REPORT OF THE LAKE ERIE COLDWATER TASK GROUP

28 March 2013

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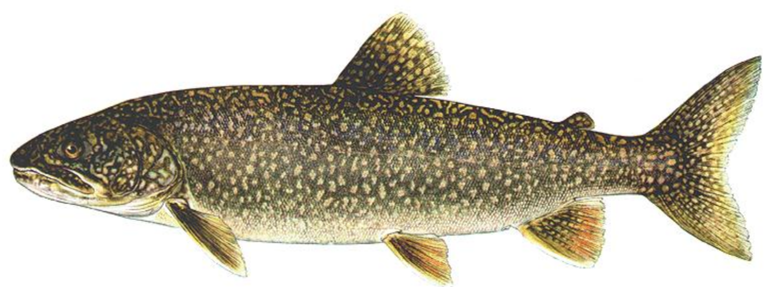

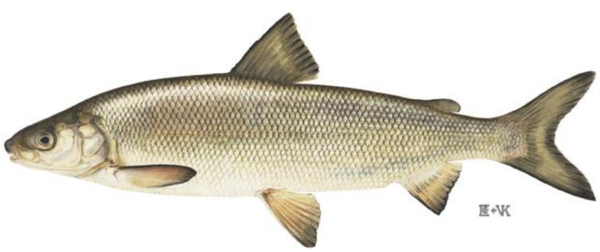

Presented to:

Standing Technical Committee
Lake Erie Committee
Great Lakes Fishery Commission

Protocol for Use of Coldwater Task Group Data and Reports

The Lake Erie Coldwater Task Group (CWTG) uses standardized methods, equipment, and protocols as much as possible; however, data sampling and reporting methods do vary across agencies. The data are based upon surveys that have limitations due to gear, depth, time, and weather constraints that are variable from year to year. Any results or conclusions must be treated with respect to these limitations. Caution should be exercised by outside researchers not familiar with each agency's collection and analysis methods to avoid misinterpretation.

The CWTG strongly encourages outside researchers to contact and involve the CWTG members in the use of any specific data contained in this report. Coordination with the CWTG can only enhance the final output or publication and benefit all parties involved. Any CWTG data or findings intended for outside publication **must** be reviewed and approved by the CWTG members. Agencies may require written permission for external use of data, please contact the agencies responsible for the data collection.

Citation:

Coldwater Task Group. 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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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.

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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

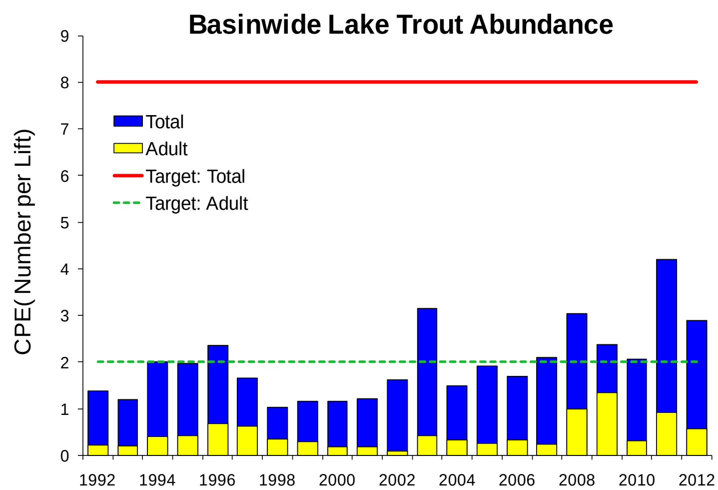
Introduction

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.

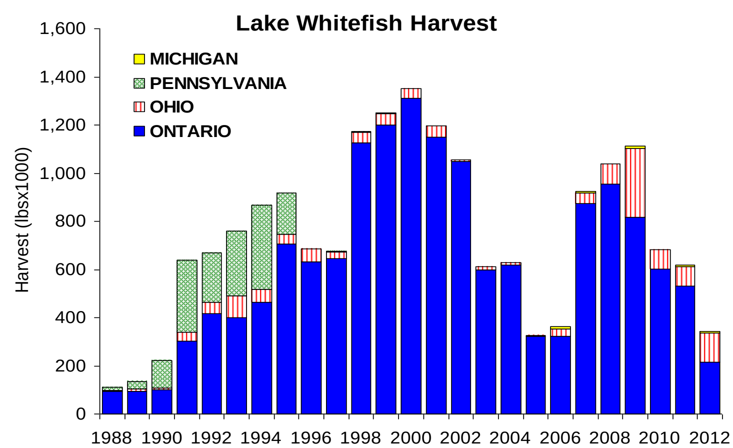
Lake Trout

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.



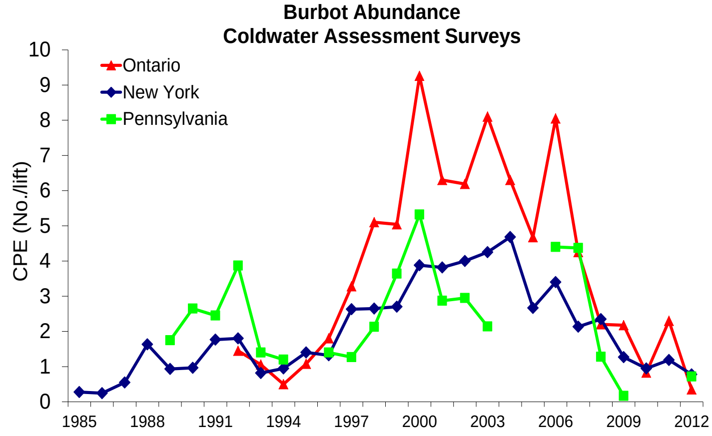
Lake Whitefish

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.



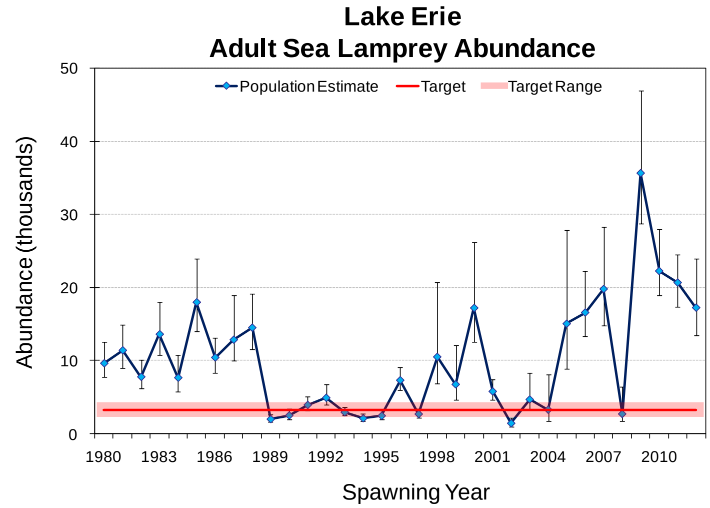
Burbot

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.



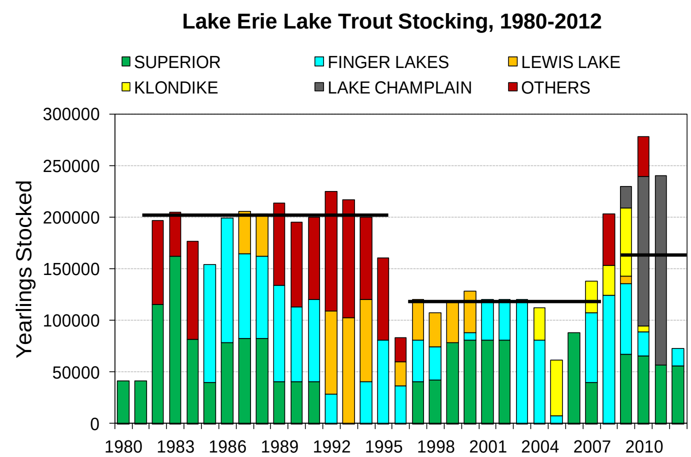
Sea Lamprey

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

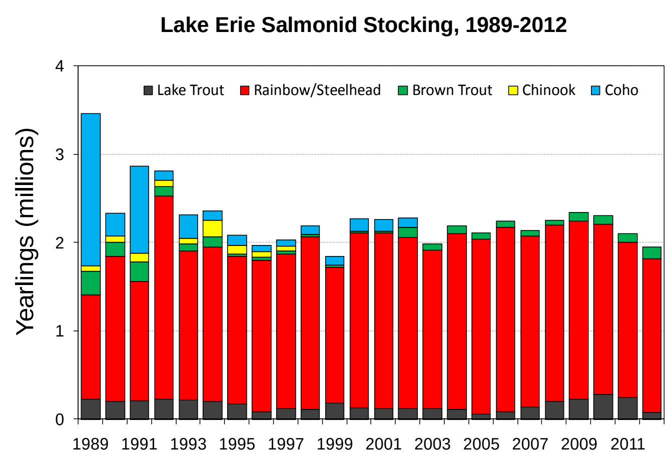
A total of 1,962,516 salmonids were stocked in Lake Erie in 2012. This was a 9% decrease in the number of yearling salmonids stocked compared to 2011 and the long-term average from 1989-2011. Declines were primarily due to temporary reductions in 2012 of lake trout and steelhead/rainbow trout stockings. 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.

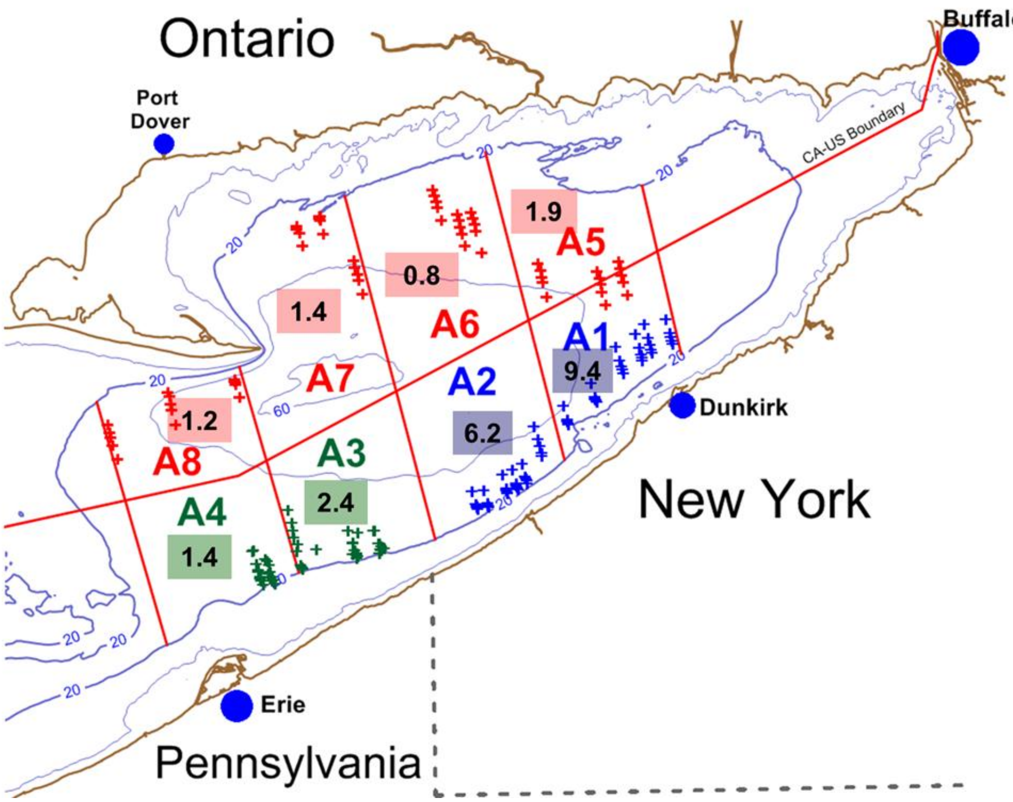


FIGURE 1.1. Standard sampling areas (A1-A8) used for assessment of lake trout in the eastern basin of Lake Erie, 2012, and catch per effort (No. per lift) of lake trout in each area. Plus signs (+) represent net location placement in 2012.

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.

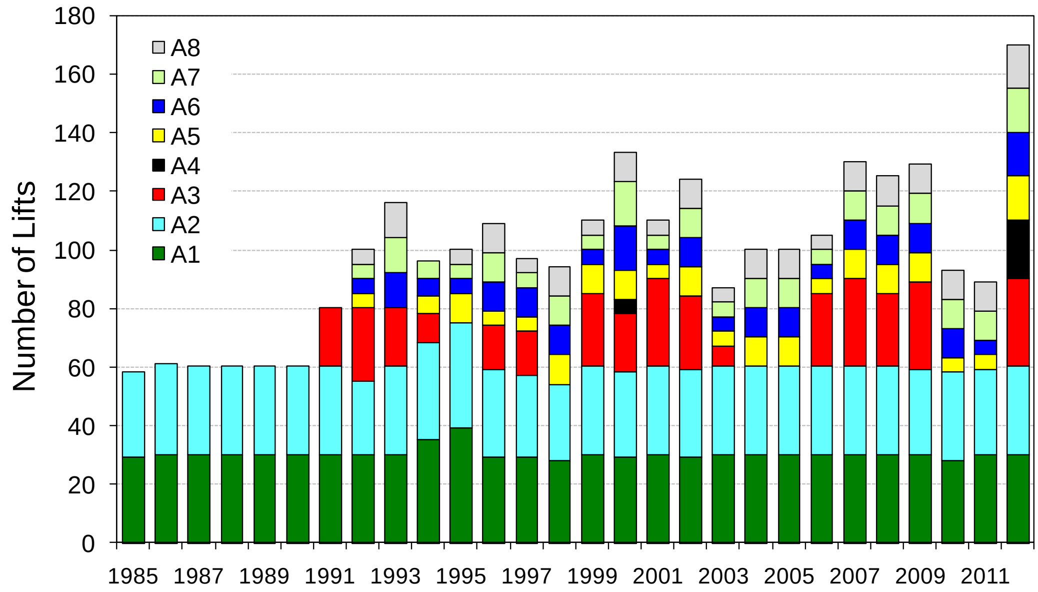


FIGURE 1.2. Number of unbiased coldwater assessment gill net lifts by area in the eastern basin of Lake Erie, 1985-2012.

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

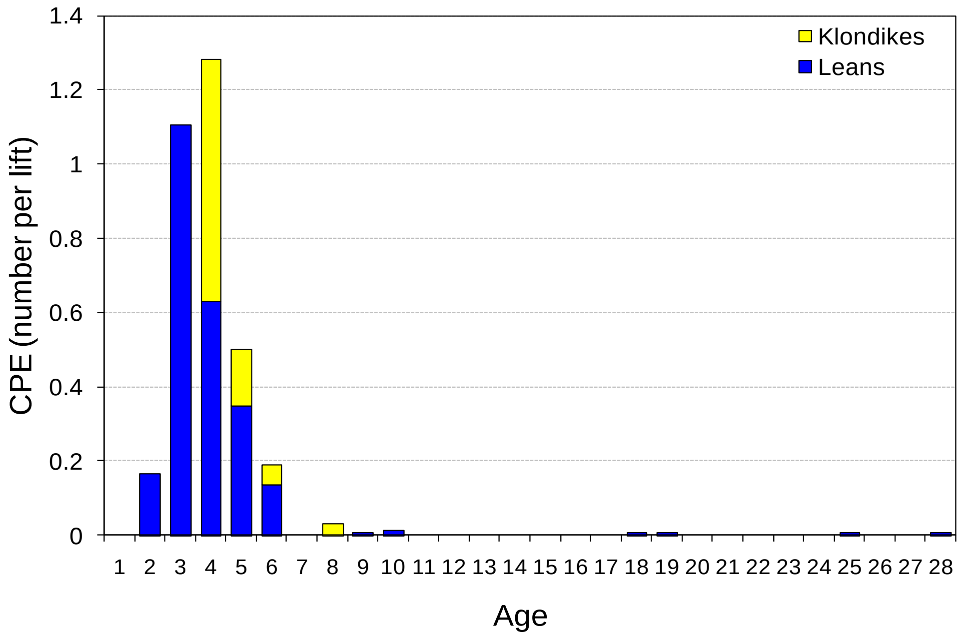


FIGURE 1.3. Relative abundance (number per lift) at age of Lean strain and Klondike strain lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie 2012.

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).

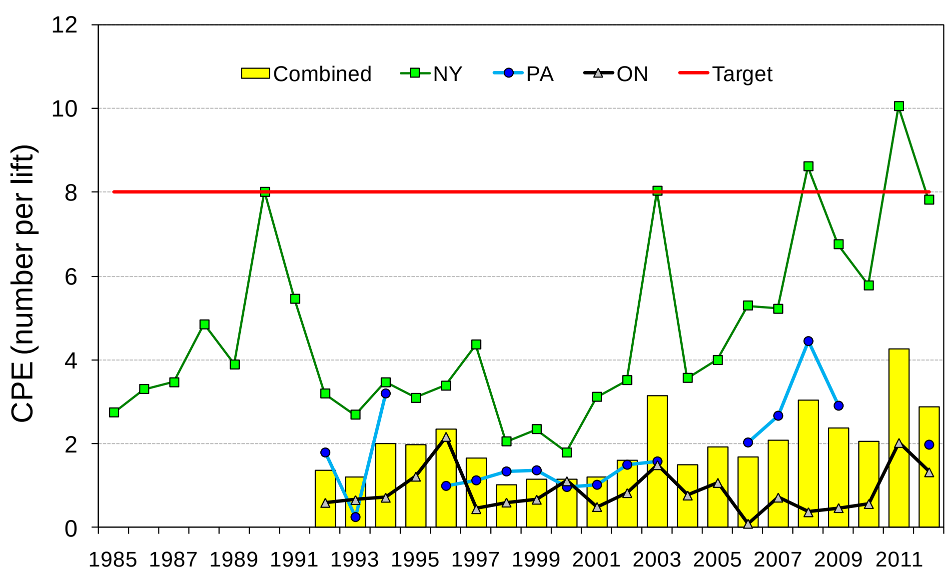


FIGURE 1.4. Mean CPE (number per lift) by jurisdiction and combined (weighted by area) for lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1985-2012.

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.

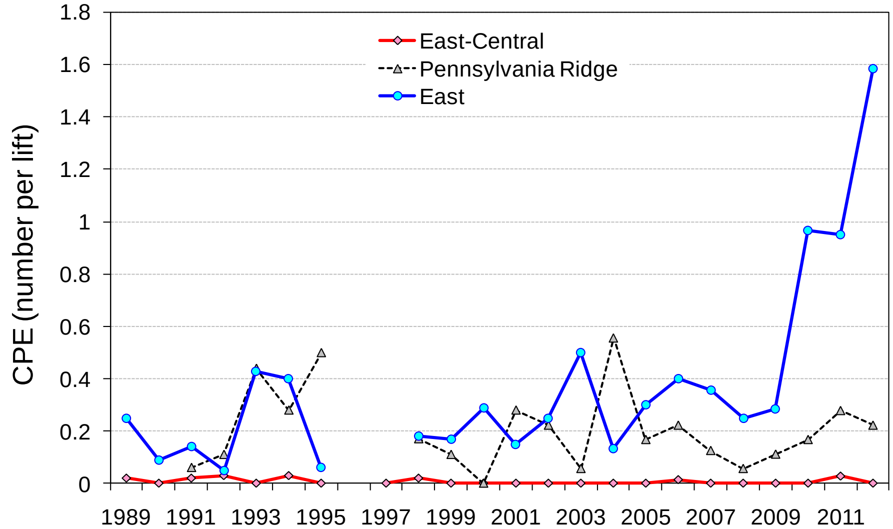


FIGURE 1.5. Lake trout CPE (number per lift) by basin from the OMNR Partnership Index Fishing Program, 1989-2012. Includes canned (suspended) and bottom gill net sets, excluding thermocline sets.

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).

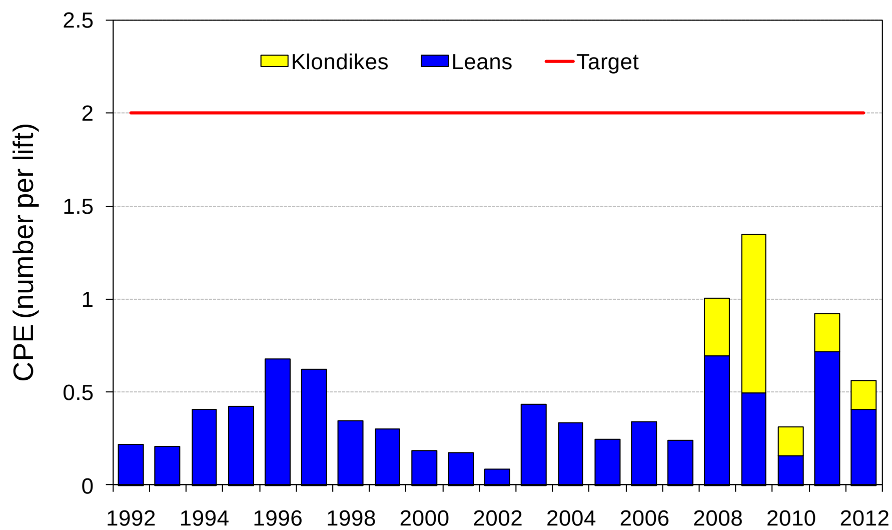


FIGURE 1.6. Relative abundance (number per lift) weighted by area of age 5 and older Lean strain and Klondike strain lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2012.

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.

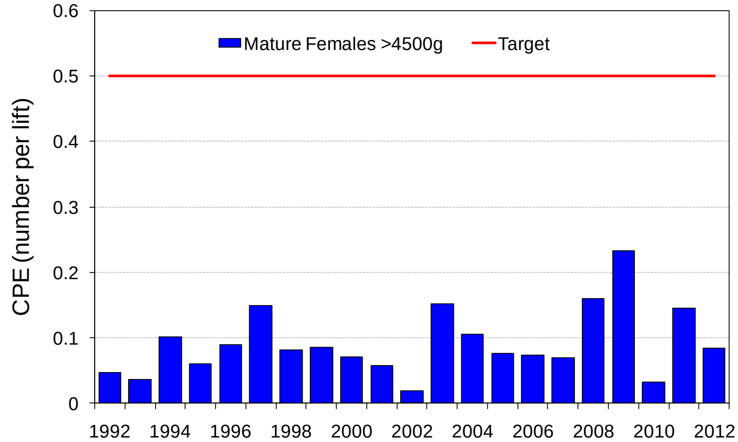


FIGURE 1.7. Relative abundance (all strains, number per lift, weighted by area) of mature female lake trout greater than 4500g in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2012.

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.

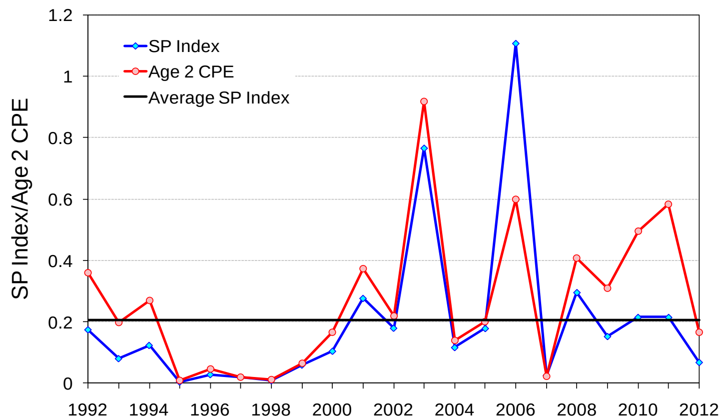


FIGURE 1.8. Stocking Performance (SP) index and age-2 CPE (number per lift) for lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1992-2012. The SP index is equal to the number of age-2 fish caught per lift for every 100,000 yearling lake trout stocked.

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.

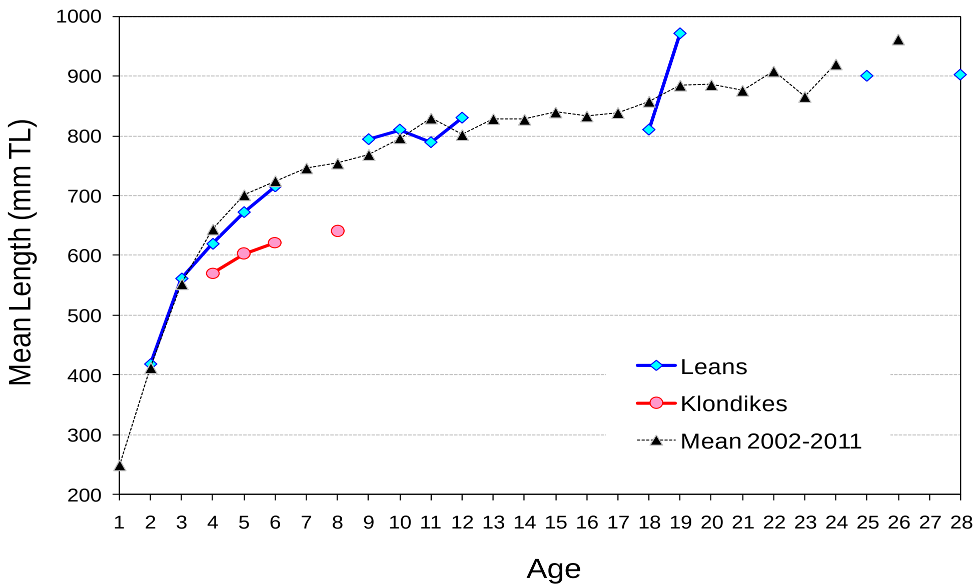


FIGURE 1.9. Mean length-at-age of Lean strain and Klondike strain lake trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2012. The previous 10-year average (2002-2011) from New York waters is shown for current growth rate comparison.

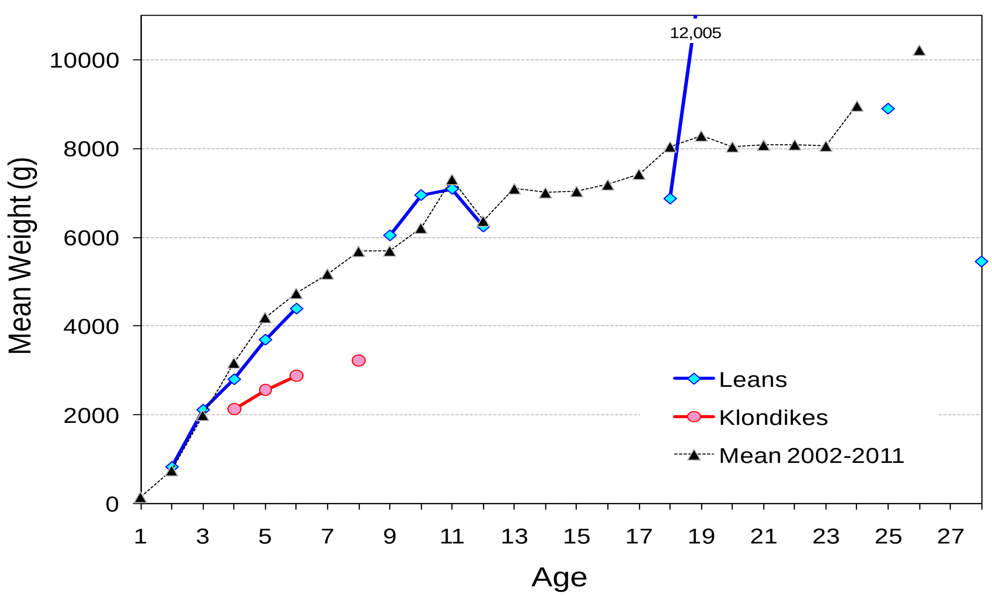


FIGURE 1.10. Mean weight-at-age of Lean strain and Klondike strain lake trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2012. The previous 10-year average (2002-2011) from New York waters is shown for current growth rate comparison.

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.

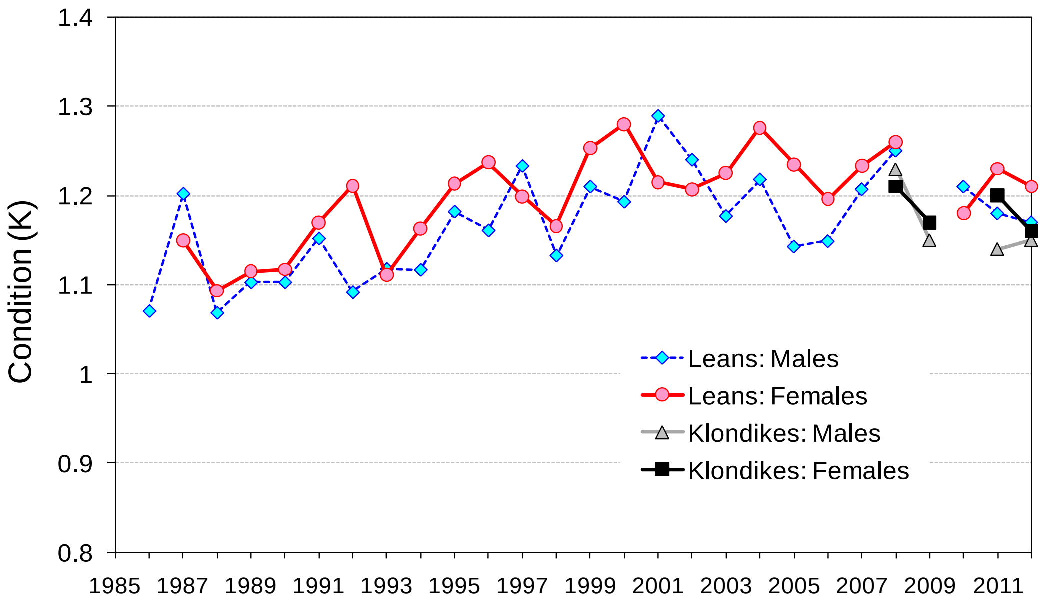


FIGURE 1.11. Mean coefficients of condition for age-5 Lean strain and Klondike strain lake trout, by sex, collected in eastern basin assessment gill nets in Lake Erie, August 1985-2012.

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.

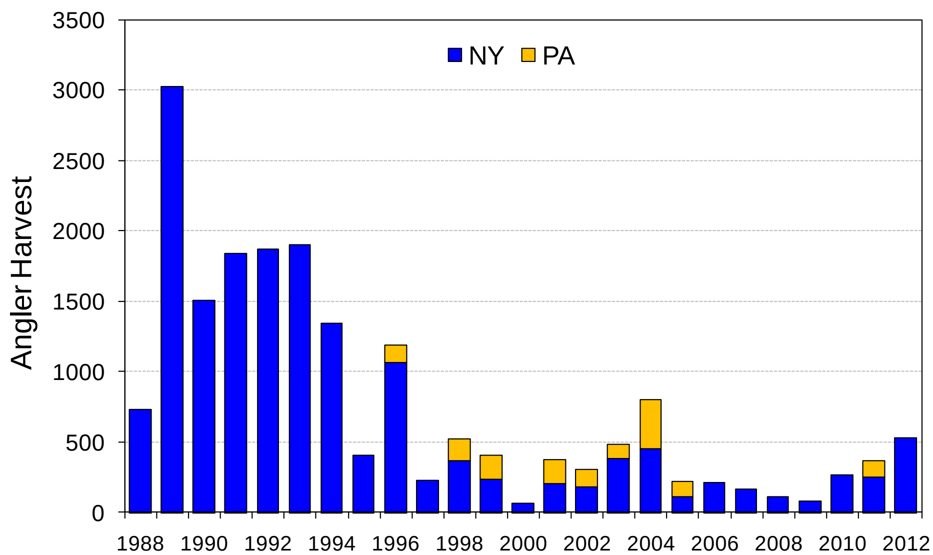


FIGURE 1.12. Estimated lake trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2012.

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.

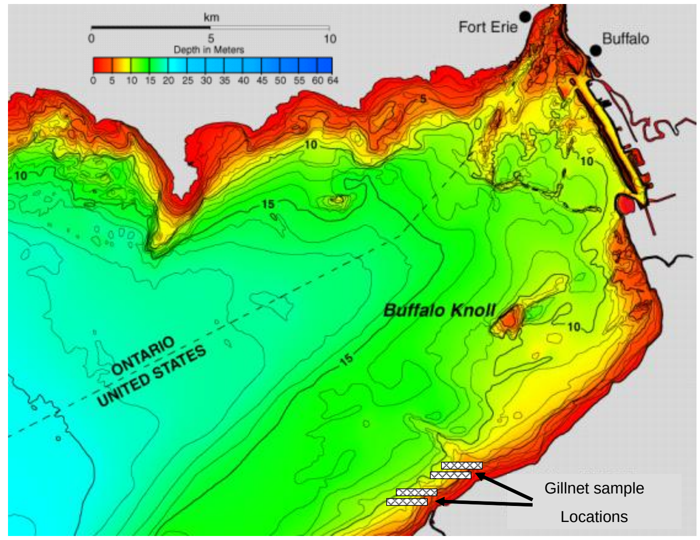


FIGURE 1.14. Gill net survey locations sampled for spawning lake trout in the New York waters of Lake Erie, November 2011 and 2012.

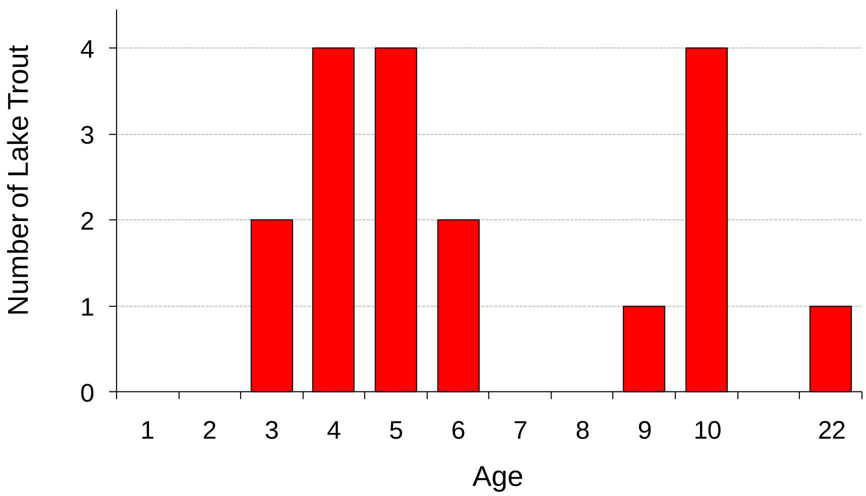


FIGURE 1.15. Age distribution of lake trout sampled in the New York waters of Lake Erie, November, 2012.

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).

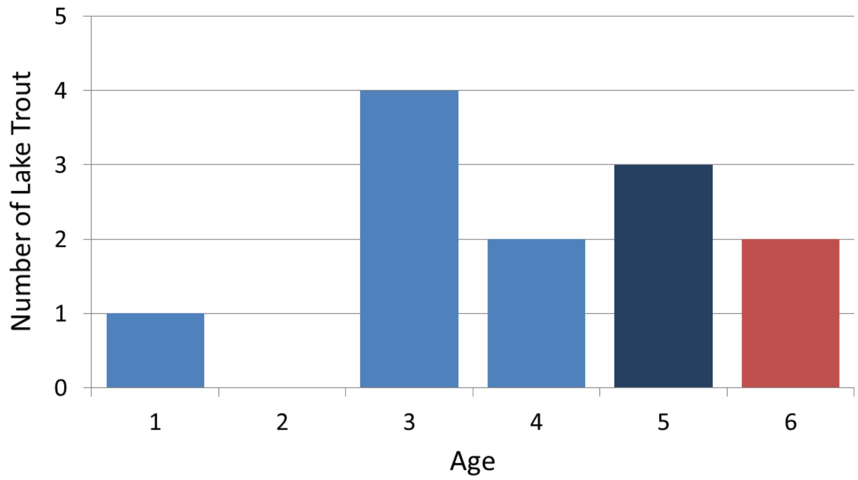


FIGURE 1.16. Age distribution of lake trout sampled in the Ontario waters of Lake Erie, November 2012. Colors represent strain/original stocking location: Red - Finger Lakes / NY waters; Dark Blue – Lake Manitou / Nanticoke Shoal; Light Blue – Slate Island/ Nanticoke Shoal.

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^{o} C) were all pre-spawning, while the two male fish caught on November 21st (9-9.5^{o} 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.

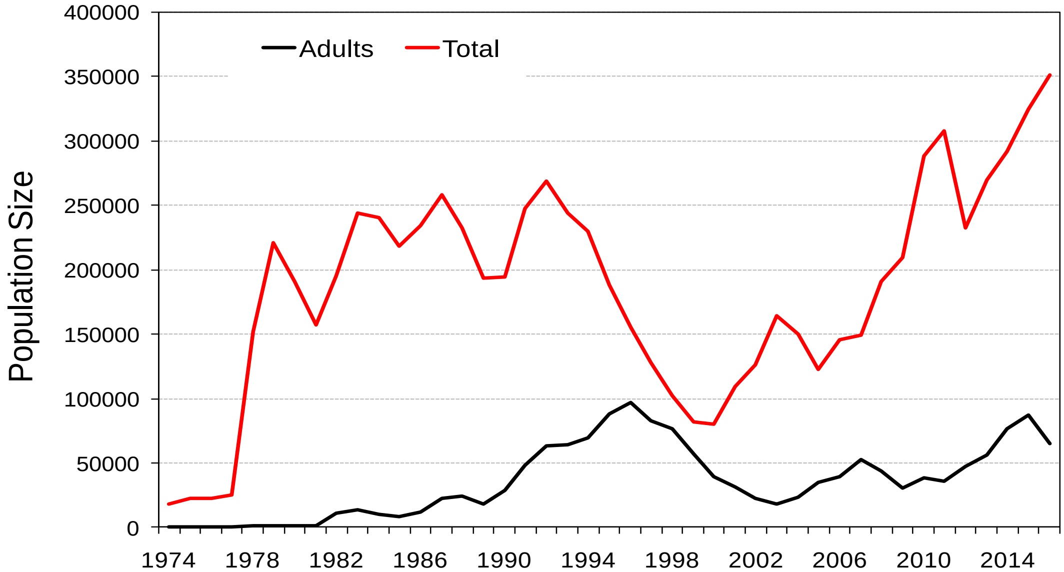


FIGURE 1.17. Projections of the Lake Erie total and adult (ages 5+) lake trout population using the CWTG lake trout model. Projections for 2013-2016 were made using low rates of sea lamprey mortality with proposed stocking rates. The model estimated the lakewide lake trout population in 2012 at 232,919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