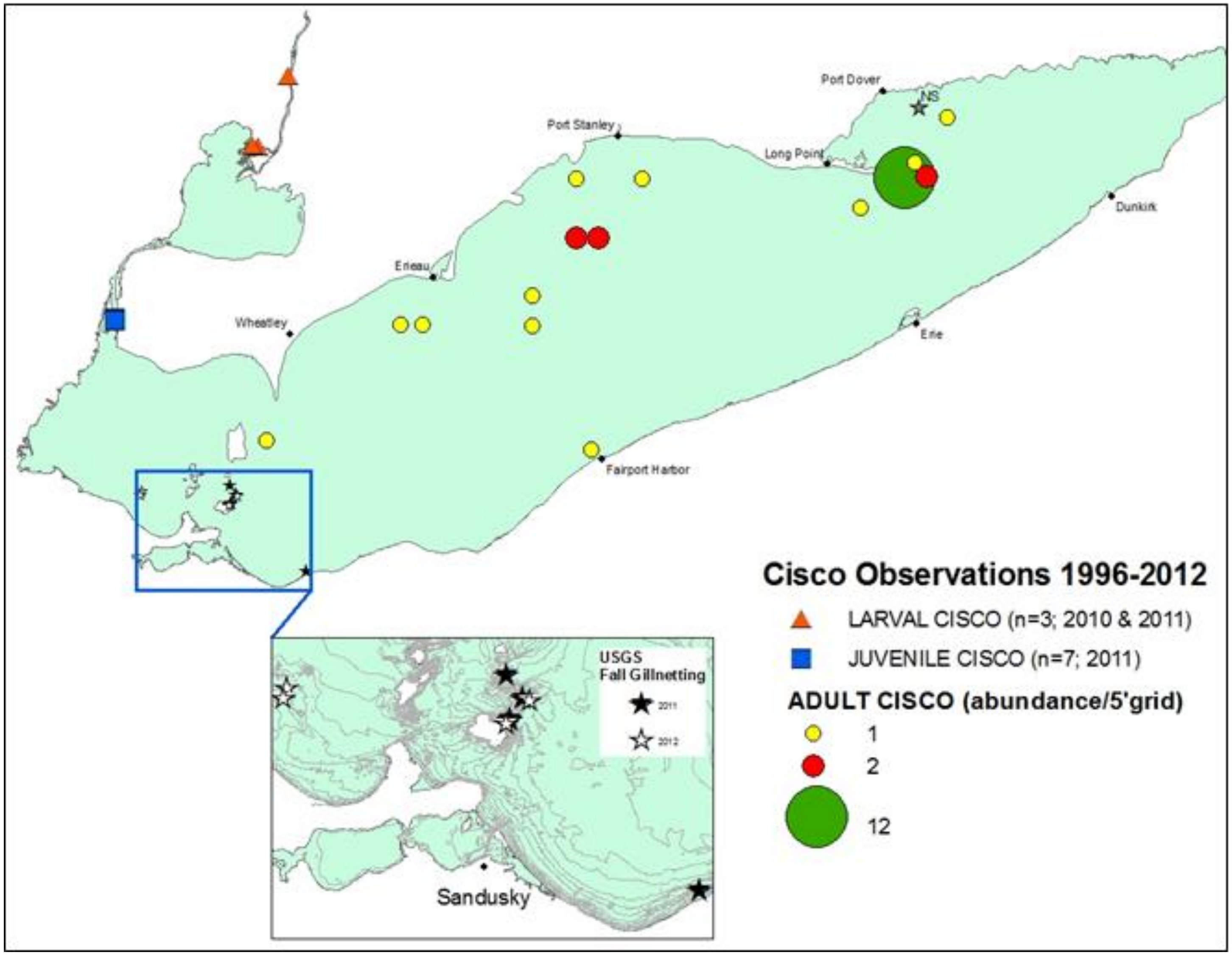

FIGURE 7.1. Cisco observations in Lake Erie and the Huron-Erie Corridor. Relative abundance of adult specimens from the commercial fishery and agency surveys is indicated with proportional, colored circles. Locations of larval and juvenile cisco observations (USGS, USFWS) are indicated with triangles and squares (not proportional). An inset map shows the locations of USGS fall gill net surveys targeting historic cisco spawning reefs. “NS” marks the location of a comparable fall gill net 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, 1996-2012.

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

* 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
12/6-16/11	Detroit River	Livingstone Channel	5 - likely Cisco 4 - Unidentified Coregonid	51-75	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	Coregonid	12	500 micron mesh bongo net
5/12/10	St. Clair River	North Channel	Coregonid	12	500 micron mesh bongo net
6/16/11	St. Clair River	North Channel	Unidentified Coregonid		500 micron mesh bongo net

* Species confirmed as “Coregonid” were identified as not being lake whitefish by genetic analysis (Wendylee Stott, USGS Great Lakes Science Center, pers. comm.).

Management Plan

The Lake Erie Coldwater Task Group was charged with preparing a Lake Erie cisco management plan at the Lake Erie Committee Annual meeting in March of 2007. Preparation of the management plan began in fall 2007; however, after several drafts, the exercise has stalled due to several outstanding issues which include:

- Do recently observed specimens represent a remnant stock?
- What is the population trend of cisco currently inhabiting Lake Erie? (There have been no directed surveys for cisco in Lake Erie. Occurrences in fishery catches are very likely unrecognized or under-reported)?
- Do Lake Erie cisco face different constraints than other coregonids which have shown evidence of recovery (e.g. whitefish; 1990s)?
- Do we stock? Should we stock on top of a possible remnant population? If so, what is the best broodstock?
- What are the genetic implications of stocking on a remnant population? Is there currently a genetic bottleneck?

In order to inform a strategy for addressing outstanding questions, the task group sought the advice of external cisco experts from around the Great Lakes, beginning with a conference call in May of 2011 and followed by email correspondence. One goal of these discussions was to better understand how cisco are sampled elsewhere and determine whether the spatial and temporal distribution of fishing and scientific sampling efforts on Erie would be effective for capturing cisco. These exchanges highlighted the fact that current fisheries assessments on Lake Erie 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 islands in the western basin, are not currently targeted by scientific monitoring or commercial fishing.

Because these issues – mainly if a remnant stock still exists in Lake Erie and the abundance of the current population – remain unresolved, the task group was unable to come to a defined direction needed for a plan to re-establish cisco in Lake Erie. Within review of the management plan, it was recommended that the current plan turn into an impediments document until these issues could be resolved. Upon consensus from the LEC and the CWTG, the current cisco management plan will be reworked and released as an impediments document, and a new and concise document to formulate a strategy for re-establishing cisco in Lake Erie will be constructed once the major issues are sufficiently addressed.

Current Activities

Genetics Assessment Research Strategy

In an effort to determine if a remnant cisco stock still exists in Lake Erie, nine recently collected cisco specimens (1990s) 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 population that is most similar to the Lake Erie remnant is from Lake Huron.

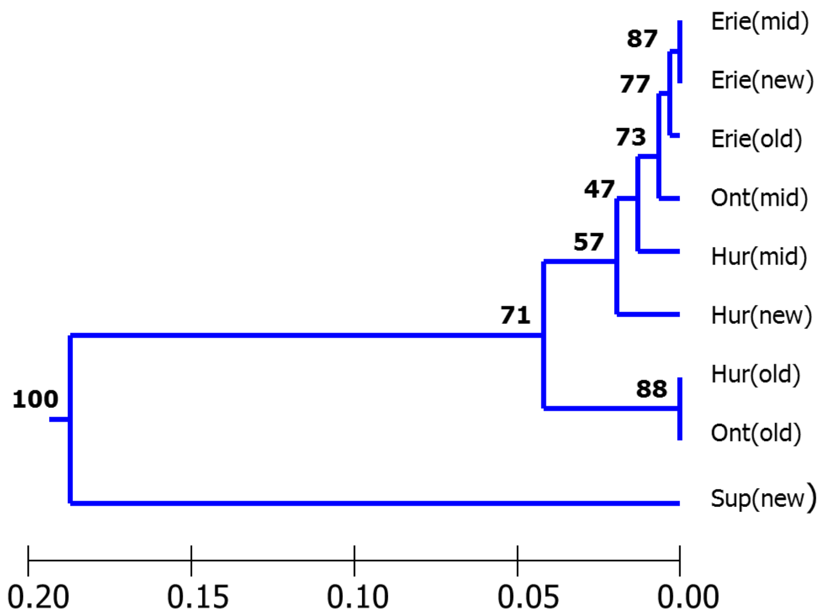

FIGURE 7.2. UPGMA tree diagram showing Nei's unbiased genetic distance of various cisco populations (Nei 1978) from Rocky Ward, unpublished data. Numbers on branches indicate percent recovery of a branch based on resampling procedures.

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 Center) to test the following hypotheses: 1) cisco from Lakes Huron and Erie existed as a single population; 2) recent Lake Erie observations represent a true remnant stock (see above); and 3) Lake Huron cisco are suitable as a potential source of broodstock for stocking Lake Erie. This research will build on the previous genetic examination (above). It will utilize the previous samples and will greatly increase the sample size by incorporating tissue samples collected from the commercial fishery since the original nine specimens were analyzed, as well as DNA extracted from a large archive of historic scale samples covering the 1920s to 1940s. Work started in July 2012 and is expected to be completed by summer 2013. This work is partially funded by the Great Lakes Restoration Initiative.

Disease Testing of Extant Populations

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 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 collected 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 stocks as a source of broodstock.

Sampling of Historic Cisco Spawning Sites

At the request of the CWTG, USGS-Sandusky conducted a limited amount of gill net sampling near Kelley's Island and Vermilion, Ohio, to characterize the fish assemblage at historical cisco spawning locations in fall of 2011 and 2012 (Figure 7.1). Results are shown in Table 7.3.

In 2011, overnight sampling was conducted at locations on the northeast side of Kelley's Island, Kelley's Island Shoal, Gull Island Shoal, and hard bottom areas southwest of the mouth of the Vermilion River. This work was added to ongoing walleye gill net comparison studies, and was constrained spatially and temporally to areas adjacent to walleye gill net sets. Sites were sampled during late October and early November, corresponding with the historical early cisco spawning period for Lake Erie. The gill nets used for sampling cisco spawning sites consisted of monofilament meshes ranging from 44 to 76 mm arranged in random order. Each panel was 1.8 m high and 15.2 m long, and there were unequal numbers of each panel mesh size (44 mm, N=4; 51 mm, N=5; 57 mm, N=3; 64 mm, N=4; 70 mm, N=4; and 76 mm, N=3) for a total length of 350 m.

The 2012 sampling was a more directed effort. Sampling was conducted off the USGS Research Vessel *Bowfin* which allowed net sets in shallow water (1.6-3.2 meters) and later into the year (late November to early December) than in 2011. Sampling sites included Crib Reef, Toussaint Reef, Kelley's Island Shoal, and a site with hard substrates on the northeast side of Kelley's Island. The gill nets consisted of 15.2 m monofilament panels that were 1.8 m tall. Mesh panels ranged from 38.1 mm to 76.2 mm that increased in 6.35 mm increments. Panels were arranged in a random order with each mesh size repeated twice for a total net length of 213.4 m.

The results indicate that spawning condition lake whitefish were captured in greater numbers during late November. Future sampling for cisco should target late November through December.

TABLE 7.3. Species composition of gill net samples from historical cisco spawning locations in the western basin, fall 2011 and 2012.

Species	2011 %	2012 %
White perch (+hybrids)	27.9	19.0
Gizzard shad	23.4	57.0
White bass	21.5	3.0
Walleye	17.7	5.0
Shorthead redhorse	5.2	
White sucker	1.4	1.0
Channel catfish	1.1	
Lake whitefish	0.4	12.0
Smallmouth bass	0.4	
Freshwater drum	0.3	1.0
Rock bass	0.3	
Yellow perch	0.3	
Black crappie	0.1	
Quillback	0.1	1.0
Spottail shiner		1.0

In 2011, November gill netting by Ontario Ministry of Natural Resources (OMNR), targeting lake trout on Nanticoke Shoal in the eastern basin (Figure 7.1), captured one pre-spawn lake whitefish; suggesting habitat potentially suitable for other coregonids. A more extensive survey at the same location in 2012 collected 5 mature pre-spawn lake whitefish on Nanticoke Shoal between November 15 and 21. Survey gear consisted of 4 x 381 m gangs of monofilament gill net with mesh sizes ranging from 32-152 mm in 50 or 100 ft. panels; thus including mesh sizes used to target cisco in the west basin (above). Though not historically documented as a spawning area for cisco, the presence of lake whitefish, and its proximity to the historic nursery habitat of Long Point Bay, makes this shoal a candidate for future fall assessments.

Additional Sampling for 2013

As Maumee Bay is recognized as a current spawning location and represents the location of the highest catches of lake whitefish in the commercial fishery, it may be possible to seek cooperation from commercial fishermen to look for cisco in the catches. Discussions have begun between the OMNR and the Ontario Commercial Fisheries Association to solicit additional samples from the Ontario commercial fishery, to date the most consistent source of cisco samples. We are hopeful that this may result in both additional samples for genetic analysis and identify additional locations for standardized assessment.

Proposed CWTG Activities for 2013

In 2013, the Coldwater Task Group members will convert the draft Management Plan into an Impediments document. Task Group members will work toward improved reporting from the Ontario Commercial Fisheries Association and other commercial fishing organizations in 2013 and 2014. Current genetic testing will be completed in 2013. Based on these activities, the CWTG will identify the need for further research to help determine the best approach for re-establishment of cisco in Lake Erie.

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