REPORT OF THE LAKE ERIE COLDWATER TASK GROUP

25 March 2011

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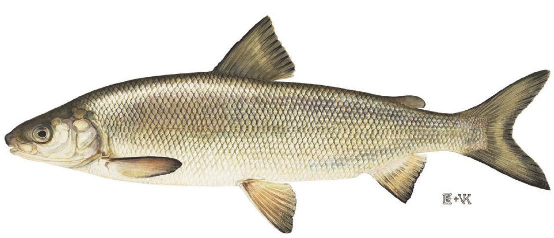
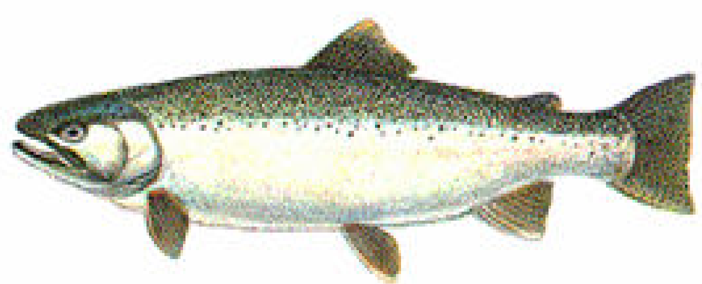


Presented to:

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. 2011. Report of the Lake Erie Coldwater Task Group, March 2011. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

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Kraft, C.E., D.M. Carlson, and M. Carlson. 2006. *Inland Fishes of New York (Online)*, Version 4.0. Department of Natural Resources, Cornell University, and the New York State Department of Environmental Conservation.

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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.
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Charge 5: Maintain an annual interagency electronic database of Lake Erie salmonid stocking and current projections for the STC, GLFC and Lake Erie agency data depositories. ***33***

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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 in by the newly-formed 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 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 dynamics have recently entered into the task group's list of charges and a new charge concerning lake herring 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 specifically designed to address activities undertaken by the task group toward each charge in this past year and is presented orally to the LEC at the annual meeting, held this year on 24-25 March 2011 in Ypsilanti, Michigan. 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

Cornelius, F. C., K. M. Muth, and R Kenyon. 1995. Lake Trout Rehabilitation in Lake Erie: A Case History. J. Great Lakes Res. 21 (Supplement 1): 65-82, International Association of Great Lakes Research.

Lake Trout Task Group. 1985. A Strategic Plan for the Rehabilitation of Lake Trout in Eastern Lake Erie. Report to the Great Lakes Fishery Commission's Lake Erie Committee, Ann Arbor, MI, USA.

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

Pare, S. M. 1993. The Restoration of Lake Trout in Eastern Lake Erie. United States Fish and Wildlife Service, Lower Great Lakes Fishery Resources Office Administrative Report 93-02. 73 pp. Prepared for the Coldwater Task Group, Lake Erie Committee.

Ryan, P.A., R. Knight, R. MacGregor, G. Towns, R. Hoopes, and W. Culligan. 2003. Fish-community goals and objectives for Lake Erie. Great Lakes Fish. Comm. Spec. Publ. 03-02. 56 pp.

COLDWATER TASK GROUP EXECUTIVE SUMMARY REPORT MARCH 2011

Lake Erie Committee

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

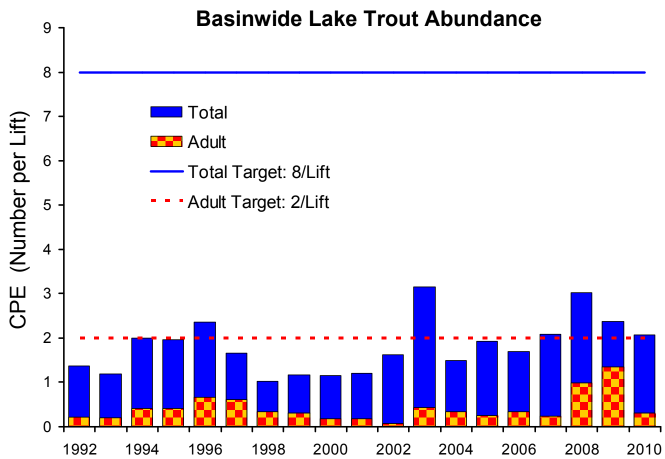
Introduction

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 2010-2011: (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) Electronic database maintenance of Lake Erie salmonid stocking information; (6) Steelhead fishery assessment and population biology, and (7) Development of a cisco management plan.

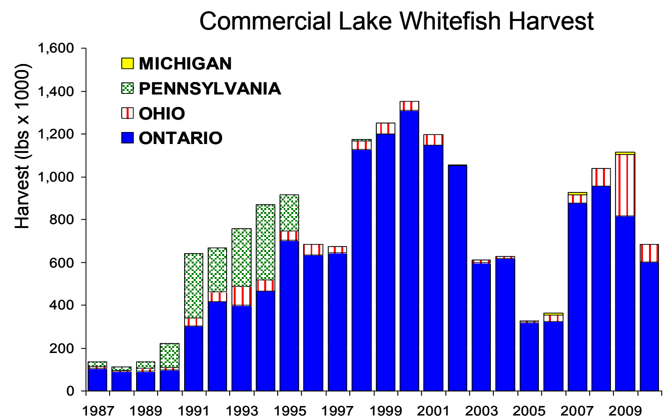
Lake Trout

A total of 338 lake trout were collected in 93 lifts across the eastern basin of Lake Erie in 2010. Young cohorts (ages 1-4) dominated catches with lake trout ages 9 and older only sporadically caught. Basin-wide lake trout abundance declined for the second consecutive year in 2010 and remains well below the rehabilitation target of 8.0 fish/lift. Adult (age 5+) abundance declined sharply (77%) in 2010 and also remains well below target. Recent estimates indicate very low rates of adult survival. Klondike and Finger Lakes strain lake trout comprise the majority of the population. Successful natural reproduction has yet to be documented in Lake Erie despite more than 30 years of restoration efforts.



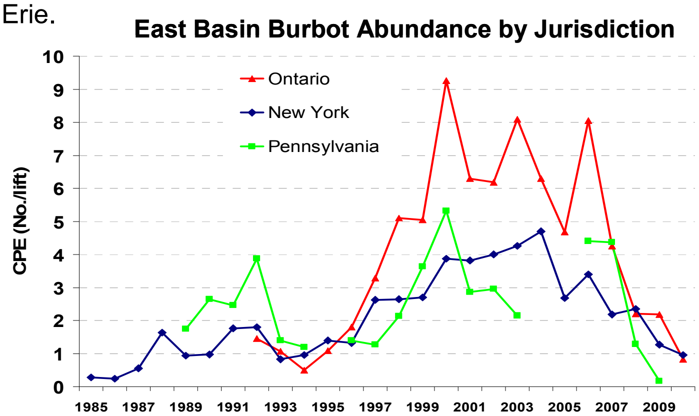
Whitefish

Lake whitefish harvest in 2010 was 683,567 pounds, distributed among Ontario (88%), Ohio (12%), Michigan (<1%) and Pennsylvania (<1%) commercial fisheries. The 2003 year class (age 7) dominated the harvest and population age structure in 2010. Ages present in the 2010 population ranged from 3 to 21 with no evidence of young-of-the-year or yearlings in surveys lakewide. With weak to moderate recruitment occurring, abundance is declining. Some recruitment of age 4 and 5 whitefish (2007, 2006 year classes) to fisheries can be expected in 2011, but these year classes may be moderate at best. Fisheries in 2011 will continue to rely on the 2003 year class followed by the 2005 cohort with some contribution from other weaker year classes. In 2010, mean condition factor of mature (ages 4+) whitefish did increase compared to 2009. For females, mean condition was above the historic average, while mean condition factor of males was near or above the historic average, depending on the agency data source.



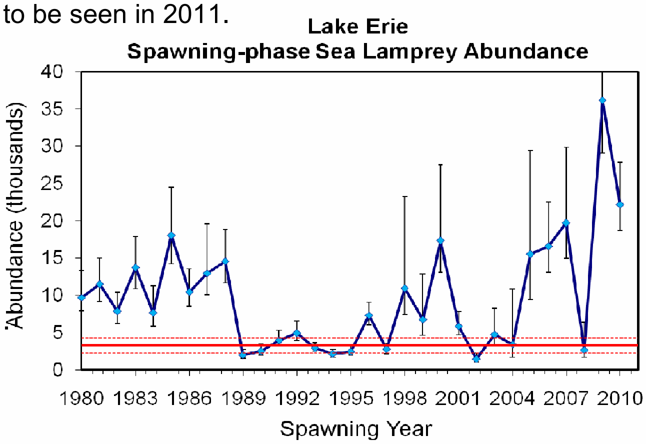
Burbot

Total commercial harvest of burbot in Lake Erie during 2010 was 3,186 pounds, a 33% decrease from 2009. Burbot abundance and biomass indices from annual coldwater gillnet assessments continued to decline throughout the east basin after time-series maxima were observed during the early- to mid-2000s. 2010 burbot abundance measures were at or near the lowest level seen in agency assessment programs since the mid-80s. Declining catch rates of burbot in assessment surveys, combined with increasing mean age of adults and persistent low recruitment, signal an impending population collapse. Round gobies and rainbow smelt continue to be the dominant prey items in burbot diets in eastern Lake Erie.



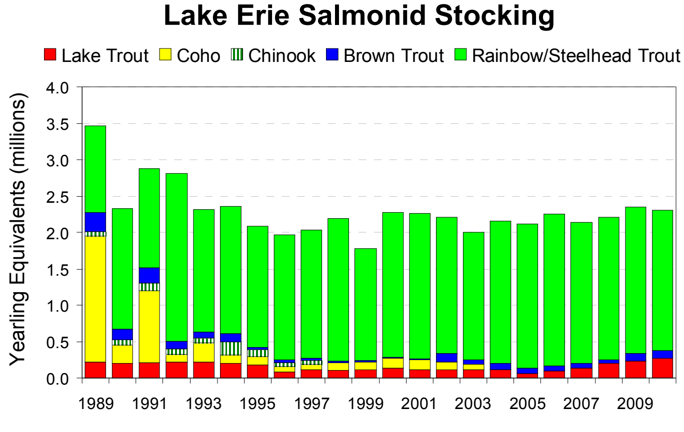
Sea Lamprey

The A1-A3 wounding rate on lake trout over 532 mm was 12.8 wounds per 100 fish in 2010. This was a 33% decline from the 2009 wounding rate of 19.3 wounds per 100 fish. Despite the decline, the wounding rate is still over two times higher than the target rate of five wounds per 100 fish. Wounding rates have been above target for 15 of the past 16 years. Large lake trout over 736 mm continue to receive the highest percentage of the fresh wounds, but high wounding rates were found in all size categories greater than 532mm. A4 wounding rates slightly increased in 2010 to 55.8 wounds/100 fish, the third highest wounding rate in the 25-year time series. A4 wounding rates on lake trout over 736 mm remain very high (200 wounds/100 fish). The estimated number of spawning-phase sea lampreys decreased from a time-series high of 35,635 in 2009 to 22,179 in 2010. However, this is the second highest population estimate in the time-series. A two-year experiment of back-to-back lampricide treatments in the nine major sea lamprey producing streams began in spring 2008. These same streams were treated again in fall 2009 with treatment results expected to be seen in 2011.



Lake Erie Salmonid Stocking

A total of 2,304,095 salmonids were stocked in Lake Erie in 2010. This was a 2% decrease in the number of yearling salmonids stocked compared to 2009, but near the long-term average from 1989-2009. By species, there were 272,939 yearling lake trout stocked in New York, Pennsylvania, and Ontario waters (the highest number of lake trout stocked in the 31-year time series); 102,127 brown trout stocked in New York and Pennsylvania waters, and a total of 1,929,029 steelhead/rainbow trout stocked by all five jurisdictions.



Steelhead

All agencies stocked yearling steelhead/rainbow trout in 2010. A summary of rainbow trout/steelhead stocking in Lake Erie by jurisdictional waters for 2010 is as follows: Pennsylvania (1,085,406; 56%), Ohio (433,446; 22%), New York (310,194; 16%), Michigan (66,536; 3%) and Ontario (33,447; 2%). Overall steelhead stocking numbers (1.929 million in 2010) represented a 6% increase above the long-term average but a 4% decrease from 2009. 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 9,178 fish, summed for all reporting agencies. This was a 5% increase over the 2009 harvest and the second consecutive increase since a record low harvest (5,431 fish) in 2008. Open lake steelhead harvest increased in both New York and Pennsylvania waters, but decreased in Ohio and Michigan waters. Overall harvest was 60% below the ten-year average. Catch rates in the open water fishery were mixed as well in 2010 and were less than half of the long-term average.

Based upon creel surveys, the majority (>90%) of the fishery effort targeting steelhead occurs in the tributaries from fall through spring. Results from the second consecutive year of creel survey in Ohio tributaries were similar to the first year with catch rates of 0.35 fish/hour with an estimated total effort of 283,107 angler-hours. Harvest rates remained around 10%. Catch rates by tributary anglers in the New York cooperative diary program declined in 2009 to 0.69 fish/hour, but remained well above the long-term average of 0.47 fish/hour.

Cisco

Cisco are considered extirpated in Lake Erie, however, commercial fishermen report them periodically. Captures have been reported in 9 of the last 14 years, with 4 reports in 2010. Genetic testing of recent catches found them to be most related to the historic Lake Erie stock, indicating the possibility that a remnant Lake Erie stock still exists.

Preparation of a cisco management plan began in 2007 with the goal of rehabilitating cisco in Lake Erie. In recognizing that stocking is a possible management decision, disease testing of potential brood stock was started. Lake Superior and Lake Ontario populations were tested, and a need identified to investigate Lake Huron and Lake Michigan stocks as a brood-stock source.

Several outstanding issues have moved the CWTG into future broader consultation with cisco experts around the Great Lakes. These include methods of investigation into the extant population size, genetics and potential constraints, implications of stocking and brood stock selection. The final draft is expected to be completed in 2011.

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/

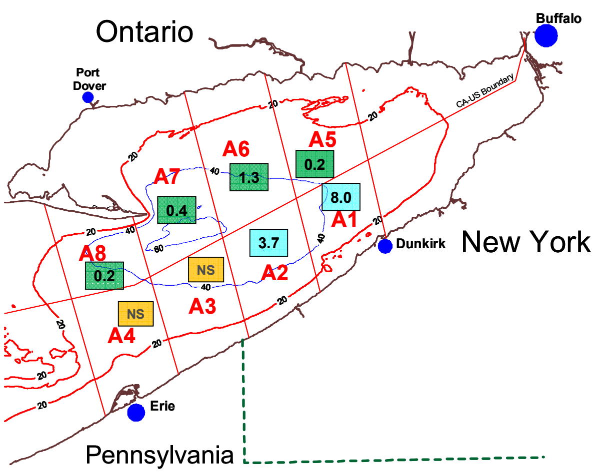


FIGURE 1.1 Standard sampling areas (A1-A8) used for assessment of lake trout in the eastern basin of Lake Erie, 2010, and catch per effort (number/lift) of lake trout in each area. Areas A3 and A4 were not sampled in 2010.

OMNR: A5 through A8.

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 compliment 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 has only been sampled once due to the lack of enough cold water to set gill nets according to the sampling protocol.

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

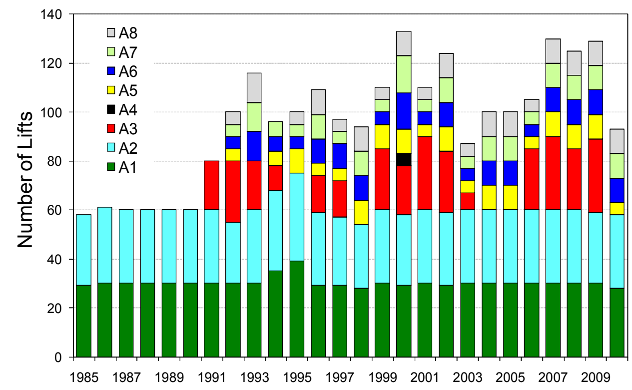


FIGURE 1.2. Number of coldwater assessment gill net lifts by area in the eastern basin of Lake Erie, 1985-2010.

(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 nets made of monofilament mesh instead of the standard multifilament nylon mesh. This modification was made following two years of comparative data collection and analysis that detected no significant difference in the total catch between the two net types (Culligan *et al.* 1996). In 1998 and 1999, all Coldwater Task Group (CWTG) agencies except the Pennsylvania Fish and Boat Commission (PFBC) switched to standard monofilament assessment nets to sample eastern basin lake trout. Personnel from the PFBC switched to monofilament mesh in 2006.

Sampling protocol requires the first gang in each five net series to be set along the contour where the 8° to 10°C isotherm intersects with the bottom. The top of the gang must be within this isotherm. The next three gangs are set in progressively deeper/colder water at increments of either 1.5 m depth (5 feet) or a 0.8 km (0.5 miles) distance from the previous (shallower) gang, whichever occurs first along the transect. The fifth and deepest gang is set 15 m (50 feet) deeper than the shallowest net (number 1) or at a maximum distance of 1.6 km (1.0

miles) from net number 4, whichever occurs first. NYSDEC and PFBC have been responsible for completing standard assessments in their jurisdictional waters since 1986 and 1991, respectively. The Sandusky office of the U.S. Geological Survey (USGS) has assumed responsibility for standard assessments in Canadian waters since 1992. The Ontario Ministry of Natural Resources (OMNR) began coordinating with USGS in 1998 to complete standard assessments in Canadian waters. Total effort for 2010 by the combined agencies was 93 unbiased standard lake trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 58 lifts by the NYSDEC and 35 by USGS/ OMNR; no sets were made in Pennsylvania waters in 2010 due to budget and personnel issues. This was the second lowest total effort since combined agency assessments began in 1992.

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

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

Abundance

Sampling was conducted in six of the eight standard areas in 2010 (Figure 1.1), collecting a total of 338 lake trout in 93 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 more than 10 times 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.

Fifteen age-classes of lake trout, ranging from ages 1 to 26, were represented in the 2010 catch of known-aged fish (Tables 1.1 and 1.2). Similar to the past nine years, young cohorts (ages 1-4) were the most abundant, representing 78% of the total catch in standard assessment nets (Figure 1.3). Cohort abundance continues to decline rapidly after age 6, and lake trout age-9 and older were only sporadically caught. Lake trout age-10 and older comprised less than 3% of the overall catch in 2010.

TABLE 1.1. Number, sex, mean length (mm), mean weight (g), and percent maturity, by age class, of **Lean** strain lake trout collected in assessment gill nets from the eastern basin of Lake Erie, August 2010.

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (g)	PERCENT MATURE
1	Combined	28	255	167	0
2	Male Female	7 8	400 406	703 758	0 0
3	Male Female	31 13	548 535	1956 1621	94 0
4	Male Female	45 16	631 639	2954 3046	100 75
5	Male Female	3 4	678 711	3803 4259	100 100
7	Male Female	6 3	733 723	4940 4547	100 100
8	Male Female	4 6	768 780	5756 6212	100 100
9	Male Female	2 2	794 794	6198 5740	100 100
10	Male Female	1 0	710 ---	3935 ---	100 ---
11	Male Female	0 1	--- 787	--- 5810	--- 100
14	Male Female	2 0	840 ---	7588 ---	100 ---
15	Male Female	0 1	--- 818	--- 6860	--- 100
17	Male Female	0 1	--- 806	--- 6135	--- 100
26	Male Female	1 0	962 ---	10230 ---	100 ---

TABLE 1.2. Number, sex, mean length (mm), mean weight (g), and percent maturity, by age class, of **Klondike** strain lake trout collected in assessment gill nets from the eastern basin of Lake Erie, August 2010.

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (grams)	PERCENT MATURE
2	Male Female	15 17	396 382	669 589	0 0
3	Male Female	31 6	510 485	1579 1352	97 0
4	Male Female	22 3	568 603	2173 2737	100 67
6	Male Female	14 12	607 633	2681 3063	100 100
7	Male Female	2 2	628 641	3135 3280	100 100

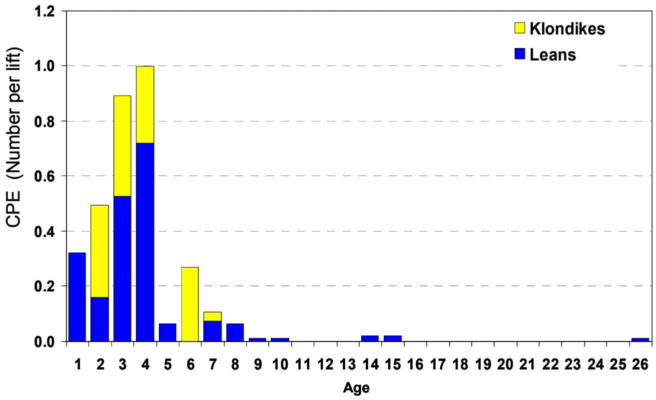


FIGURE 1.3 Relative abundance (number fish/lift) at age of Lean strain and Klondike strain lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, August 1992-2010.

The overall trend in area-weighted mean CPE of lake trout caught in standard nets in the eastern basin decreased in 2010 to 2.07 fish/lift (Figure 1.4). This was the second consecutive decline following a decade of steadily increasing basin-wide abundance. Declines were observed in NY waters in 2010 while a slight increase was found in ON waters. Abundance remains well below the rehabilitation target of 8.0 fish/lift (Markham *et al.* 2008).

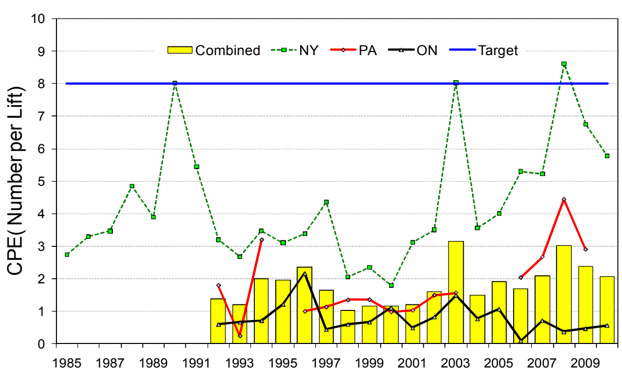


FIGURE 1.4. Mean CPE (number fish/lift) by jurisdiction and combined (weighted by area) for lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, 1985-2010.

The abundance of lake trout in the OMNR Partnership Index Fishing Program increased for the second consecutive year in both the East and Pennsylvania Ridge areas in 2010 (Figure 1.5). 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. Abundance estimates in 2010 were the highest in the time series in the East basin, mainly due to a high catch of recently stocked (age-1) lake trout, but remained below average in the Pennsylvania Ridge area.

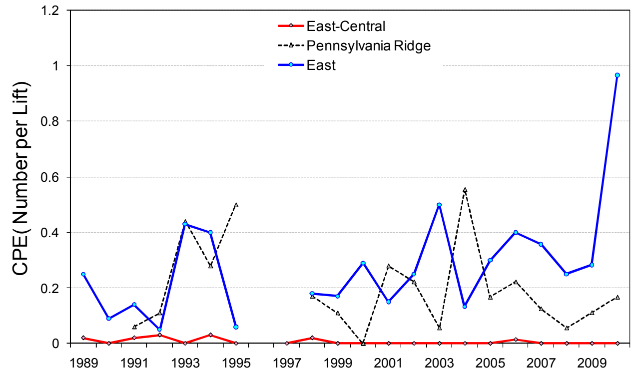


FIGURE 1.5. Lake trout CPE (number fish/lift) by basin from the OMNR Partnership Index Fishing Program, 1989-2010. Includes canned (suspended) and bottom gill net sets excluding thermocline sets.

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 declined sharply in 2010 to 0.31 fish/lift, a 77% decrease from the time-series high in 2009 (Figure 1.6). Declines were observed in both Lean strain and Klondike strain lake trout. The index remains well below the rehabilitation target of 2.0 fish/lift (Markham *et al.* 2008).

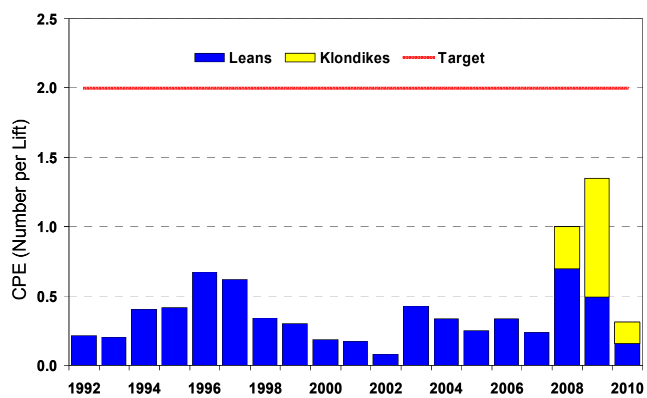


FIGURE 1.6 Relative abundance (number fish/lift) weighted by surface area of age 5 and older Lean strain and Klondike strain lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, August 1992-2010.

The relative abundance of mature females over 4500g, an index of repeat-spawning females ages 6 and older, also declined sharply in 2010 to 0.03 fish/lift (Figure 1.7). This represents an 86% decline from the time-series high in 2009. This index value remains well below the rehabilitation plan target of 0.50 adult females per lift (Markham *et al.* 2008). A prevailing pattern of low and variable lake trout spawner abundance may be a key contributing factor to our continued unsuccessful efforts to discover any evidence of natural reproduction in Lake Erie.

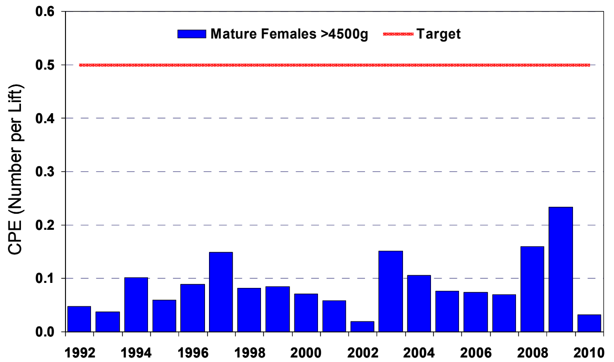


FIGURE 1.7 Relative abundance (number fish/lift) weighted by surface area of mature female lake trout greater than 4500g sampled in standard assessment gill nets in the eastern basin of Lake Erie, August 1992-2010.

Recruitment

The proportion of stocked lake trout surviving to age 2 provides an index of recruitment. This index is 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 recruitment to the number of age-2 lake trout caught per lift per 100,000 yearling lake trout stocked. The 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).

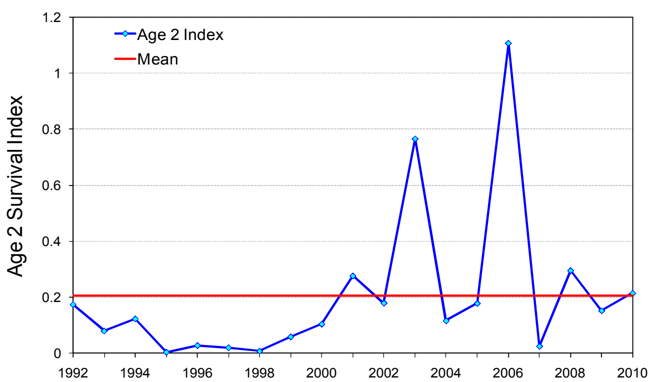


FIGURE 1.8. Index of survival for age-2 lake trout sampled in standard assessment gill nets in the eastern basin of Lake Erie, August 1992-2010. The index is equal to the number of age-2 fish caught per lift for every 100,000 yearling lake trout stocked.

The index increased beginning in 1999, likely due to a combination of improvements in 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 2010 age-2 survival index was 0.22, which was slightly above average for the time series. These lake trout were comprised of Klondike, Finger Lakes, Apostle Island, Lake Champlain, Slate Island, and Lewis Lake strains of which Klondikes demonstrated the greatest age-2 recruitment.

Strains

Seven different lake trout strains were found in the 335 fish caught with hatchery-implanted coded-wire tags (CWTs) or fin-clips in 2010 (Table 1.3). The majority were either Finger Lakes (FL; 42%) or Klondike (KL; 38%) strain lake trout. Finger Lakes have been the most prevalent strain stocked in Lake Erie while Klondikes have only been stocked in five of the past seven years. Traverse Island (TI) and Lake Champlain (LC) were the only other strains caught in significant numbers. Superior (SUP) strain lake trout, stocked extensively in Lake Erie in the 1980s and again from 1997-2002, disappeared in assessment netting in 2010, presumably due to high mortality from sea lampreys. The FL strain continues to show the most consistent returns at older ages, including one age-26 fish, the oldest lake trout ever caught in Lake Erie's assessment surveys.

TABLE 1.3. Number of lake trout per stocking strain by age collected in gill nets from the eastern basin of Lake Erie, August 2010. Stocking strain codes are: FL = Finger Lakes, LL = Lewis Lake, KL = Klondike, SI = Slate Island, TI = Traverse Island, AI = Apostle Island, LC = Lake Champlain. Shaded cells indicate cohorts with a stocking history.

AGE	FL	LL	KL	SI	TI	AI	LC
1							29
2	4	3	32	4		2	1
3	49		38				
4	51		28		25		
5	7						
6			26				
7	10		4				
8	10						
9	4						
10	1						
11	1						
12							
13							
14	2						
15	2						
16							
17	1						
18							
19							
20							
21							
22							
23							
24							
25							
26	1						
TOTAL	143	3	128	4	25	2	30

Returns of the deepwater Klondike (KL) lake trout strain were excellent through age 5. The number of age-3 returns from 31,600 yearlings stocked in 2004 (2003 year-class) was almost five times greater than a concurrent stocking of 80,000 FL strain Lean lake trout when adjusted for stocking rates (Table 1.4a). Return rates decreased at age 4 and age 5 but remained at least two times higher than FL strain lake trout. However, as six-year-old fish in 2009 and seven-year-old fish in 2010, returns of KL strain fish continued to decline and were equal to or outnumbered by FL strain.

Stocking-adjusted return rates of the 2005 stocking (2004 year-class; 54,200 yearlings) at age 2 were the highest in the time-series in 2006 (see Figure 1.8) and over three times higher than KL strain and 13 times higher than FL strain lake trout (2003 year-class) at age 2 (Table 1.4b). Return rates at ages 3 and 4 were similarly high, and remained high at age 5 despite a large decline in overall returns. Return rates continued to decline in 2010 (age 6) and were similar to both KL and FL strain lake trout stocked in 2004 for that age.

TABLE 1.4a. Return rates (number per 100,000 yearlings stocked) of Klondike (KL) and Finger Lakes (FL) strain lake trout stocked in 2004 by age class and strain from the eastern basin of Lake Erie, August 2004-2010.

AGE	STRAIN	NUMBER STOCKED	NUMBER RETURNS	RETURN RATES (per 100,000 stocked)	RATIO FL:KL
1	FL	80,000	4	5	1.7:1
	KL	31,600	1	3	
2	FL	80,000	7	9	1:3.9
	KL	31,600	11	35	
3	FL	80,000	19	24	1:4.6
	KL	31,600	35	111	
4	FL	80,000	70	88	1:2.0
	KL	31,600	55	174	
5	FL	80,000	81	101	1:2.4
	KL	31,600	77	244	
6	FL	80,000	51	64	1:0.8
	KL	31,600	16	51	
7	FL	80,000	10	13	1:1
	KL	31,600	4	13	

TABLE 1.4b. Return rates (number per 100,000 yearlings stocked) of Klondike (KL) strain lake trout stocked in 2005 by age class from the eastern basin of Lake Erie, August 2005-2010.

AGE	STRAIN	NUMBER STOCKED	NUMBER RETURNS	RETURN RATES (per 100,000 stocked)
1	KL	54,200	14	26
2	KL	54,200	61	113
3	KL	54,200	146	269
4	KL	54,200	329	607
5	KL	54,200	194	358
6	KL	54,200	26	48

Survival

Cohort analysis estimates of annual survival (S) were calculated by strain and year class using a 3-year running average of CPE with ages 4 through 11 (Table 1.5). A running average was applied to decrease the high year-to-year variability in catches. Mean overall adult survival estimates varied by strain and year. The Finger Lakes (FL) strain, the most consistently stocked lake trout strain in Lake Erie, had an overall mean survival estimate of 0.710. Survival estimates prior to 1986 were low due a large sea lamprey population. Survival of the 1987 – 1991 year classes were comparably higher as sea lamprey abundance decreased and the number of adult lake trout increased, decreasing the affect of host density. Survival estimates during this period (1987-91) were highest for the FL strain (0.83) and lowest for the SUP strain (0.79). The LO strain, a cross between SUP and FL strains, was intermediate at 0.81. Survival estimates declined beginning with the 1992 year class as the lamprey population increased.

Table 1.5. 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, 1985–2010. Three-year running averages of CPE from ages 4–11 were used due to year-to-year variability in catches. Shaded cells indicate survival estimates that fall below the 0.60 target rate. Asterisk (*) indicates years where straight CPE's were used for ages 4-10 (FL 2000), 4-9 (SUP 2000, FL 2001), 4-8 (SUP 2001), 5-8 (FL 2002), 5-7 (FL 2003, KL 2003), or 4-6 (KL 2004).

	STRAIN					
Year Class	LE	LO	LL	SUP	FL	KL
83				0.687		
84				0.619	0.502	
85				0.543	0.594	
86				0.678		
87				0.712	0.928	
88		0.784		0.726	0.818	
89		0.852		0.914	0.945	
90		0.84		0.789	0.634	
91		0.763	0.616			
92	0.719		0.568			
93	0.857				0.85	
94						
95						
96					0.780	
97				0.404	0.850	
98				0.414		
99*				0.323	0.760	
00*				0.508	0.735	
01*				0.312	0.706	
02*					0.512	
03*					0.328	0.260
04*						0.316
MEAN	**0.788**	**0.810**	**0.592**	**0.587**	**0.710**	0.288

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 0.312-0.508 (Table 1.5). Survival estimates from the 1996, 1997, and 1999-2001 FL strain are much higher, but are based on very low returns. More recent estimates from the 2002 and 2003 year classes of FL strain indicate lower survival rates. All of these survival estimates are below the ranges that were observed for these strains during the period of high-lamprey control. Preliminary estimates of the 2003 and 2004 year classes of Klondike strain fish indicate very low survival rates (0.260 – 0.328) at adult ages. Mean overall survival estimates were above the target goal of 60% or higher (Lake Trout Task Group 1985; Markham ***et al.*** 2008) for LE, LO, and FL strains but below target for the LL, SUP, and KL strains.

Growth and Condition

Mean length-at-age and mean weight-at-age of eastern basin Lean strain lake trout remain consistent with averages from the previous ten years (2000-2009) through age 9 (Figures 1.9 and 1.10). Deviations at age-10 and older were due to low sample sizes. Klondike strain lake trout show lower growth trajectories than Lean strain lake trout through age 7. Mean length and weight of Klondike strain lake trout was significantly less than FL strain fish by age 3 (two sample t-test; P<.01).

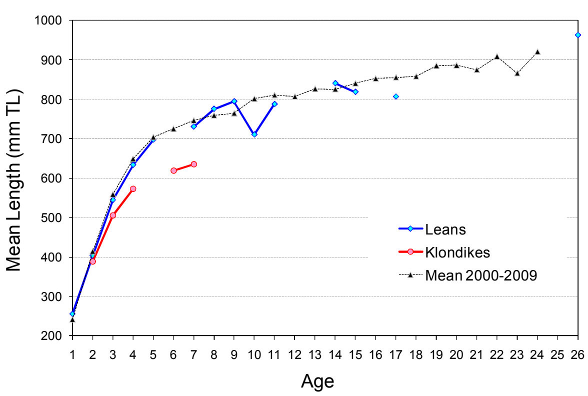


FIGURE 1.9. Mean length-at-age of Lean strain and Klondike strain lake trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2010. The previous 10-year average (2000-2009) from New York is shown for current growth rate comparison.

Mean coefficients of condition (Everhart and Youngs 1981) were calculated for age-5 lake trout by sex to determine time-series changes in body condition. Overall condition coefficients for age-5 lake trout remain well above 1.0, indicating that Lake Erie lake trout are, on average, heavy for their length (Figure 1.11). Condition coefficients for age-5 male and female 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. Condition of male and female age-5 fish was lower for Klondike than for Lean strain lake trout in 2008; condition of Klondike's in both sexes decreased in 2009. Condition coefficients decreased slightly for both Lean strain males and females in 2010 compared to 2008.

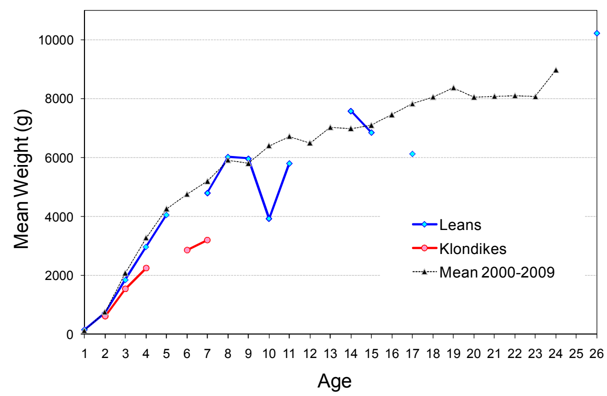


FIGURE 1.10. Mean weight-at-age of Lean strain and Klondike strain lake trout sampled in assessment gill nets in the eastern basin of Lake Erie, August 2010. The previous 10-year average (2000-2009) from New York is shown for current growth rate comparison.

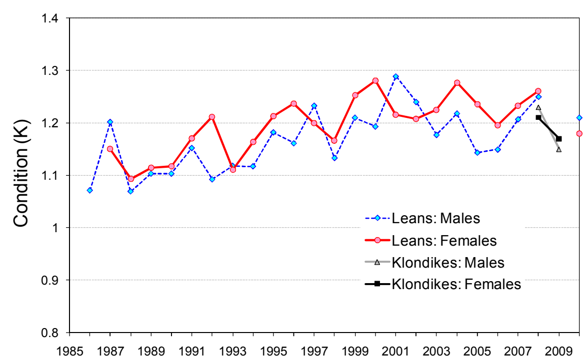


FIGURE 1.11. Mean coefficients of condition for age 5 Lean strain and Klondike strain lake trout, by sex, collected in NYSDEC assessment gill nets in Lake Erie, August 1985-2010.

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 1.1). Maturity rates of Klondike and Lean strain lake trout were similar for both males and females (Tables 1.1 and 1.2).

Harvest

Angler harvest of lake trout in Lake Erie remains very low. Approximately 261 lake trout were harvested in New York waters and none in Pennsylvania waters in 2010 (Figure 1.12).

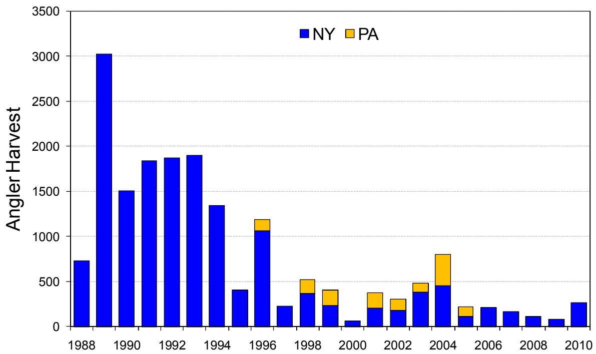


FIGURE 1.12. Estimated lake trout harvest by recreational anglers in the New York and Pennsylvania waters of Lake Erie, 1988-2010.

Natural Reproduction

Despite more than 30 years of lake trout stocking in Lake Erie, no naturally reproduced lake trout have been documented. Six potentially wild fish (no fin clips; no CWT's) were caught in eastern basin coldwater gill net surveys in 2010, making a total of 49 potentially wild lake trout recorded over the past ten years. Otoliths are collected from lake trout found without CWTs or fin-clips and will be used in future stock discrimination studies.

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). Several funding proposals (Canada-Ontario Agreement; USFWS Restoration Funds) were accepted in 2007 and 2008 to further examine the sites identified in the GIS-phase of this exercise using side-scan sonar and underwater video imaging. Preliminary analyses of acoustic and video data indicate that potential spawning habitat may exist on Brocton Shoal, Presque Isle Bay, Nanticoke Shoal, Hoover Point, and Tecumseh Reef. However, habitat quality has deteriorated, especially at Brocton Shoal, mainly due to dreissenid colonization and extensive sedimentation. Bottom habitats near Presque Isle Bay and Nanticoke Shoal have fewer dreissenids, and appear to hold more favorable spawning substrate.

For the third consecutive year, a gill net survey was conducted by the NYSDEC during November to determine if lake trout in spawning condition were present in former spawning areas near Dunkirk, NY. A total of eight gill nets (2400 gill net feet) were set overnight in five locations targeting spawning lake trout on 9-10 November 2010. Two sets were made on Brocton Shoal (offshore, deep), two at Lake Erie State Park (nearshore, shallow), one at Van Buren Reef (nearshore, shallow), one at Battery Point (nearshore, shallow), and two off the Dunkirk breakwalls (nearshore, shallow) (Figure 1.13). Bottom water temperature during all sampling was 50F. A total of 35 lake trout were caught. Nearly half of these fish (16) were captured off Battery Point over a flat bedrock outcropping, eight were taken in the two nets off the Dunkirk breakwalls, and only two lake trout were caught in the two sets on Brocton Shoal. Males comprised the majority of the catch (30 fish), and one of the females caught at Battery Point was ripe. All the lake trout were Finger Lakes (FL) strain or FL strain hybrid fish, and ages ranged from 3-24 years old, with the majority of the lake trout (19) age 4 (Figure 1.14). Twenty-five of the lake trout caught were stocked offshore of Dunkirk and the rest were stocked offshore at Barcelona (2) or shore-stocked in Pennsylvania (2).

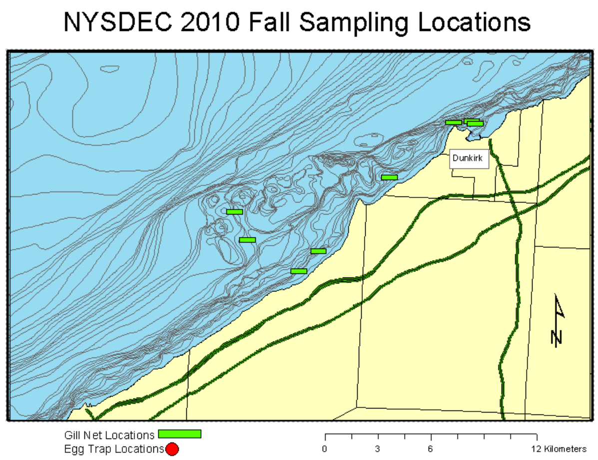


FIGURE 1.13. Gill net survey locations sampled for spawning lake trout in the New York waters of Lake Erie, November 2010.

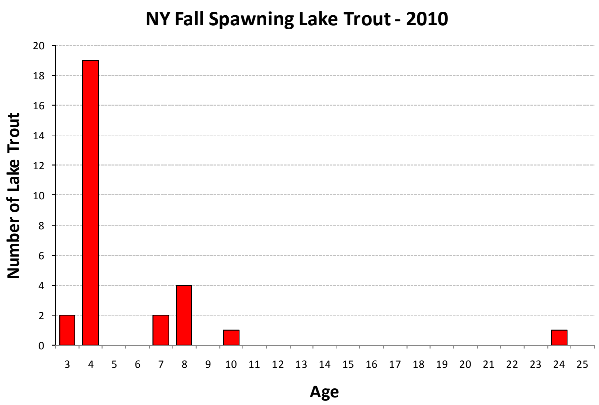


FIGURE 1.14. Age distribution of lake trout sampled in the New York waters of Lake Erie, November 2010.

Two nets (200 gill net feet) were also set in Presque Isle, PA on 10 November 2010 in cooperation with the Pennsylvania Department of Environmental Protection (Figure 1.15). One net was set on an underwater sewer line covered with riprap, and the other on a nearby rocky shoal. Both sites were considered nearshore and shallow. A total of 31 lake trout were caught at these two sites (19 males, 12 females); eight at the shoal and 23 on the sewer rip-rap. Most of the females were caught at the sewer rip-rap site; one female was ripe and one was spent, indicating active spawning activity. Similar to New York, all the lake trout were FL or FL-hybrid strain with the exception of one age-6 Klondike strain fish.

Presque Isle, PA 2010 Fall Sampling Locations

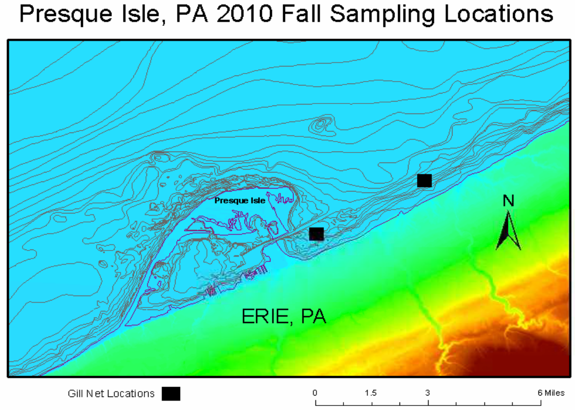


FIGURE 1.15. Gill net survey locations sampled for spawning lake trout in the Pennsylvania waters of Lake Erie, November 2010.

Ages of the fish ranged from 4 to 25, and abundance by age was more evenly distributed compared to the New York samples (Figure 1.16). Stocking locations of these fish varied; 15 were shore-stocked in PA, three were boat-stocked offshore in PA, and 14 were boat-stocked offshore in New York. Egg traps were also set on these two locations, but poor weather conditions and early ice cover prohibited retrieval of the traps.

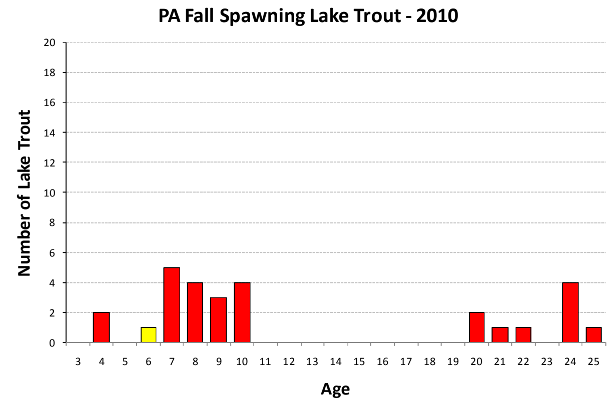


FIGURE 1.16. Age distribution of lake trout sampled in Lake Erie at Presque Isle Bay, Pennsylvania, November 2010. The yellow bar represents a Klondike strain lake trout.

Lake Trout Population Model

The CWTG has assisted the Forage Task Group (FTG) in the past by providing a lake trout population model (beginning in late 1980's) to estimate the lake trout population in Lake Erie. The model is a spreadsheet-type accounting table, , 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 discriminate strain-specific mortality, sea lamprey mortality, and stocking. The individual strains are then combined in 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 with mortality estimates that are similar to those measured from survey data. While the absolute numbers generated from model simulations may not be realistic, the model does provide a good tool for examining population dynamics under various management scenarios (eg. stocking levels and strain types) and biological factors (eg. sea lamprey mortality).

The 2010 lake trout model estimated the Lake Erie population at 288,594 fish and the age-5 and older population at 38,554 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 proposed stocking rates show that the adult lake trout population would be suppressed by one-third over the next decade with moderate sea 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.

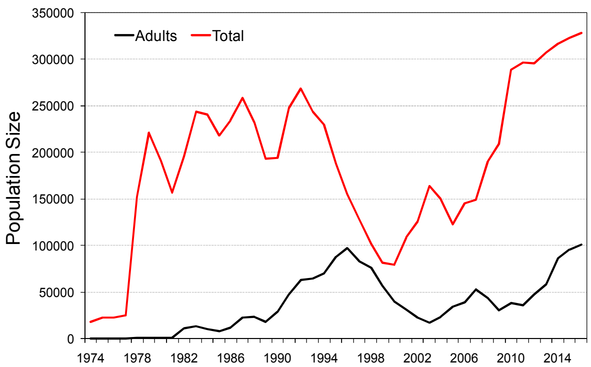


FIGURE 1.17. Projections of the Lake Erie total and adult (ages 5+) lake trout population using the CWTG lake trout model. Projections for 2011-2016 were made using low rates of sea lamprey mortality with proposed stocking rates. The model estimates the lakewide lake trout population in 2010 at 288,594 and the adult population at 38,554.

Diet

Seasonal diet information for lake trout is not available based on current sampling protocols. Diet information was limited to fish caught during August 2010 in the coldwater gill net assessment surveys in the eastern basin of Lake Erie. Analysis of the stomach contents of lake trout revealed diets comprised mainly of rainbow smelt and round gobies (Table 1.6). Rainbow smelt were the most prevalent diet item (61%) in Lean strain lake trout with round gobies also commonly encountered (41%). Conversely, round gobies were more common in Klondike strain fish (57%) followed by rainbow smelt (49%). Overall species diversity in lake trout diets was high in 2010 with yellow perch, gizzard shad, emerald shiners, alewife, and trout perch also identified in the stomach samples.

TABLE 1.6. 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 2010.

PREY SPECIES	Lean Lake Trout (N = 112)	Klondike Lake Trout (N = 63)
Smelt	68 (61%)	31 (49%)
Yellow Perch	2 (2%)	1 (2%)
Round Goby	46 (41%)	36 (57%)
Gizzard Shad	3 (3%)	4 (6%)
Emerald Shiner	1 (1%)	
Alewife		1 (2%)
Trout Perch		2 (3%)
Unknown Fish	6 (5%)	5 (8%)
Number of Empty Stomachs	87	28

The occurrence of round gobies increased in both Lean strain and Klondike strain lake trout diets in 2010 (Figure 1.18). Diets of lake trout appear to be closely related to the abundance of these two species in Lake Erie (see Forage Task Group 2011). 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 gobies in their diets compared to lean strain lake trout, possibly indicating that they are a more bottom oriented strain.

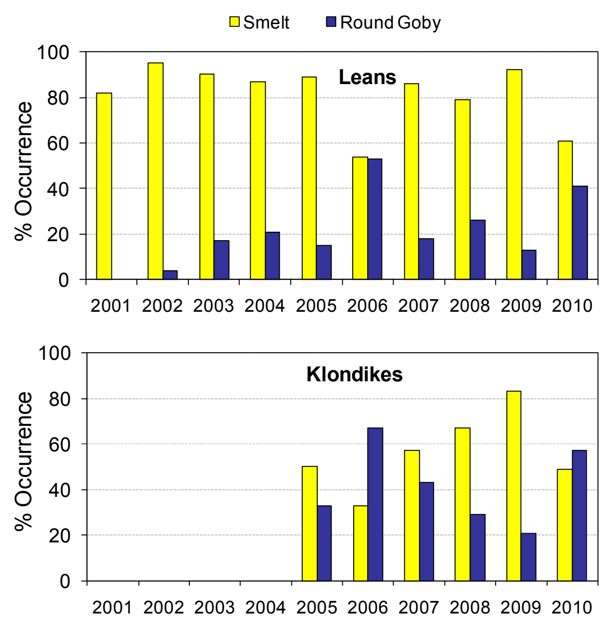


FIGURE 1.18. Percent occurrence of smelt and round goby in the diet of Lean strain (top) and Klondike strain (bottom) lake trout sampled in assessment gill nets in the eastern basin of Lake Erie, 2001-2010.

References

Culligan, W. J., F. C. Cornelius, D. W. Einhouse, D. L. Zeller, R. C. Zimar, B. J. Beckwith, and M. A. Wilkinson. 1996. 1995 Annual Report to the Lake Erie Committee. New York State Department of Environmental Conservation, Albany, New York, USA.

Everhart, W.H., and W.D. Youngs. 1981. Principles of Fishery Science, Second Edition. Cornell University Press, Ithaca, NY.

Forage Task Group. 2011. Report of the Lake Erie Forage Task Group, March 2011. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Habitat Task Group. 2006. Report of the Lake Erie Habitat Task Group, March 2006. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Habitat Task Group. 2011. Report of the Lake Erie Habitat Task Group, March 2011. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission. Ann Arbor, Michigan, USA.

Lake Trout Task Group. 1985. A Strategic Plan for the Rehabilitation of Lake Trout in Eastern Lake Erie. Report to the Great Lakes Fishery Commission's Lake Erie Committee, Ann Arbor, Michigan, USA.

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

Charge 2: Continue to assess the whitefish population age structure, growth, diet, seasonal distribution and other population parameters.

Andy Cook, OMNR and Kevin Kayle, ODW

Commercial Harvest

The total harvest of Lake Erie lake whitefish in 2010 was 683,567 pounds (Figure 2.1). Ontario accounted for 88% of the total, harvesting 600,072 pounds, followed by Ohio (12%; 83,303 lbs), with negligible harvest in Michigan (<1%; 26 lbs) and Pennsylvania (<1%; 166 lbs). Total harvest in 2010 was 38% lower than the total harvest in 2009. Whitefish harvest in 2010 declined 71% in Ohio waters and 26% in Ontario from 2009.

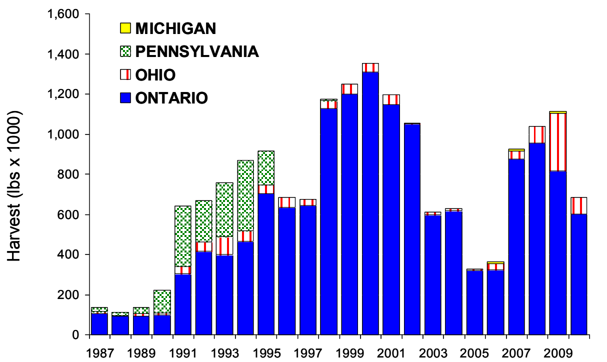


FIGURE 2.1. Total Lake Erie commercial whitefish harvest from 1987-2010 by jurisdiction. Pennsylvania ceased gill netting in 1996 and Michigan resumed commercial fishing in 2006, 2007.

The majority (99%) of Ontario's 2010 lake whitefish harvest was taken in gill nets. The remainder was caught in smelt trawls (<1%). The majority (74%) of Ontario's whitefish harvest was divided equally between the west basin (OE 1) and the western part of the central basin (OE 2). Harvest in OE 1 occurred primarily during the fall, whereas OE 2 peaked from March through April. Whitefish harvest in the far eastern portion of Lake Erie (OE 5) accounted for 22% of Ontario's harvest, landed mostly from Aug-Sep. The remaining 4% were caught in OE 3 and OE 4 during early spring and September, respectively. In Ontario, 84% of whitefish were harvested from gill nets targeting whitefish, followed by white bass (10%) and walleye (4%) with minimal harvest by white perch, smelt (trawl) and yellow perch fisheries.

Ohio's whitefish trap net effort occurred primarily in the western basin in November (28%) and in the central basin in May (32%); however, the peak harvest occurred during November in the west (95%).

Ontario annual commercial catch rates targeting whitefish dropped in quota areas 1 and 3 but increased in quota area 2 (Figure 2.2). The mean catch rate of the three quota areas decreased 12%. In the west basin (OE 1), targeted gill net effort and harvest in 2010 was greatest in November (Figure 2.4). OE 1 catch rates in 2010 were below 2009 levels during October and November, but were higher in December. Ohio and to a lesser degree, Pennsylvania commercial trap net catch rates dropped sharply from 2009 (Figure 2.3).

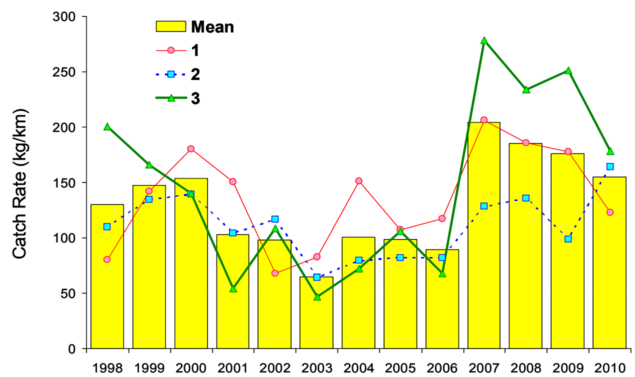


FIGURE 2.2. Ontario annual commercial large mesh gill net catch rates targeting lake whitefish by quota zone, 1998 - 2010. Bars represent averages of catch rates across quota zones. Quota zone 1 refers to the west basin, zone 2 extends eastward to the middle of the central basin. The eastern portion remaining is quota zone 3.

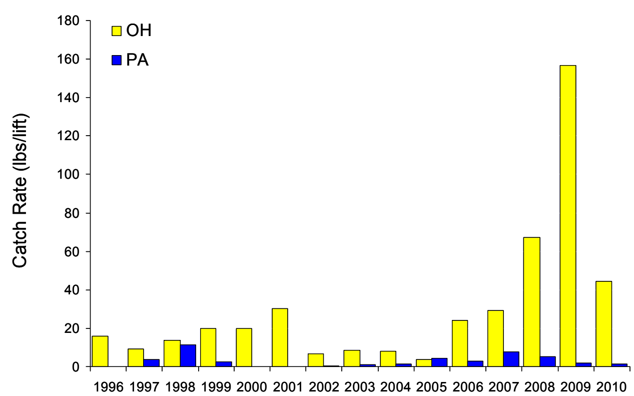


FIGURE 2.3. Ohio and Pennsylvania lake whitefish commercial trap net catch rates (pounds per lift), 1996-2010.

The landed weight of roe from Ontario's 2010 whitefish fishery was 13,491 pounds, most of which came from OE1 (95%) during November and to a lesser extent during October. The remaining fraction of roe (4%) was collected from OE 5 during September and October with minimal contribution (<1%) from OE 2 and OE 3. The approximate landed value of the roe was CDN $42,606.

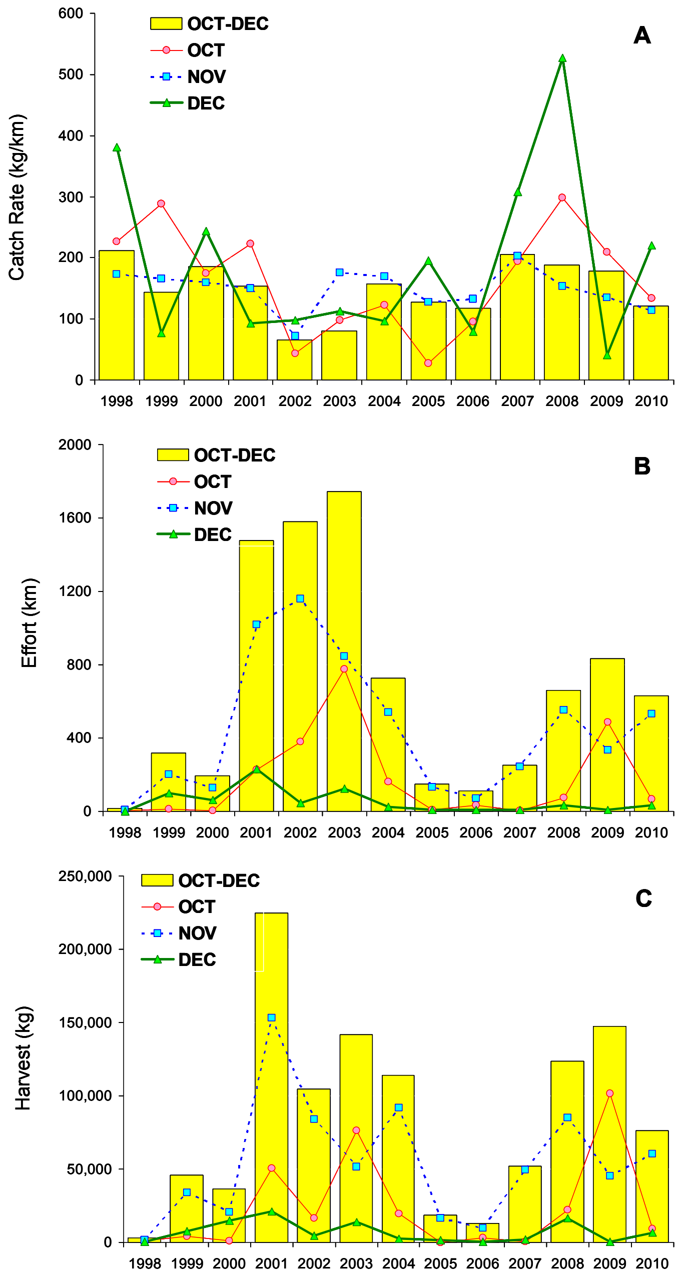


FIGURE 2.4. Targeted large mesh gill net catch rate (A), gill net effort (B) and harvest (C) for lake whitefish in the west basin for October, November, December and pooled (Oct-Dec) 1998 - 2010.

Ontario's west basin fall lake whitefish fishery was dominated by age-7 fish (Figure 2.5). The strong 2003 cohort dominated catches in targeted and non-targeted (white bass) fisheries (Figure 2.6). Age 5 was the next most abundant year class (2005) and the oldest whitefish in Ontario's harvest was 18. (Figure 2.5 and 2.6). There was no characterization of the lake whitefish commercial fishery by age in Ohio or Pennsylvania waters in 2010.

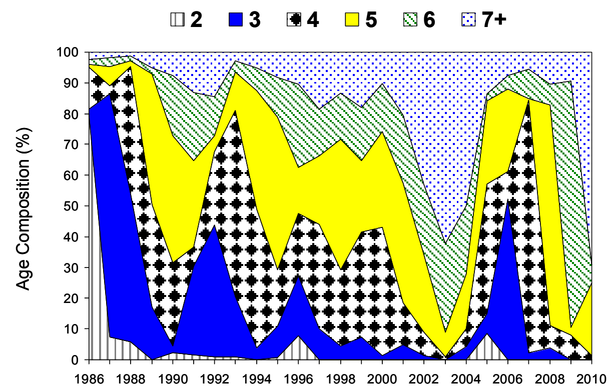


FIGURE 2.5. Ontario fall commercial whitefish harvest age composition in statistical district 1, 1986-2010. From effort with gill nets >=3 inches with whitefish in catch from October to December.

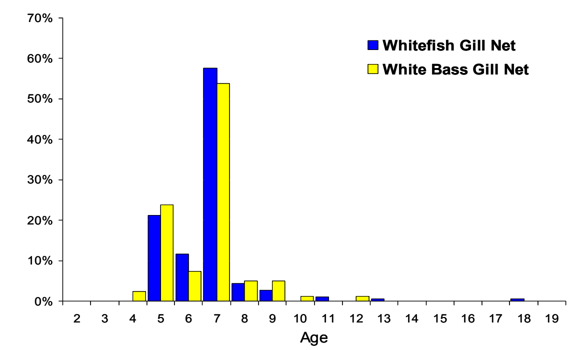


FIGURE 2.6. Age composition of lake whitefish caught commercially in Ontario waters of Lake Erie in 2010 by target species fisheries. Otoliths and scales were used to age whitefish samples.

Assessment Surveys

Lake whitefish abundance indices in the 2010 gill net assessments varied among jurisdictions and basins (Figures 2.7 and 2.8). Lake whitefish catch rates dropped in Ontario waters of the central basin and in Pennsylvania Ridge surveys, but increased in the east basin (Figure 2.7).

The lake whitefish catch rate (3.1 fish per lift) in the 2010 New York coldwater assessment surveys declined from 2009 surveys (4.9 fish per lift), and was comparable to the 1985-2010 time series average (2.8 fish per lift; Figure 2.8).Length-frequency distributions of lake whitefish captured in Ontario partnership index gill netting showed the advance in size of the 2003 cohort (Figure 2.9). The majority of lake whitefish sampled in the Ontario surveys were from the 2003 cohort, followed by the 2005, 2002 and 2001 year classes (Figure 2.10).

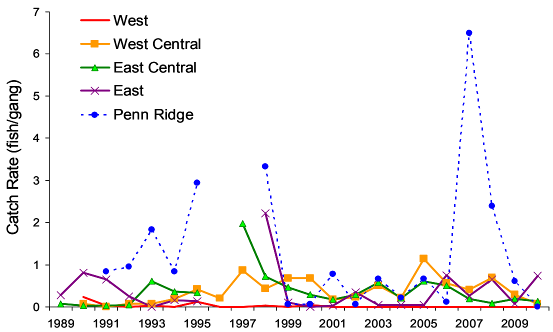


FIGURE 2.7. Catch rate (number per gang) of lake whitefish from Ontario partnership index gill netting by basin, Lake Erie, 1989 - 2010.

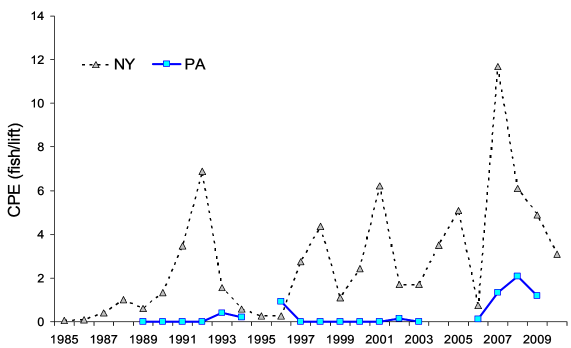


FIGURE 2.8. Catch per effort (number fish/lift) of lake whitefish caught in standard assessment gill nets from New York waters of Lake Erie, August 1985 - 2009 (triangles) and in Pennsylvania August assessment gill nets (squares) 1989 - 2009. No index sampling took place in Pennsylvania waters 1995, 2004, 2005 and 2010.

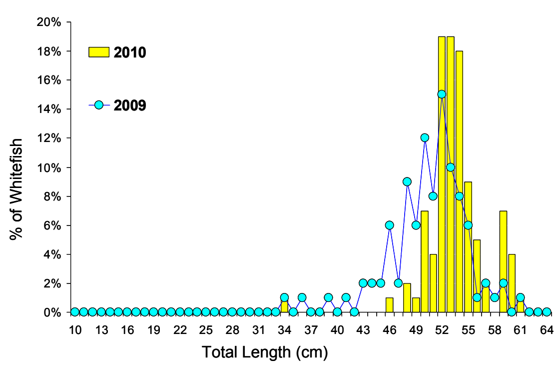


FIGURE 2.9. Length frequency distributions of lake whitefish collected during lake-wide partnership index fishing, 2008 and 2010. Standardized to equal effort among mesh sizes.

Ohio trawl surveys in the central basin of Lake Erie assess juvenile lake whitefish and describe the presence or general magnitude of year classes. Since the strong 2003 year class, Ohio central basin District 2 and District 3) bottom trawl surveys conducted in August and October caught young-of-the-year (YOY) from the 2004, 2005 and 2007 year classes. In addition, yearlings from the 2004 and 2005 year classes have been caught in Ohio bottom trawls. While District 2 surveys suggest these three cohorts are moderate at best, District 3 indices appeared higher for the 2005 and 2004 year classes. The 2008, 2009, and 2010 year classes were not present in the surveys. In trawl and gill net assessment surveys in Ohio waters of Lake Erie during 2010, a total of 23 adult lake whitefish were sampled. The 2003 year class (age 7) was most numerous (43%), followed by whitefish from 2005 (age 5; 26%); older whitefish ages 8 to 17 represented 30% of the age composition. The length-at-age and size compositions are presented in Figure 2.11.

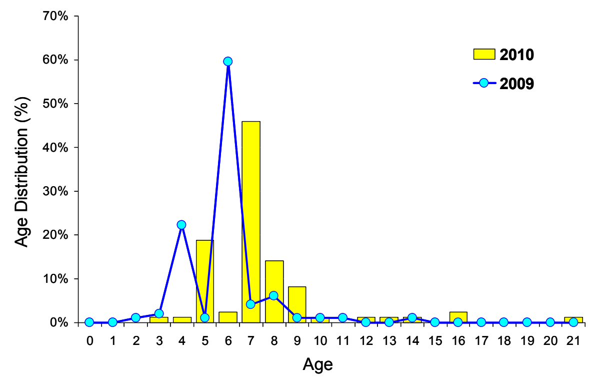


FIGURE 2.10. Age frequency distributions of lake whitefish collected during lake-wide partnership index fishing, 2009 and 2010. Standardized to equal effort among mesh sizes.

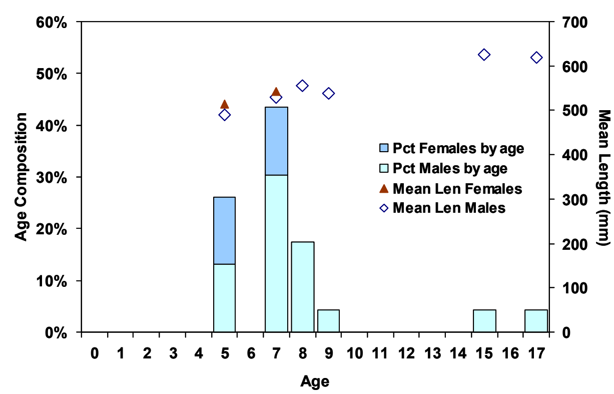


FIGURE 2.11. Age distribution and mean length-at-age of lake whitefish collected during trawl and gill net assessment surveys in Ohio waters of Lake Erie during 2010 (N=23).

Growth and Diet

Lake whitefish sampled in Ohio assessment trawl and gillnet surveys in 2010 indicated that condition of age 4 and older males (mean K= 1.057) and females (mean K= 1.146) were above Van

Oosten and Hile's (1947) historic condition reference values (Figure 2.12).

In 2010, female lake whitefish condition (mean = 1.160) assessed using Ontario fall commercial fishery and gillnet survey data was above the historic average (1.131) while male condition (1.007) approached the historic average (1.015) following a gradual increase in recent years (Van Oosten and Hile 1947; Figure 2.13). For condition analyses, Ontario whitefish included age 4 and older lake whitefish that were not spent or running, collected from October to December.

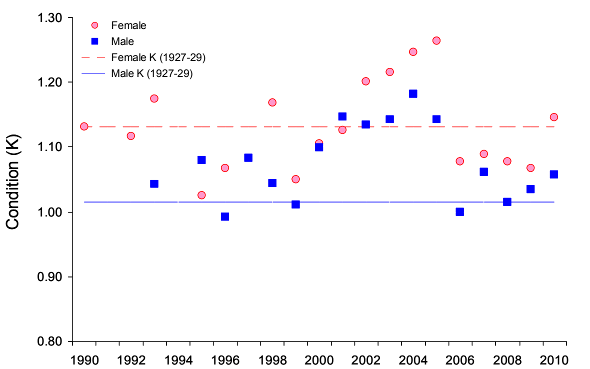


FIGURE 2.12. Mean condition (K) factor values of ages 4 and older lake whitefish sampled during Ohio assessment surveys in the central basin of Lake Erie, May-October 1990-2010. Historic mean condition (1927) presented as dashed lines from Van Oosten and Hile (1947).

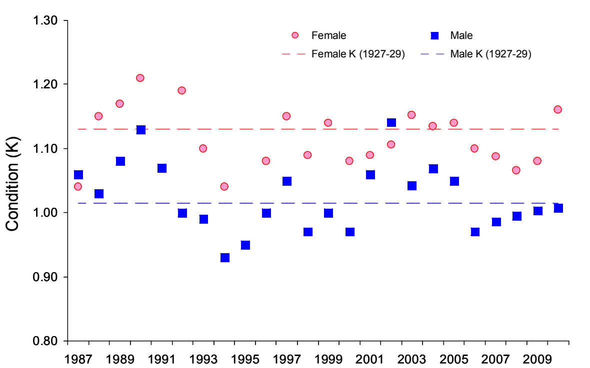


FIGURE 2.13. Mean condition (K) factor values of age 4 and older lake whitefish obtained from Ontario commercial and partnership survey data (Oct-Dec) by sex from 1987-2010. Historic mean condition (1927-29) presented as dashed lines calculated from Van Oosten and Hile (1947).

Lake whitefish collected from Ohio surveys in 2010 (N=18) exhibited overlap in diet composition between samples examined from Ohio central basin Districts 2 and 3 (Figure 2.14). Approximately one-half of the diet samples taken from lake whitefish in 2010 were empty (N=9). Whitefish diet expressed as percentage total dry weight of all prey taxa was more diverse in District 2, consisting of fingernail clams (sphaeriids), worms (annelids), snails (gastropods), dreissenid mussels, isopods, and chironomids (Figure 2.14). In District 3, lake whitefish consumed isopods, gastropods, sphaeriids and dreissenid mussels.

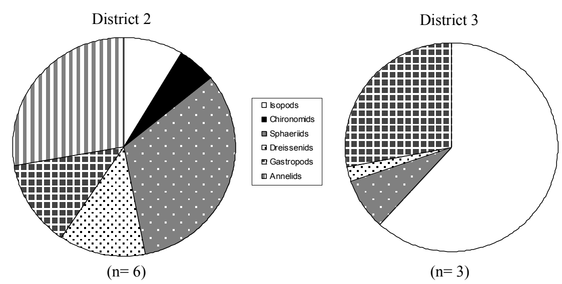


FIGURE 2.14. Diet composition (% dry weight) of lake whitefish from Ohio central basin assessment sites in 2010.

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 population, age structure, growth, diet, seasonal distribution and other population parameters

Larry Witzel (OMNR), Richard Kraus (USGS), Elizabeth Trometer (USFWS), and Martin Stapanian (USGS)

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 (2268 kg) (Table 3.1). Harvest began to increase in 1990, coinciding with an increase in abundance and harvest of lake whitefish. Most 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.

Table 3.1 Total burbot commercial harvest (thousands of pounds) in Lake Erie by jurisdiction, 1980-2010.

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

Harvest decreased in Pennsylvania waters after 1995 with a shift from a gill net to 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. The Ontario harvest is now a by-catch from various fisheries. Most of the burbot caught by the commercial fishing industry in 2010 was by-catch in gillnets from the lake whitefish fishery (83%) followed by the walleye fishery (8%). The total commercial harvest for Lake Erie in 2010 was 3,186 pounds (1445 kg); a 33% decrease from 2009.

Assessment Programs

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 (Figures 3.1 and 3.2).

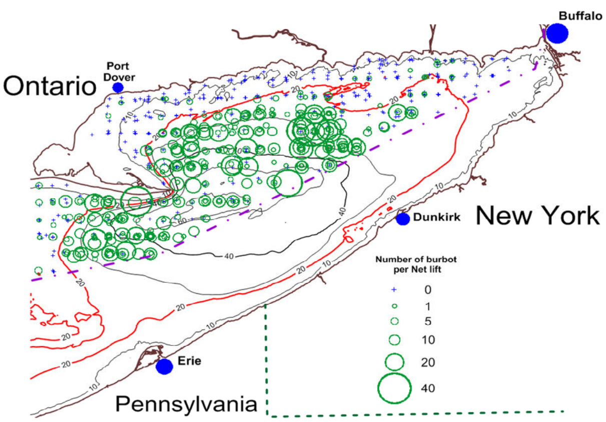


FIGURE 3.1 Distribution of burbot catches (No. per lift) in Ontario Partnership gill nets during August surveys of eastern Lake Erie, 1989 - 2010.

The Ontario Partnership Index Fishing Program is an annual lakewide gillnet survey of the Canadian waters of Lake Erie and has provided an additional and spatially robust assessment of fish species abundance and distribution since 1989. During the early 1990s, burbot abundance was low throughout the lake; catch rates in partnership index gill nets averaged less than 0.5 burbot/lift (Figure 3.2). Burbot abundance increased rapidly after 1993 in the Pennsylvania Ridge area and in the eastern basin, reaching a peak of about 4 burbot/lift in 1998.

Burbot numbers in the central basin also peaked in 1998, but at a much lower catch rate of 0.5 burbot/lift. Catch rates in the Pennsylvania Ridge area during 1998 to 2004 remained high, but variable, ranging between 2.0 and 4.2 burbot/lift and then decreased to about 0.5 burbot/lift in 2005-2006. Catch rates in the eastern basin since 1998 have been variable but exhibit an overall decreasing trend. In 2010, only two burbot were captured in the central basin and abundance continued to decrease in the east basin and Pennsylvania Ridge, representing declines of 96% and 89% respectively from 1989 peak abundance (Figure 3.2).

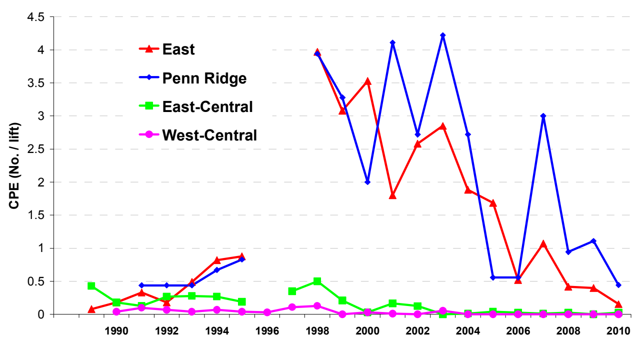


FIGURE 3.2 Burbot CPE (number of fish/lift) by basin from the Ontario Partnership surveys 1989–2010 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets).

An examination of only the bottom sets in the Ontario Partnership assessment data for combined sample locations in the east basin and Pennsylvania Ridge show that the numeric abundance of burbot (in fish/lift) increased approximately eight-fold from 1993 to 1998, whereas the biomass CPE did not peak until 2003, some five years after maximum numeric abundance was observed (Figure 3.3). Burbot number and biomass have steadily decreased after reaching their respective peaks. Burbot abundance decreased in 2010 to only one-twentieth of 1998 peak numbers and one-twelfth of 2003 peak biomass (Figure 3.3).

Numeric abundance of burbot as determined from coldwater assessment gillnetting increased sharply after 1993, peaking in 2000 in all eastern basin jurisdictions except New York, where peak abundance was not observed until 2004 (Figure 3.4). The highest catch rates of burbot have occurred in Ontario waters during most years since 1996. Burbot numeric abundance has decreased across all eastern basin jurisdictions in recent years. In 2010, burbot catch rates were similarly low in New York (0.95 burbot/lift) and in Ontario (0.8 burbot/lift). Pennsylvania waters were not surveyed in 2010.

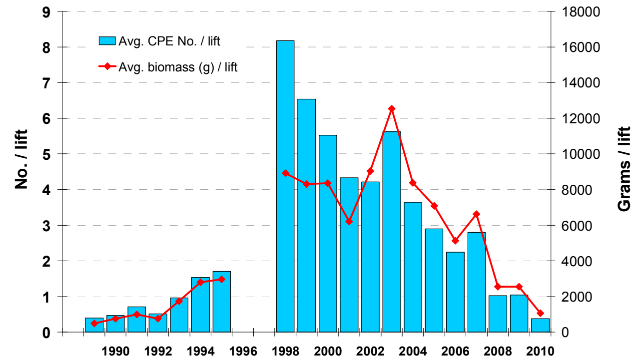


FIGURE 3.3. Average catch rate (CPE as number of fish/lift) and biomass (grams/lift) of burbot in Ontario waters of eastern Lake Erie, Ontario Partnership gillnet survey 1989–2010 (includes only bottom sets, all mesh sizes; PA-ridge and east basin sample sites).

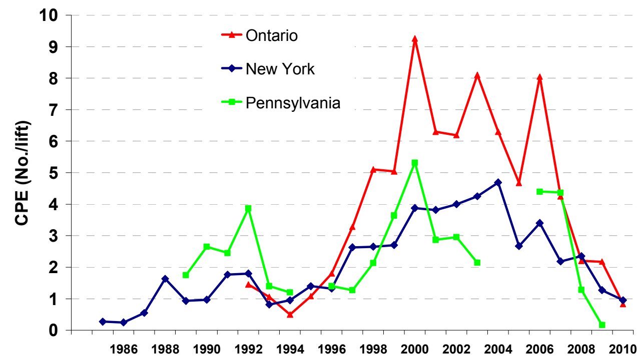


FIGURE 3.4 Average burbot catch rate (number of fish/lift) from summer coldwater gill net assessment by jurisdiction, 1985-2010. Pennsylvania waters were not surveyed in 2010.

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 average burbot biomass observed in 2010 represents a 4.5- to 8.9-fold decrease from peak levels recorded within the respective data series for New York and Ontario (Figure 3.5). In Pennsylvania, the 2009 burbot biomass estimate was the lowest in their time series; no assessment occurred in 2010.

Burbot ages (from examinations of otoliths) have been estimated for fish caught in coldwater assessment gill nets in Ontario waters since 1997. Mean age of burbot has increased steadily since 1998 and preliminary results suggest that this trend continued in 2010 (Figure 3.6). Recruitment of age-4 burbot increased almost 2-fold from 1997 to 2000, but was followed by an abrupt decrease in 2002 and remained poor through 2008 (Figure 3.6). A recently published analysis (Stapanian et al 2010) suggests that recruitment during 1997-2007 was associated with abundance of yearling and older yellow perch when the burbot were age 0, and winter water temperatures during the spawning and egg development phases of burbot. Preliminary results suggest that burbot recruitment was also low in 2010.

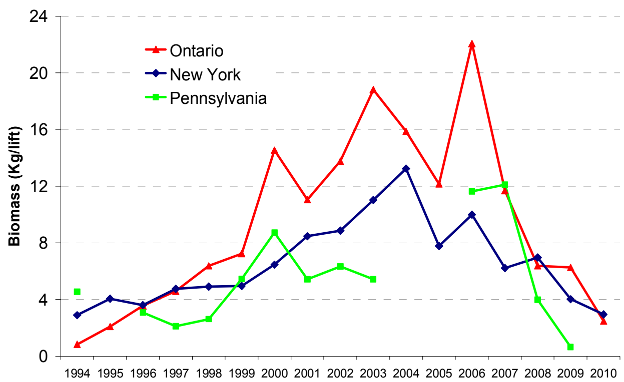


FIGURE 3.5 Average burbot biomass (kg/lift) from summer coldwater gill net assessment by jurisdiction, 1994-2010. Pennsylvania waters were not surveyed in 2010.

Burbot have the highest reproductive success at water temperatures between 0 and 2C, and are susceptible during early life to predation by yellow perch. Further, burbot between 4 and 7 years old were found to be larger in the years following 2002 (when a diet shift to round gobies occurred) than before, suggesting a release from intraspecific competition indicative of recruitment failure (Stapanian et al. in review). Declining catch rates of burbot in assessment surveys, combined with increasing mean age of adults and persistent low recruitment signal an impending population collapse. For accurate assessment of this ageing population, the use of otolith thin-sections is recommended as the best approach for accurate age determination (Edwards et al. in review). 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.

Growth

Mean total length of burbot increased across surveyed areas in 2010, continuing a trend that has predominated since the late 1990s (Figure 3.7). Average weight of burbot has followed a similar trend, increasing steadily since 1998, reaching a time-series maxima in 2009 or 2010 respectively in New York and Ontario (Figure 3.8). These results reflect the increasing mean age of the burbot population.

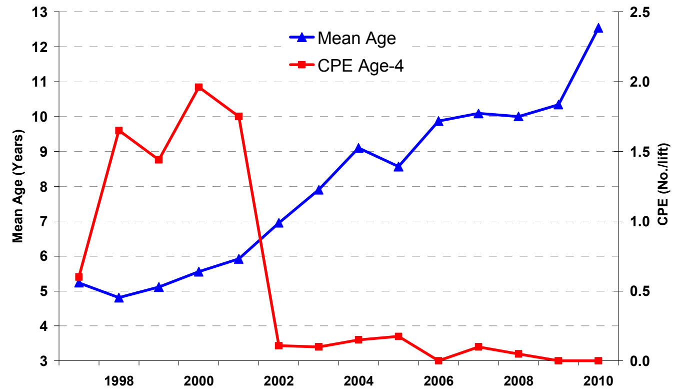


FIGURE 3.6. Mean age and average CPE of AGE-4 burbot caught in summer gill net assessment in Ontario waters of eastern Lake Erie during 1997-2010.

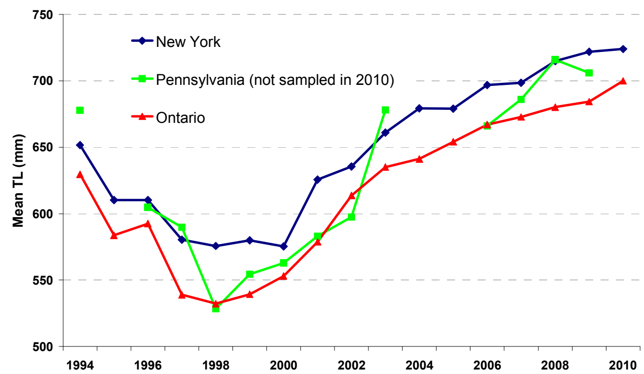


FIGURE 3.7 Average total length (TL) of burbot caught in summer gill net assessments by jurisdiction during 1994-2010. Pennsylvania waters were not surveyed in 2010.

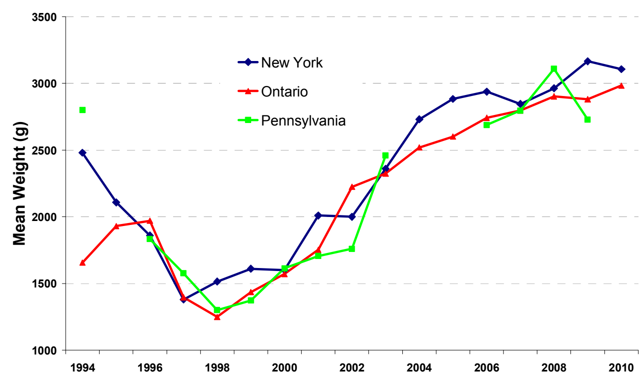


FIGURE 3.8 Average weight of burbot caught in summer gill net assessments by jurisdiction during 1994-2010. Pennsylvania waters were not surveyed in 2010.

Diet

Seasonal diet information for burbot is not available based on current sampling protocols. Diet information was limited to fish caught during August 2010 coldwater gill net assessment surveys in the eastern basin of Lake Erie. Analysis of stomach contents revealed a diet made up mostly of fish (Figure 3.9). Burbot diets continued to be diverse with five different fish and one invertebrate species found in stomach samples. Round goby were the dominant prey item, occurring in 65% of the burbot stomachs, followed by rainbow smelt (37% occurrence). Other identifiable taxa were found in 6% or less of the stomachs and included yellow perch, gizzard shad, emerald shiners, and dreissenids.

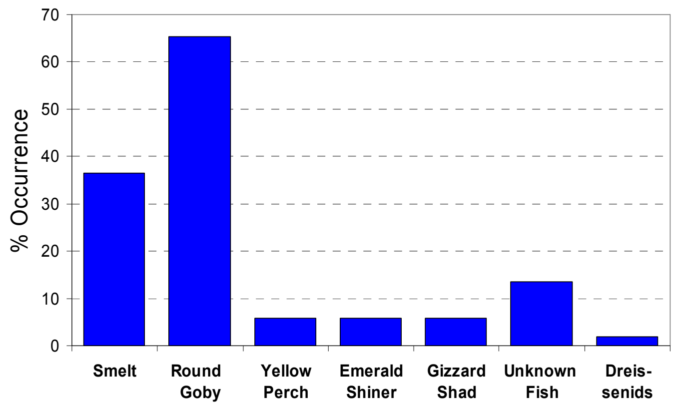


FIGURE 3.9. Frequency of occurrence of diet items from non-empty stomach of burbot sampled in gill nets from the eastern basin of Lake Erie, August 2010. "Unknown Fish" refers to fish remains that could not be identified to species. Sample size is 52 stomachs.

Gobies have increased in the diet of burbot since they first appeared in the eastern basin in 1999 (Figure 3.10). They were the main diet item for burbot in six of the last eight years. Smelt were the dominant prey in 2005 and again in 2009.

Preliminary analyses indicate that burbot exhibit 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.

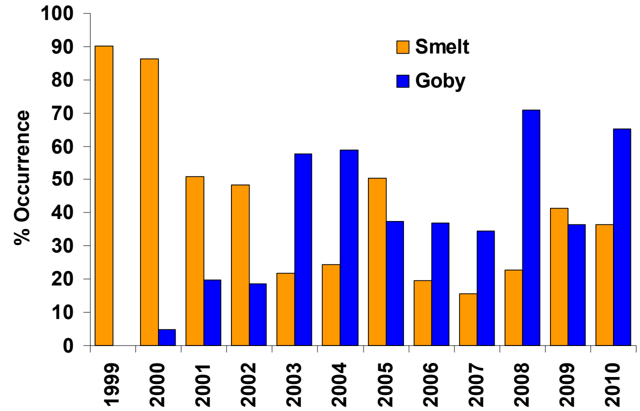


FIGURE 3.10. Frequency of occurrence of rainbow smelt and round goby in the diet of burbot caught in the eastern basin of Lake Erie, 1999-2010.

References

Coldwater Task Group (CWTG). 1997. Report of the Coldwater Task Group to the Standing Technical Committee of the Lake Erie Committee, March 24, 1997.

Madenjian, C.P., M.A. Stapanian, L.D. Witzel, D.W. Einhouse, S.A. Pothoven, and H.L. Whitford. 2011. Predatory effects of a recovered native piscivore on an invasive fish: a bioenergetics model approach. Biological Invasions (in press).

Stapanian, M.A., L.D. Witzel, and A. Cook. 2010. Recruitment of burbot *Lota lota* in Lake Erie: an empirical modeling approach. Ecology of Freshwater Fish 19: 326-337.

Stapanian, M.A., W.H. Edwards, and L.D. Witzel. (in review). Recent changes in burbot growth in Lake Erie. Journal of Applied Ichthyology.

Edwards, WH, Stapanian MA, Stoneman AT (in review) Precision of Two Methods for Estimating Age from Burbot Otoliths. Journal of Applied Ichthyology.

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.

Jeff Slade (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 31 A1-A3 wounds were found on 242 lake trout greater than 532 mm (21 inches) total length in 2010, equaling a wounding rate of 12.8 wounds per 100 fish (Table 4.1; Figure 4.1). This was a 33% decline from the 2009 wounding rate of 19.3 wounds/100 fish. Despite the decline, the wounding rate is still over two times higher than the target rate of five wounds per 100 fish (Lake Trout Task Group 1985; Markham et al. 2008). Wounding rates have remained above target for 15 of the past 16 years following reduced sea lamprey control measures in the mid-1990's (Sullivan et al. 2003). Lake trout over 736 mm (29 inches) continue to be preferred targets for sea lamprey (Table 4.1). High wounding rates were also found in the 635 – 739 mm range (25 - 29 inches). Small lake trout in the 432-532 mm (17-21 inch) size category did not record any fresh wounds in 2010 for the second consecutive year.

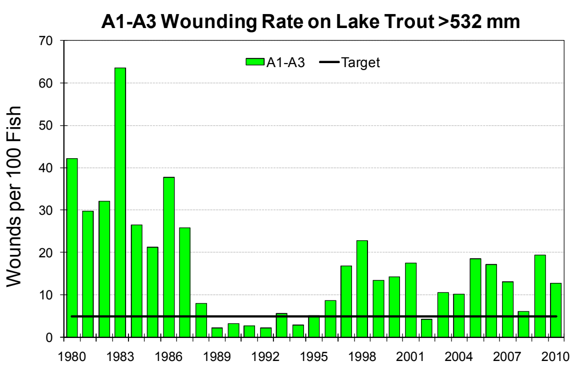


FIGURE 4.1. Number of fresh (A1-A3) sea lamprey wounds per 100 adult lake trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2010. The target rate is 5 wounds per 100 fish.

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 2010.

Size Class Total Length (mm)	Sample Size	Wound Classification A1	A2	A3	A4	No. A1-A3 Wounds per 100 Fish
432-532	69	0	0	0	7	0
533-634	131	1	4	5	37	7.6
635-736	83	3	3	7	42	15.7
>736	28	1	2	5	56	28.6
>532	242	5	9	17	135	12.8

Fresh A1 wounds are considered indicators of the attack rate for the current year at the time of sampling (August). A1 wounding in 2010 was 2.1 wounds per adult lake trout greater than 532 mm, which was equal to both the 2009 A1 wounding rate and the time series average (Table 4.1; Figure 4.2). A total of five A1 wounds were spread across all size categories > 533mm.

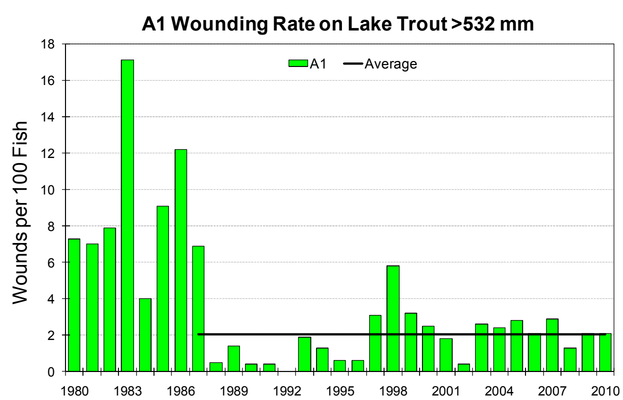


FIGURE 4.2. Number of A1 sea lamprey wounds per 100 adult lake trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1980-2010. The post-treatment average includes 1987-2009.

The past year's cumulative attacks are indicated by A4 wounds. A4 wounding rates slightly increased in 2010 to 55.8 wounds/100 fish (Figure 4.3). This was the third highest A4 wounding rate in the time series and over two times greater than the time series average of 22.8 wounds/100 fish. Unlike past surveys where the majority of A4 wounds were on fish greater than 636 mm (25 inches) in total length, A4 wounds were more evenly spread across all length categories (Table 4.1). A4 wounding rates on lake trout over 736 mm (29 inches) remain very high (200.0 wounds/100 fish) with many fish possessing multiple wounds.

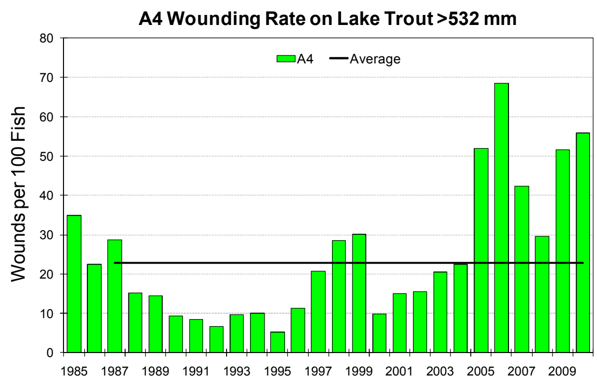


FIGURE 4.3. Number of healed (A4) sea lamprey wounds per 100 adult lake trout greater than 532 mm (21 inches) sampled in assessment gill nets in the eastern basin of Lake Erie, August-September, 1985-2010. The post-treatment average includes 1987-2009.

Finger Lakes (FL) and Klondike (KL) strain lake trout were the most prevalent strains sampled, and they accounted for the majority of the fresh (A1-A3) and A4 sea lamprey wounds (Table 4.2). Overall, fresh A1-A3 wounding rates were higher on KL strain compared to FL strain lake trout while A4 wounds were higher on FL strain fish. However, almost all of the lake trout over 736 mm, which are the preferred targets, were FL strain fish. A1-A3 wounding rates were high on Traverse Island (TI) strain lake trout despite low sample sizes, showing the susceptibility of this Lake Superior strain lake trout to sea lamprey attacks.

TABLE 4.2. Frequency of sea lamprey wounds observed on lake trout >532 mm, by strain, collected from assessment gill nets in the eastern basin of Lake Erie, August 2010.

LAKE TROUT STRAIN	SAMPLE SIZE	WOUND CLASSIFICATION				NO. A1-A3 WOUNDS PER 100 FISH	NO. A4 WOUNDS PER 100 FISH
		A1	A2	A3	A4		
FL	119	2	3	7	76	10.1	63.9
KL	61	2	1	6	35	14.8	57.4
TI	25	1	4	2	9	28.0	36.0

Burbot Wounding Rates

The burbot population, once the most prevalent coldwater predator in the eastern basin of Lake Erie, has declined 80% since 2004 (see Charge 3). Coincidentally, both A1-A3 and A4 wounding rates on burbot have increased since 2004 in New York waters of Lake Erie. Wounding rates on burbot declined in 2010; the fresh (A1-A3) wounding rate on burbot decreased to 3.4 wounds/100 fish while the A4 wounding rate declined to 5.2 wounds/100 fish (Figure 4.4). Both rates represent the fourth highest wounding rates in the ten year time series.

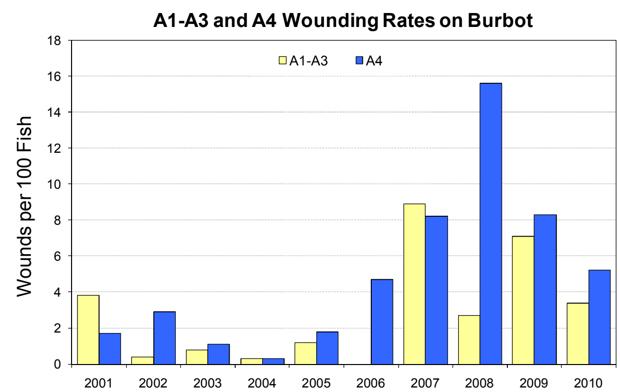


FIGURE 4.4. Number of A1-A3 and A4 sea lamprey wounds per 100 burbot (all sizes) sampled in assessment gill nets in the New York waters of Lake Erie, August, 2001-2010.

Lake Whitefish Wounding Rates

Sea lamprey wounds on lake whitefish have been consistently recorded in Lake Erie agency assessment surveys since 2001. Wounds on lake whitefish did not appear in New York assessment surveys until 2003, which coincides with the lowest level of adult lake trout abundance since the mid-1980's (see Charge 1). Fresh wounding rates increased in 2010 to 1.08 wounds/100 fish, which was the highest wounding rate in the ten year time series (Figure 4.5). A4 wounding rates decreased to 3.24 wounds/100 fish, which was the second highest value in the time series. Overall, wounding rates on lake whitefish are low compared to lake trout and burbot, which may be due to higher post-wounding mortality.

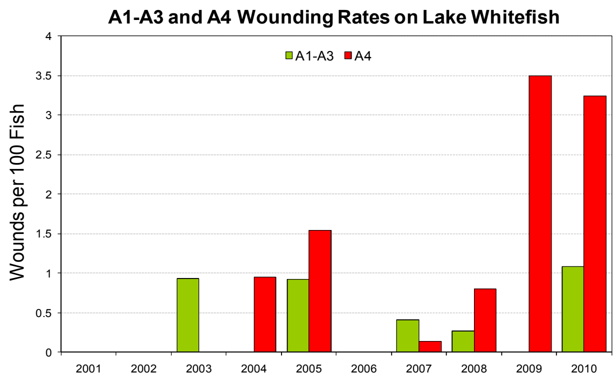


FIGURE 4.5. Number of A1-A3 and A4 sea lamprey wounds per 100 lake whitefish (all sizes) sampled in assessment gill nets in the New York waters of Lake Erie, August, 2001-2010.

Steelhead Wounding Rates

Similar to burbot and whitefish, sea lampey 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 rely on other sampling methods and surveys. Sea lamprey wounding rates on steelhead have historically relied on haphazard collections from tributary creel surveys and collections for research or contaminants (Table 4.3). Wounding rates on these surveys vary. In 2010, Pennsylvania began a more directed survey during their annual fall steelhead run to address this shortfall. A total of four A1-A3 wounds and five A4 wounds were found on 142 adult steelhead, yielding wounding rates of 2.8 A1-A3 wounds/100 fish and 3.5 A4/100 fish respectively (Table 4.3). It should be noted that an additional 17 B-type wounds were also found, which normally are not used in wounding rate calculations.

TABLE 4.3. Frequency of sea lamprey wounds observed on steelhead from various Lake Erie surveys, 2003-2010.

Survey	State	Sample Size	# wounds	Wounding Rate (%)	Comments
2003-04 Tributary Creel Survey	NY	249	31	12.5	All wounds combined
2004-05 Tributary Creel Survey	NY	89	15	16.9	All wounds combined
2007-08 Tributary Creel Survey	NY	88	12	13.6	All wounds combined
2008-09 Tributary Creel Survey	OH	418	30	7.2	13 A1-A3; 17 A4
Fall 2009 Cattaraugus Creek	NY	50	15	30.0	4 A1-A3; 11 A4
Fall 2009 Chautauqua Creek	NY	50	20	40.0	7 A1-A3; 13 A4
2009-10 Tributary Creel Survey	OH	108	11	10.2	7 A1-A3; 4 A4
Spring 2010 Cattaraugus Creek	NY	50	9	18.0	4 A1-A3; 5 A4
Fall 2010 Directed Wounding Survey	PA	142	26	18.3	4 A1-A3; 5 A4; 17 B1-B4

2010 Sea Lamprey Control Actions

South Otter Creek was treated for the second consecutive year in 2010. This completed the back-to-back treatments of all known sea lamprey producing tributaries to the main basin of Lake Erie. Intensive larval assessment surveys captured only one residual larva in Cattaraugus Creek so it was not scheduled for treatment.

Assessments for larval sea lamprey were conducted in 57 tributaries (42 U.S., 15 Canada) and offshore of 4 U.S. tributaries (Table 4.3). Recruitment of the 2010 cohort was only detected in two tributaries. Larval assessments designed to evaluate effectiveness of recent treatments indicated successful treatments in all streams, with low numbers of residuals found in only two streams, Conneaut Cr. (2) and Cattaraugus Cr. (1). Surveys to detect new populations were conducted in 34 tributaries (29 U.S, 5 Canada) and no new populations were discovered.

The estimated number of spawning-phase sea lampreys decreased from 35,635 in 2009 to 22,179 in 2010 (Figure 4.6), a decrease of 38%. A total of 3,929 spawning-phase sea lamprey were trapped in four tributaries (2 U.S., 2 Canada).

The sea lamprey barrier on Normandale Creek that was destroyed by a flood in 2008 was reconstructed in August 2010. Several repairs and improvements were made to the Big Creek barrier including, installation of a new air hoist to improve trapping, repair of a hole under the east section of wall, and raising the height of the existing wall by two feet to ensure blockage. Efforts to inventory and ground truth the information contained in the National Inventory of Dams continued. Existing barriers on twelve tributaries were inspected for their ability to block sea lamprey migrations and at least one additional barrier upstream was inspected. The U.S. Army Corps of Engineers (USACE) completed the Preliminary Restoration Plan for repair or rebuild of the Harpersfield dam on the Grand River, Ohio.

The Lake Erie chapter of the Sea Lamprey Management plan was reviewed by the CWTG. The chapter includes recommended actions to get to targets within the next five years.

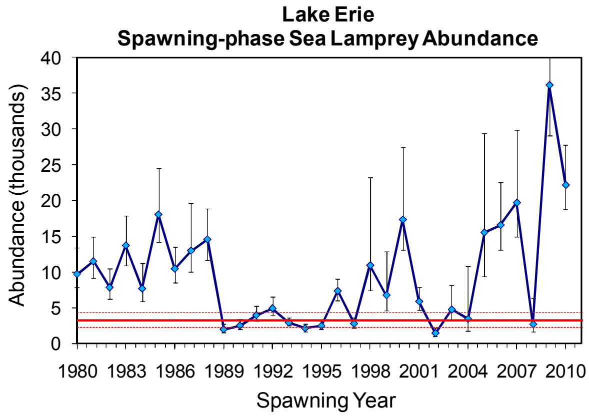


FIGURE 4.6. Lakewide estimate of spawning-phase sea lampreys in Lake Erie with 95% confidence limits, 1980-2010. Thick solid line indicates spawner abundance target level with 95% confidence range (thin lines).

2011 Sea Lamprey Control Plans

Due to the recent back-to-back treatment of nine streams in 2008 and 2009 and 1 stream in 2009 and 2010, there are no streams scheduled for treatment in 2011.

Larval assessment surveys are scheduled for 65 streams (57 U.S., 8 Canada) (Table 4.3). A habitat based population estimate will be conducted in the St. Clair River. Bottom substrate will be delineated using Roxanne seabed classification sonar. Granular Bayluscide will be applied to estimate larval density.

Adult assessment traps will be operated on four streams (2 U.S., 2 Canada) to estimate lakewide spawning-phase abundance.

The USACE will conduct a study to assess the feasibility of repairing or rebuilding the Harpersfield Dam on the Grand River. Construction of a permanent trap at Springville Dam on Cattaraugus Creek will be completed.

A bioassay will be conducted to determine the toxicity of TFM to logperch (*Percina caprodes*). Logperch are the primary host for the snuffbox mussel (*Epioblasma triquetra*), which was proposed for federal listing during 2010. Snuffbox mussels are found in several Lake Erie tributaries that have a history of sea lamprey infestation, including the Grand, Thames, and Pine rivers.

The Lake Erie chapter of the Sea Lamprey Management Plan will be completed and presented to the Lake Erie Committee.

TABLE 4.3 Larval sea lamprey assessments of Lake Erie Tributaries during 2010 and plans for 2011.

Stream	History	Surveyed in 2010	Survey Type[1]	Results	Plans for 2011
Canada					
Detroit R.	Negative	Yes	Detection	Negative	None
Big Creek	Negative	No			Detection
Sixteenmile Creek	Negative	Yes	Detection	Negative	None
Kettle Creek	Negative	Yes	Detection	Negative	Detection
East Creek	Positive	Yes	Evaluation	Negative	None
Catfish Creek	Positive	Yes	Evaluation	Negative	None
Silver Creek	Positive	Yes	Dist/Trt. Eval.	Negative	Evaluation
Big Otter Creek	Positive	Yes	Dist/Trt. Eval.	Negative	Evaluation
South Otter Creek	Positive	Yes	Trt. Eval/Dist	Negative	Evaluation
Big Creek	Positive	Yes	Trt. Eval.	Negative	Evaluation
Forestville Creek	Positive	Yes	Evaluation	Negative	None
Normandale Creek	Positive	Yes	Evaluation	Negative	None
Fishers Creek	Positive	Yes	Evaluation	Negative	None
Youngs Creek	Positive	Yes	Trt. Eval.	Negative	Evaluation
Frenchman Creek	Negative	No			Evaluation
Welland River	Negative	Yes	Detection	Negative	None
Unnamed (E-592)	Negative	Yes	Detection	Negative	None
United States					
Buffalo River	Positive	Yes	Evaluation	Negative	None
Rush Creek	Negative	Yes	Detection	Negative	None
Bay View Creek	Negative	Yes	Detection	Negative	None
Locksley Park Creek	Negative	Yes	Detection	Negative	None
Wanakah Creek	Negative	Yes	Detection	Negative	None
Clifton Hts Cr.- E	Negative	Yes	Detection	Negative	None
Clifton Hts Cr.-W	Negative	Yes	Detection	Negative	None
Eighteenmile Creek	Negative	Yes	Detection	Negative	None
Pike Creek	Negative	Yes	Detection	Negative	None
Wendt Park Creek	Negative	Yes	Detection	Negative	None
Little Sister Creek	Negative	Yes	Detection	Negative	None
Big Sister Creek	Negative	No			Detection
Delaware Creek	Positive	Yes	Evaluation	Negative	None
Muddy Creek	Negative	No			Detection
Cattaraugus Creek	Positive	Yes	Trt. Eval.	Positive	None
(lentic)	Positive	Yes	Evaluation		None
(estuary)	Positive	Yes	Evaluation-gB	Negative	None

TABLE 4.3 (Continued) Larval sea lamprey assessments of Lake Erie Tributaries during 2010 and plans for 2011.

Stream	History	Surveyed in 2010	Survey Type[1]	Results	Plans for 2011
Halfway Brook	Positive	Yes	Evaluation	Negative	None
Silver Creek	Negative	No			Detection
Eagle Bay Creek	Negative	Yes	Detection	Negative	None
Crooked Brook	Negative	Yes	Detection	Negative	None
Canadaway Creek	Positive	No			Evaluation
Van Buren Cr. No.2	Negative	No			Detection
Van Buren Cr. No.3	Negative	No			Detection
Hall Rd. Creek	Negative	No			Detection
Swede Rd. Creek	Negative	No			Detection
Lk Erie Park Creek	Negative	No			Detection
Corell Creek	Negative	No			Detection
Walker Creek	Negative	No			Detection
West Forest Ave Cr.	Negative	No			Detection
Pratt Road Creek	Negative	No			Detection
Bournes Creek	Negative	No			Detection
Spring Creek	Negative	No			Detection
Doty Creek	Negative	No			Detection
Vorce Creek	Negative	No			Detection
Freeling Creek	Negative	No			Detection
Ripley Airport No.1	Negative	No			Detection
Shortman Rd Creek	Negative	No			Detection
Dewey Road Creek	Negative	No			Detection
Woodmere Rd Cr. #2	Negative	No			Detection
Eight Mile Creek	Negative	Yes	Detection	Negative	None
Seven Mile Creek	Negative	No			Detection
Six Mile Creek	Negative	Yes	Detection	Negative	None
Gannondale Creek	Negative	No			Detection
Four Mile Creek	Negative	Yes	Detection	Negative	None
Mill Creek (Erie Pa.)	Unknown	No			Detection
Wilkins Rd Creek	Negative	No			Detection
Pasadena Rd Creek	Negative	No			Detection
Walnut Creek	Negative	No			Detection
Grt Lakes Camp Cr.	Negative	No			Detection
Trout Run	Negative	No			Detection
Melhorn Rd Cr.	Negative	No			Detection
Camp Sherwin Cr.	Negative	No			Detection

TABLE 4.3 (Continued) Larval sea lamprey assessments of Lake Erie Tributaries during 2010 and plans for 2011.

Stream	History	Surveyed in 2010	Survey Type[1]	Results	Plans for 2011
Fairplain Creek	Negative	Yes	Detection	Negative	None
Nursery Rd Creek	Negative	No			Detection
Lake Erie Park Cr.	Negative	No			Detection
Elk Creek	Negative	No			Detection
Townline Creek	Negative	Yes	Detection	Negative	None
Crooked Creek	Positive	Yes	Trt. Eval	Negative	None
Camp Lambec Cr. 2	Negative	No			Detection
Camp Lambec Cr. 3	Negative	No			Detection
Raccoon Creek	Positive	Yes	Trt. Eval	Negative	None
Turkey Creek	Negative	Yes	Detection	Negative	None
Conneaut Creek	Positive	Yes	Trt. Eval	Positive	Evaluation/Ranking
Conneaut Cr. E Br.	Positive	No			Barrier
Conneaut Cr. lower	Positive	Yes	Evaluation-gB		Evaluation
(lentic)	Positive	Yes	Evaluation-gB	Negative	None
Ashtabula River	Positive	Yes	Evaluation	Negative	None
Wheeler Creek	Positive	No			Evaluation
Arcola Creek	Negative	No			Detection
Grand River	Positive	Yes	Trt.Eval/Barr	Negative	None
(lentic)	Positive	Yes	Evaluation-gB	Negative	None
Chagrin River	Positive	Yes	Evaluation	Negative	None
Euclid Creek	Negative	No			Detection
Cuyohoga River	Negative	Yes	Detection	Negative	None
Rocky River	Negative	Yes	Detection	Negative	None
Cahoon Creek	Negative	Yes	Detection	Negative	None
Porter Creek	Negative	Yes	Detection	Negative	None
Beaver Creek	Negative	No			Detection
Vermillion Creek	Negative	Yes	Detection	Negative	None
Chappel Creek	Negative	Yes	Detection	Negative	None
Old Woman Creek	Negative	Yes	Detection	Negative	None
Huron River (OH)	Negative	No			None
South Creek	Negative	No			Detection
Sandusky River	Negative	No			Detection-gB
Portage River	Negative	No			Detection
Toussaint River	Negative	No			Detection
Maumee River	Negative	No			Detection-gB
Flat Creek	Negative	Yes	Detection	Negative	None

TABLE 4.3 (Continued) Larval sea lamprey assessments of Lake Erie Tributaries during 2010 and plans for 2011.

Stream	History	Surveyed in 2010	Survey Type[1]	Results	Plans for 2011
Little Lake Creek	Negative	Yes	Detection	Negative	None
La Plaisance Creek	Negative	Yes	Detection	Negative	None
River Raisin	Negative	No			Detection
Sandy Creek	Negative	Yes	Detection	Negative	None
Swan Cr. (Monroe Co.)	Negative	No			Detection
Huron River (lentic)	Negative	Yes	Detection-gB	Negative	Detection-gB
Black River (Mill Cr.)	Positive	No			Evaluation
Pine River	Positive	No			Evaluation
Belle River	Positive	No			Evaluation
Clinton River	Positive	No			Evaluation
River Rouge	Negative	No			Detection
St. Clair River	Positive	No			Evaluation-gB
Detroit River	Negative	Yes	Detection-gB	Negative	Evaluation-gB

[1]*Evaluation survey* – conducted to detect larval recruitment in streams with a history of sea lamprey infestation; "-gB" refers to granular Bayluscide.
Detection survey – conducted to detect larval recruitment in streams with no history of sea lamprey infestation.
Distribution survey – conducted to determine instream geographic distribution or to determine lampricide treatment application points.
Treatment evaluation survey – conducted to determine the relative abundance of survivors from a lampricide treatment.
Ranking survey – conducted to index the larval population to determine need for lampricide treatment the following year. Projected treatment cost is divided by the estimate of larvae > 100 mm to provide a ranking against other Great Lakes tributaries for lampricide treatment.
Biological collection – conducted to collect lamprey specimens for research purposes.
Barrier survey - conducted to determine larval recruitment upstream of barriers.

References

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

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

Sullivan, W. P., G. C. Christie, F. C. Cornelius, M. F. Fodale, D. A. Johnson, J. F. Koonce, G. L. Larson, R. B. McDonald, K. M. Mullett, C. K. Murray, and P. A. Ryan. 2003. The sea lamprey in Lake Erie: a case history. Journal of Great Lakes Research 29 (Supplement 1):615-636.

Charge 5: Maintain an annual interagency electronic database of Lake Erie salmonid stocking and current projections for the STC, GLFC and Lake Erie agency data depositories.

Chuck Murray (PFBC) and James Markham (NYSDEC)

Lake Trout Stockings

The current lake trout stocking goal for Lake Erie (160,000 yearlings) was met for the third consecutive year (Figure 5.1). This also marks the second consecutive year that lake trout were stocked in each eastern basin jurisdiction within the same year. In 2010, lake trout were stocked in New York waters (144,772 yearlings), Ontario waters (126,864 yearlings) and Pennsylvania waters (37,014 fall fingerlings). Combined, the 272,939 yearling equivalents stocked in 2010 were the most lake trout stocked into Lake Erie in a single year since rehabilitation efforts began in 1969.

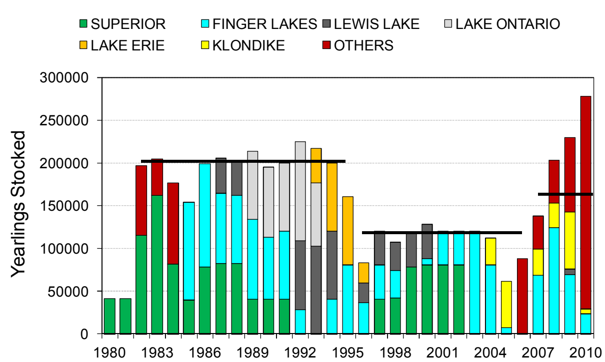


Figure 5.1. Yearling lake trout stocked (in yearling equivalents) in eastern basin waters of Lake Erie, 1980-2010, by strain. The current stocking goal (black line) is 160,000 yearlings per year. OTHERS = Clearwater Lake (1982-84), Slate Island (2006, 2009, 2010), Traverse Island (2007), Lake Manitou (2008), Apostle Island (2009), Lake Champlain (2009, 2010), and Michipocoten (2010).

While the Allegheny National Fish Hatchery (ANFH) remains closed for renovations, lake trout stocked in New York waters continued to be raised at White River National Fish Hatchery, a federal facility located in Vermont. These lake trout were stocked by New York Department of Environmental Conservation (NYDEC) staff offshore of Dunkirk in approximately 70 feet of water via the R/V ARGO between 27 April and 11 May, 2010. All of these were Lake Champlain strain fish. The Vermont hatcheries are scheduled to raise lake trout for Lake Erie until renovations at the ANFH are complete. Current projections for resuming production at the ANFH have been pushed back to 2013. The Ontario Ministry of Natural Resources (OMNR) stocked three lean strains of lake trout (Finger Lakes, Slate Island, Michipocoten) off Nanticoke Shoal (boat stocked) and Port Maitland (shore stocked) between 8 April and 28 April, 2010. This was the fourth lake stocking in Ontario waters in the last five years. Fall fingerling Klondike strain lake trout were shore stocked by the USFWS near Presque Isle Bay, PA on 8 November 2010. These were surplus fish from the Jordan River National Fish Hatchery.

Stocking of Other Salmonids

In 2010, over 2.3 million yearling trout were stocked in Lake Erie, including rainbow/steelhead trout, brown trout and lake trout (Figure 5.2).

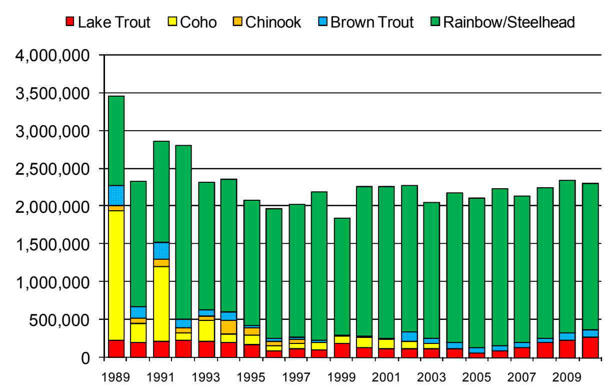


FIGURE 5.2: Annual stocking of all salmonid species (in yearling equivalents) in Lake Erie by all agencies, 1989-2010.

Total salmonid stocking decreased 2% from 2009 but remained near the long-term average (1989-2009). Annual summaries for each species stocked within individual state and provincial areas are summarized in Table 5.1, and are standardized to yearling equivalents.

All of the US fisheries resource agencies and a few non-governmental organizations (NGO's) in Ontario and Pennsylvania presently stock rainbow/steelhead trout in the Lake Erie watershed. A total of 1,929,029 yearling rainbow/steelhead trout were stocked in 2010, accounting for 84% of all salmonids stocked. This represented a 4% decrease from 2009, but remained 6% above the long-term average. The increase above the long-term average is primarily a result of the increased emphasis of rainbow trout/steelhead in jurisdictional fisheries and the elimination of other pacific salmon (Coho and Chinook salmon) over the last decade. A full account of rainbow/steelhead trout stocked in Lake Erie by jurisdiction for 2010 can be found under charge 6 of this report, and details the location and strain of rainbow trout stocked across Lake Erie.

Brown trout stocking in Lake Erie totaled 102,127 yearlings in 2010. This was a 1% decrease from 2009, but a 21% increase from the long-term average. Most of this increase is attributed to the stocking of yearlings and advanced fingerlings in the New York and Pennsylvania waters of Lake Erie. The purpose of these efforts is the development of a trophy brown trout fishery to compliment and diversify the stream and offshore trout fisheries. Brown trout stocking is expected to continue at this rate for 2011 for New York and Pennsylvania.

Most (76%) of the brown trout placed in the New York and Pennsylvania waters of Lake Erie were stocked for the purposes of providing a put-grow-take (PGT) trophy brown trout fishery for offshore boat anglers and seasonal tributary anglers. Some brown trout (24%) are stocked to provide adult trout for the opening day of trout season in Pennsylvania.

Between 22 April and 30 April the NYDEC stocked 37,490 yearling brown trout in Cattaraugus Creek, Barcelona Harbor, 18-mile Creek and Dunkirk Harbor. An additional 40,000 spring fingerlings were stocked on July 1 in Barcelona 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.

Pennsylvania also stocked brown trout in the Lake Erie watershed. Between 16 April and 29 April 22,084 adult brown trout (mean length = 267mm) were stocked to provide catchable trout for the opening of Pennsylvania trout season. Yearling and fall fingerling brown trout were also stocked in Pennsylvania waters in support of a PGT brown trout program started in 2009. Various NGO's stocked 39,700 yearling brown trout in May which were adipose clipped. The PFBC stocked an additional 41,059 fall fingerlings between 28 September and 7 October. 10,750 (26%) were stocked in Presque Isle Bay and were left ventral clipped. The remaining 30,300 (74%) were stocked in nursery streams and marked with a right ventral fin clip.

TABLE 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1989-2010.

Agency	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
ONT.	--	--	--	--	14,370	14,370
NYS DEC	143,200	154,210	70,370	54,590	141,740	564,110
PFBC	80,000	1,166,480	--	62,450	720,920	2,029,850
ODNR	--	--	--	92,120	242,000	334,120
MDNR	--	400,190	--	50,350	69,560	520,100
1989 Total	**223,200**	**1,720,880**	**70,370**	**259,510**	**1,188,590**	**3,462,550**
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**

TABLE 5.1. (Continued) Summary of salmonid stockings in number of yearling equivalents, 1989-2010.

Agency	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/Steelhead	Total
ONT.	--	--	--	--	10,787	10,787
NYS DEC	92,200	--	--	--	298,330	390,530
PFBC	40,000	137,204	--	17,163	1,237,870	1,432,237
ODNR	--	--	--	--	375,022	375,022
MDNR	--	--	--	--	60,000	60,000
2000 Total	**132,200**	**137,204**	**0**	**17,163**	**1,982,009**	**2,268,576**
ONT.	--	--	--	100	40,860	40,960
NYS DEC	80,000	--	--	--	276,300	356,300
PFBC	40,000	127,641	--	17,000	1,185,239	1,369,880
ODNR	--	--	--	--	424,530	424,530
MDNR	--	--	--	--	67,789	67,789
2001 Total	**120,000**	**127,641**	**0**	**17,100**	**1,994,718**	**2,259,459**
ONT.	--	--	--	4,000	66,275	70,275
NYS DEC	80,000	--	--	72,300	257,200	409,500
PFBC	40,000	100,289	--	40,675	1,145,131	1,326,095
ODNR	--	--	--	--	411,601	411,601
MDNR	--	--	--	--	60,000	60,000
2002 Total	**120,000**	**100,289**	**0**	**116,975**	**1,940,207**	**2,277,471**
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**

Charge 6: Report on the status of rainbow trout in Lake Erie, including stocking numbers, strains being stocked, academic and resource agency research interests, and related population parameters, including growth and exploitation.

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

Stocking

All Lake Erie jurisdictions stocked lake-run rainbow trout (or steelhead) in 2010 (Table 6.1). Yearling plants take place each spring, between March and May, when smolts average about 150 mm in length. Additionally, a small number of domestic and golden rainbow trout were stocked to supplement the put-and-take trout fishery in Pennsylvania.

Based on these efforts, a total of 1,929,029 yearling steelhead/rainbow trout were stocked in 2009, representing a 4% decrease from 2009 and a 6% increase above the long-term (1989-2009) average. Nearly all of the rainbow trout stocked in Lake Erie originated from naturalized Great Lakes strains. A Lake Erie strain accounted for 56% of the strain composition, followed by a Lake Michigan strain (26%) and a Lake Ontario strain (17%); less than 1% of the rainbow trout stocked in Lake Erie were miscellaneous strains including a Finger Lakes strain (0.01%), a domestic strain (0.6%), and a golden rainbow trout strain (0.01%). There were no fin clipped rainbow trout stocked in 2010 (Table 6.2).

Assessment of Natural Reproduction

In anticipation of a fish passage project scheduled to be completed in 2010 on a series of dams in Chautauqua Creek (NY), a comprehensive survey of the fish community and assessment of juvenile production of steelhead both below and above the two existing fish barriers was conducted in 2007, 2008, and 2009 by the NYSDEC. The results of these surveys showed the impact of the two dams on the passage of steelhead and the overall fish community. Abundance of YOY steelhead was 3-4 times higher below the dams compared to sites above the dams, and composition of non-trout species differed as well. These results indicate that while some steelhead do make it over both barriers and are able to migrate upstream to spawn, the bulk of the fish are stopped and spawn in the riffle areas below the dams. Weather conditions play a large role in production and migration upstream with greater abundances of YOY steelhead above the dams in high flow years and greater survival in cool and wet summers. The abundance of YOY steelhead in Chautauqua Creek was comparable to fall densities found in higher quality Michigan streams (Seelbach 1993; Godby et al. 2007). However, densities were lower than Spooner Creek (3,245 fish/acre), which is considered the top steelhead producing stream in New York's Lake Erie watershed (Culligan et al. 2002). Further studies need to be conducted to determine if this production is contributing to the adult steelhead population of this stream.

Exploitation

Although 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 2010 was 9,178 steelhead in all US waters; a 5% increase from the estimated 2009 steelhead harvest (Table 6.3). Harvest increased for the second consecutive year after hitting a record low of 5,431 rainbow trout in 2008. Losses seen in Ohio and Michigan fisheries were offset by increases in Pennsylvania. Harvests in New York fisheries remained low but stable.

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 Pennsylvania (500%) and slightly (14%) in New York, and decreased considerably (-49%) in Ohio from 2009. Average harvest by these three jurisdictions combined was 60% below the ten-year average.

TABLE 6.1. Rainbow trout/steelhead stocking by jurisdiction and location for 2010.

Agency	Location	Strain	Number	Life Stage	Yearling Equivalents	
Michigan	Flat Rock	Manistee River, L. Michigan	66,536	Yearling	**66,536**	**Sub-Total**
Ontario	Mill Creek	Ganaraska River, L. Ontario	31,897	Yearling	31,897	
	Erieau Harbour	Ganaraska River, L. Ontario	1,550	Yearling	1,550	
					33,447	**Sub-Total**
Pennsylvania	Conneaut Creek	Domestic	4,618	Adult	4,618	
	East Branch of Conneaut Creek	Domestic	410	Adult	410	
	Elk Creek	Domestic	207	Adult	207	
	Taylor Run	Domestic	510	Adult	510	
	Conneaut Creek	Golden	47	Adult	47	
	Crooked Creek	Golden	10	Adult	10	
	East Branch of Conneaut Creek	Golden	7	Adult	7	
	Elk Creek	Golden	4	Adult	4	
	Sevenmile Creek	Golden	30	Adult	30	
	Taylor Run	Golden	4	Adult	4	
	Conneaut Creek	Trout Run, L. Erie	75,000	Yearling	75,000	
	Crooked Creek	Trout Run, L. Erie	78,480	Yearling	78,480	
	Elk Creek	Trout Run, L. Erie	246,626	Yearling	246,626	
	Fourmile Creek	Trout Run, L. Erie	19,620	Yearling	19,620	
	Godfrey Run	Trout Run, L. Erie	38,620	Yearling	38,620	
	Presque Isle Bay	Trout Run, L. Erie	88,292	Yearling	88,292	
	Raccoon Creek	Trout Run, L. Erie	19,745	Yearling	19,745	
	Sevenmile Creek	Trout Run, L. Erie	19,620	Yearling	19,620	
	Sixteenmile Creek	Trout Run, L. Erie	19,620	Yearling	19,620	
	Trout Run	Trout Run, L. Erie	68,050	Yearling	68,050	
	Trout Run	Trout Run, L. Erie	18,000	Spr Fing	180	
	Twelvemile Creek	Trout Run, L. Erie	39,240	Yearling	39,240	
	Twentymile Creek	Trout Run, L. Erie	156,959	Yearling	156,959	
	Walnut Creek	Trout Run, L. Erie	209,507	Yearling	209,507	
					1,085,406	**Sub-Total**
Ohio	Chagrin River	Manistee River, L. Michigan	90,467	Yearling	90,467	
	Conneaut Creek	Manistee River, L. Michigan	75,001	Yearling	75,001	
	Grand River	Manistee River, L. Michigan	105,001	Yearling	105,001	
	Rocky River	Manistee River, L. Michigan	90,293	Yearling	90,293	
	Vermilion River	Manistee River, L. Michigan	72,684	Yearling	72,684	
					433,446	**Sub-Total**
New York	Buffalo River	Domestics	3,890	Yearling	3,890	
	Canadaway Creek	Domestics	10,500	Fall Fing	371	
	Chautauqua Creek	Domestics	10,500	Fall Fing	371	
	Erie Basin Marina	Domestics	970	Yearling	970	
	Chautauqua Creek	Finger Lakes Wild	25,000	Fall Fing	883	
	18 Mile Creek	Washington	23,790	Yearling	23,790	
	18 Mile Creek S. Branch	Washington	23,790	Yearling	23,790	
	Buffalo Creek	Washington	17,840	Yearling	17,840	
	Buffalo River Net Pens	Washington	11,890	Yearling	11,890	
	Canadaway Creek	Washington	24,000	Yearling	24,000	
	Cattaraugus Creek	Washington	107,040	Yearling	107,040	
	Cayuga Creek	Washington	11,890	Yearling	11,890	
	Cazenovia Creek	Washington	11,890	Yearling	11,890	
	Chautauqua Creek	Washington	47,580	Yearling	47,580	
	Silver Creek	Washington	12,000	Yearling	12,000	
	Walnut Creek	Washington	12,000	Yearling	12,000	
					310,194	**Sub-Total**
					1,929,029	**Grand Total**

TABLE 6.2. Rainbow trout fin-clip summary for Lake Erie, 1999-2010.

Year Stocked	Year Class	Michigan	New York	Ontario	Ohio	Pennsylvania
1999	1998	RP	ADRP	RV; AD; ADRV	-	-
2000	1999	RP	RV	LP	-	-
2001	2000	RP	AD	-	-	-
2002	2001	RP	ADLV	-	-	-
2003	2002	RP	RV	LP	-	-
2004	2003	RP	-	LP	-	-
2005	2004	RP	ADLP	RP	-	-
2006	2005	-	-	LP	-	-
2007	2006	-	ADLP	-	-	-
2008	2007	-	ADLP	-	-	-
2009	2008	RP				
2010	2009	-	-	-	-	-

AD=adipose; RP= right pectoral; RV=right ventral; LP=left pectoral LV=left ventral

Table 6.3. Estimated harvest by open lake boat anglers in Lake Erie, 1999-2010.

Year	Ohio	Pennsylvania	New York	Ontario	Michigan	Total
1999	20,396	7,401	1,000	13,000	100	41,897
2000	33,524	11,011	1,000	28,200	100	73,835
2001	29,243	7,053	940	15,900	3	53,139
2002	41,357	5,229	1,600	75,000	70	123,256
2003	21,571	1,717	400	N/A*	15	23,703
2004	10,092	2,657	896	18,148	0	31,793
2005	10,364	2,183	594	N/A*	19	13,160
2006	5,343	2,044	354	N/A*	0	7,741
2007	19,216	4,936	1,465	N/A*	68	25,685
2008	3,656	1,089	647	N/A*	39	5,431
2009	7,662	857	96	N/A*	150	8,765
2010	3,911	5,155	109	N/A*	3	9,178

* no creel data collected by OMNR in 2003, 2005-2010

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

On the south shore, most of the reported harvest was concentrated in central basin waters of Pennsylvania (52%) and Ohio (32%). The west-central basin waters of Ohio accounted for 10% the harvest. The east basin accounted for 5% of the harvest, mostly in Pennsylvania waters (4%). Very few (0.2%) rainbow trout were harvested in the western basin.

Similar to harvest estimates from the open lake boat fishery, catch rate statistics were mixed across the lake (Figure 6.1). The 2010 catch rates by boat anglers targeting steelhead were very similar in Ohio (0.06 steelhead/angler hour) and Pennsylvania (0.07 steelhead/angler hour) and both were less than half of the long-term averages (1999-2009).

Trends in catch rate were contrasting; 2010 steelhead boat angler catch rate in Ohio declined sharply from 2009 to the lowest value in the time series. This was due to the lack of charter angler interviews which are normally very high. The 2010 catch rate in Pennsylvania increased for the second consecutive year after hitting a record low in 2008. The rainbow trout catch rate by Ontario anglers (areas combined) also increased from 2009 and was highest among all boat anglers in 2010, influenced by above average catch rates in the east-central basin (Figure 6.1).

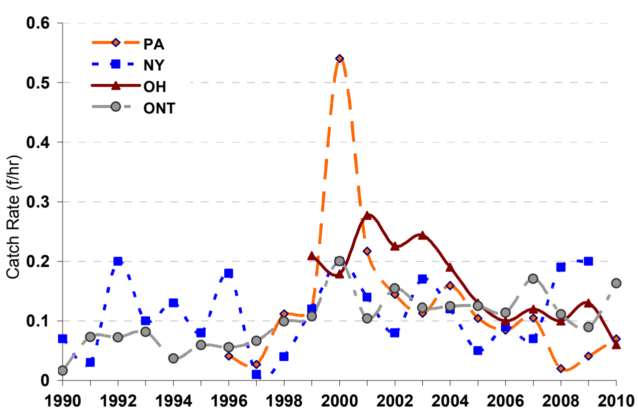


FIGURE 6.1. Targeted steelhead catch rates (fish/angler hour) in Lake Erie by open lake boat anglers in Ohio, Pennsylvania, New York and Ontario.

The Ontario Ministry of Natural Resources did not conduct open water angler surveys during 2010 that could provide measurable estimates of rainbow trout harvest, effort or catch rates in open lake waters of Lake Erie. However, they collected angler diary reports that can detail trends over time by area of the lake.

In 2010, diarists reported targeted rainbow trout trips and catch in west-central and east-central basin waters of Lake Erie. No rainbow trout fishing activity was recorded in through the diary program in the east basin for 2010. Angler diary reports from Ontario show that rod-hours for steelhead increased in the west central basin for the first time in three years (Figure 6.2). Rod hours for rainbow trout declined in the east central basin for the fifth year (Figure 6.3).

Rainbow trout catch rates for Ontario diarists in 2010, in the west-central basin (0.115 fish/rod-hour), were 28% lower than 2009 values, but 6% higher than the long-term average (0.08 fish/rod-hour). Rainbow trout catch rates by Ontario diarists in the east-central basin (0.24 fish/rod hour) were 84% higher than 2009, and 65% higher than the long-term average (0.15 fish/rod hour).

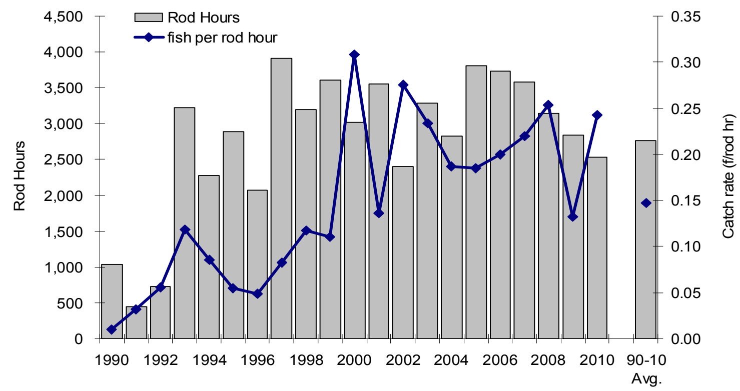


FIGURE 6.2. Targeted steelhead effort and catch rates in Lake Erie's west central basin as reported in angler diaries by open lake boat anglers in Ontario.

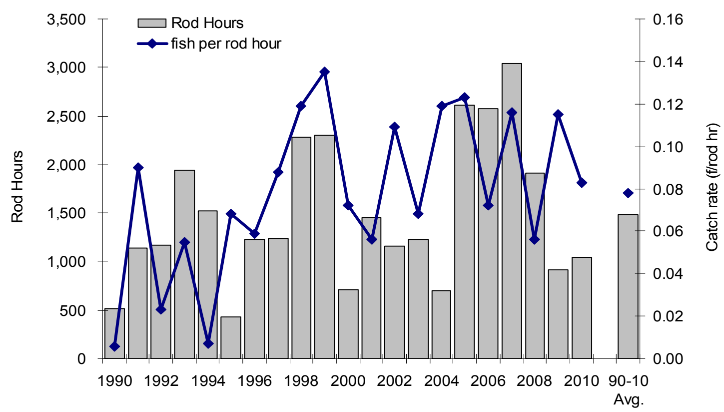


FIGURE 6.3. Targeted steelhead effort and catch rates in Lake Erie's east central basin as reported in angler diaries by open lake boat anglers in Ontario.

Tributary Creel Surveys

The Lake Erie tributaries are the focal point of the steelhead fishery. Data on this segment of the sport fishery is fragmented, preventing a review of annual trends in targeted effort and catch rate.

An angler diary program maintained by the NYSDEC Lake Erie Fisheries Unit provides the best review of annual catch rates by tributary anglers through 2009. This data shows that catch rates by steelhead anglers in New York streams had steadily increased throughout most of the last two decades and peaked in 2006. Catch rates declined to 0.69 steelhead/angler hour in 2009, but remained well above the long-term average of 0.47 steelhead per angler hour (Figure 6.4).

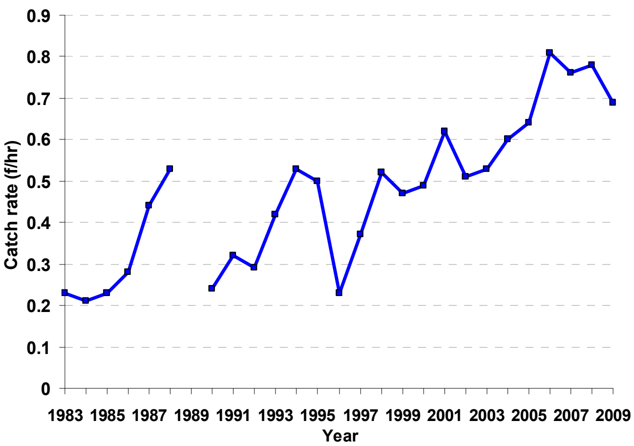


FIGURE 6.4. Targeted salmonid catch rates (fish/angler hour) in Lake Erie tributaries by New York angler diary cooperators, 1987-2009.

Ohio Division of Wildlife personnel completed the second of two consecutive years of creel surveys for the steelhead fishery on Ohio's Lake Erie tributaries and access points (Kayle 2009). Seventeen different streams and 89 locations were surveyed by two creel survey clerks during the period of late September, 2009, to early May, 2010. A total of 1,873 interviews of 3,451 anglers were completed during the survey period. Nearly all anglers interviewed (98%) were seeking steelhead. An estimated total of 283,107 angler hours were expended during the September-May survey period over all survey locations. The Grand River had the most angler effort (97,095 hours), followed by Conneaut Creek and Rocky River. Overall steelhead catch rate during the 2009-2010 time period was 0.354 fish per hour; with the harvested steelhead catch rate of 0.031 fish kept per hour and the released steelhead catch rate of 0.323 fish caught and released per hour.

An estimated 100,145 steelhead were captured in the study areas during the survey period, of which 90,984 (91%) were released. Release rates of legal-sized steelhead at 89% and 91% for the two creel-survey years are comparable to those seen in Pennsylvania and New York tributary creel surveys during the 2000s (Figure 6.5). Average size of the 107 observed steelhead during the surveys was 633 mm. About 10% of steelhead observed by creel clerks in the 2009-2010 surveys exhibited new or old sea lamprey wounds.

Demographic information collected during the creel surveys found that steelhead anglers came from 42 of Ohio's 88 counties, from 18 other US states, the Canadian province of Ontario, and Scotland to fish for steelhead in Ohio waters. Gear preferences for steelhead angling method were predominantly spinning (63%), followed by fly fishing (33%) and center pinning (4%). The majority of anglers (51%) stated that it was not important for them to keep the steelhead they caught; 24% stated it was only slightly important. Trip hours and expenditures were also calculated. For the second consecutive year, nearly all (98%) of the anglers recorded by sex in the survey were male, and the most frequent age for anglers (by decade) was the 40s.

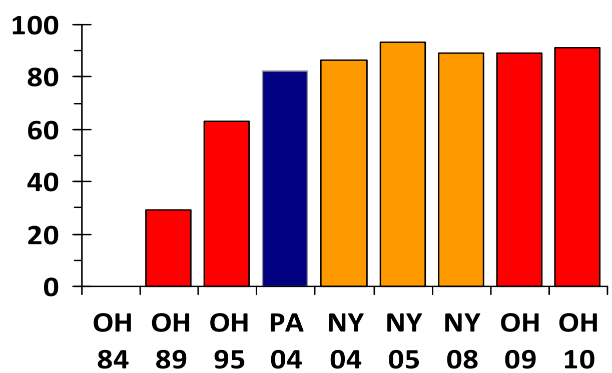


FIGURE 6.5. Legal release rates observed in Lake Erie steelhead tributary creel surveys.

Otolith Microchemistry Research

An update of the steelhead otolith research has been provided by Dr. Jeff Miner and Dr. John Farver of Bowling Green State University (BGSU) for this report (personal communication). The goal of this investigation is to use otolith chemistry to identify hatchery-specific chemical signatures for steelhead smolts from all New York, Pennsylvania, Ohio, and Michigan hatcheries providing smolts to Lake Erie. Standard signatures were developed by assessing juvenile hatchery fish collected in 2008 and 2009; these signatures are being further refined by analyzing additional hatchery fish before the 2010 stocking. Adult spawning fish have been obtained in various tributaries to Lake Erie for otolith extraction and chemical analysis. After the chemical signature is obtained from these structures, spatial statistical analysis will be applied to differentiate the stocks.

An investigation of the steelhead returns to Conneaut Creek has been ongoing. In spring and fall 2009, Pennsylvania Fish and Boat Commission and Ohio Division of Wildlife fisheries staff assisted BGSU researchers with the collection of returning adult steelhead in the Pennsylvania and Ohio waters of Conneaut Creek using electro-fishing gear.

Both agencies stock about 75,000 smolts each year, but Pennsylvania stocks fish about 35 miles upstream from the river mouth while Ohio stocks just several miles upstream from the river mouth. Preliminary results show that in both spring and fall collections, about 50% of the fish collected at the mouth of the river were Ohio fish (others were likely Pennsylvania fish, but this is more difficult to determine). In the Pennsylvania waters of Conneaut Creek, only one fish of 100 sampled (spring and fall combined) was of Ohio origin. These results suggest that spawning steelhead show good specificity to the stocking location and that stocking upstream in Pennsylvania is a good management decision for Pennsylvania anglers.

Additional samples of spawning steelhead in tributaries across Lake Erie (US and Ontario waters) were collected in fall 2009 and in spring 2010 with help from state and provincial fisheries biologists. These collections provided more information on steelhead stocking site fidelity, and the contribution of natural reproduction.

In an attempt to identify and quantify natural reproducing of rainbow trout in Lake Erie, summer 2009, resident steelhead (<200 mm TL) were collected from Cattaraugus and Chautauqua Creeks in NY to compare the proportions growing in streams that had converted the calcium carbonate matrix in their otoliths from an aragonite form to a vaterite form. While all steelhead start growing otoliths with aragonite, some will switch to growing at least part of their otolith as vaterite which they cannot revert. Stress is thought to be the reason for this shift.

The proportion of steelhead in New York hatcheries that had undergone this shift were compared with the proportion found in stream residents. The results show a higher proportion of hatchery fish had vaterite in their otoliths than did stream resident fish, suggesting that increased proportions of vaterite indicate possible hatchery origin. These results will be confirmed through increased sampling efforts. Additionally, BGSU researchers hope to determine if the proportion of stocked fish returning with vaterite in their otoliths is lower than the proportion of that year class when it was stocked, thereby suggesting differential mortality in the lake.

References

Culligan, W. J., D. W. Einhouse, J. L. Markham, D. L. Zeller, R. C. Zimar, and B. J. Beckwith. 2002. NYSDEC Lake Erie 2001 Annual Report to the Lake Erie Committee. New York Department of Environmental Conservation, Albany, NY.

Godby, N. A. Jr., E. S. Rutherford, and D. M. Mason. 2007. Diet, feeding rate, growth, mortality, and production of juvenile steelhead in a Lake Michigan tributary. North American Journal of Fisheries Management 27:578-592.

Kayle, K.A. 2009. Steelhead Tributary Creel Surveys Year 1 Progress Report. Supplement to Annual Project Report. Ohio Department of Natural Resources, Division of Wildlife. Federal Aid in Sport Fish Restoration Project F-69-P, State Project FFDR08. Fairport Harbor, OH.

Miner, Jeffery and John Farver. Pers. Comm. Department of Biological Sciences. Aquatic Ecology & Fisheries Laboratory. Bowling Green State University. Bowling Green, OH.

Seelbach, P. W. 1993. Population biology of steelhead in a stable-flow, low-gradient tributary of Lake Michigan. Transactions of the American Fisheries Society 122:179-198.

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) and Kurt Oldenburg (OMNR)

Cisco (formerly lake herring; *Coregonus artedi*) is indigenous to the Great Lakes and historically supported one of the most productive fisheries in Lake Erie (Scott and Crossman 1973, Trautman 1981). Cisco is considered extirpated in Lake Erie, although commercial fishermen report it 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) documented consumption of cisco eggs by rainbow smelt. Evans and Loftus (1987) summarized two studies in which smelt consumed large numbers of larval cisco.

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 is some evidence to indicate that this has occurred for whitefish (Oldenburg et al. 2007). Cisco should also be favored by these conditions. Rainbow smelt abundance declined sharply in the 1990's and continues to remain relatively low (Ryan et al. 1999 and FTG 2010). Alewives have never been very abundant in Lake Erie due to overwinter temperatures that frequently prove lethal (Ryan et al. 1999).

With the recent recovery of other native coldwater species (i.e. lake whitefish and burbot), and the relatively low abundance of rainbow smelt compared to the past, there has been an opportunity for cisco to recover in Lake Erie. Commercial fishermen have reported cisco in 9 of the last 14 years, although in small numbers. Recent reports and collections are summarized in Table 7.1 with locations shown in Figure 7.1. Although there were no reports of cisco in 2009, four were reported from the commercial fishery in 2010. While young cisco (age 1 and 2) were observed in the early part of the 2000's, none have been observed lately. The most recent year class observed is that of 2003.

Cisco – Recent Observations

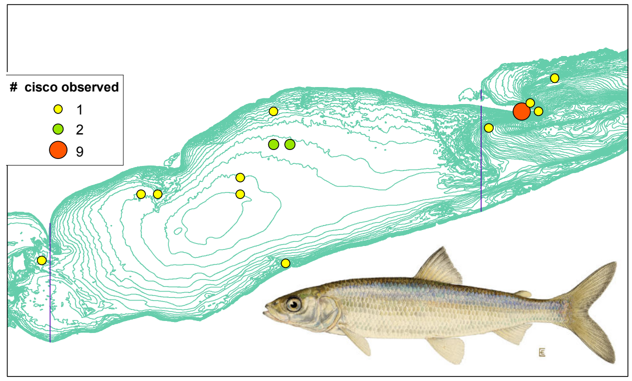


FIGURE 7.1. Spatial distribution of recent (1996-2010) cisco observations. All reports are from the Ontario commercial gillnet and trawl fisheries with the exception of one occurrence in the ODNR index gillnet program near Fairport Harbor, OH.

TABLE 7.1. Sampling details from a selection of cisco captured during commercial and fishing efforts, 1996-2010.

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

* indicates age extrapolated from total length measure

F = female; M = male; u = unknown

Rehabilitation Efforts

In recent years, there have been several management actions directed at the objective of re-establishing cisco in Lake Erie. A workshop sponsored by the Great Lakes Restoration Act was held in July 2003 reviewing the status and impediments for cisco recovery in the Great Lakes (Fitzsimons and O'Gorman 2004). The goal of the workshop was to help managers and interested researchers develop actions to assess cisco stocks and develop research with the goal of recovering remnant stocks. The loss of stocks was identified by the workshop participants as the most important impediment facing Great Lakes restoration efforts. Consequently, restoration stocking was identified as necessary, but only where it will not affect an existing remnant stock. Another cisco workshop was held in April 2006 to discuss a model developed for Lake Superior and implications for restoration in the Lower Great Lakes.

In an effort to determine if a remnant cisco stock still exists in Lake Erie, nine cisco specimens gathered over the past several years 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 of this research 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, unpublished data). The extant surviving cisco that is most similar to the Lake Erie remnant is from Lake Huron. The implications of these findings pose difficult management decisions for restoration efforts involving stocking with cisco from other sources of brood stock. However, the current stocks may not be large enough to re-establish themselves as a significant forage fish in the eastern basin of Lake Erie.

In recognizing that stocking is one possible outcome of the management decision process, and realizing that a long lead time is necessary between the decision to stock and the first stocking event, proactive disease testing of potential broodstock from viable sources has begun.. Positive results for BKD from Lake Superior bloaters in 2005 have eliminated this lake as a potential source of cisco broodstock gametes. Ciscoes collected from eastern Lake Ontario from November 2006 through 2009 were screened for various diseases by the NYSDEC Fish Disease Control Unit. Tests for VHS, IHN, IPN, BKD, heterosporis, and furunculosis were all negative for these fish. Negative results are required for three consecutive years before the collection of brood stock or gametes can be considered. There is a need to investigate the possibility of using Lake Huron or Lake Michigan stocks as a source of brood stock.

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 underreported)
- 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 brood stock?
- What are the genetic implications of stocking on a remnant population? Is there currently a genetic bottleneck?

After discussions in February 2011, the CWTG have devised a plan of attack that involves a review of a draft decision tree and consultation with cisco experts from around the Great Lakes. This exercise will specifically consider the outstanding Lake Erie issues and questions and will create a roadmap to completion of the management plan. This exercise will result in a specific set of actions linked with the decision tree that will ultimately be organized into management actions within the plan.

To inform this exercise, CWTG members will be conducting a synthesis of current fishery assessment programs around the lake and overlaying it with historic information on cisco distribution. The purpose is to determine if current assessment programs are adequate (spatially, temporally and gear specific) to assess cisco status. Sufficient additional genetic samples have been gathered to re-examine the genetics question and the CWTG is pursuing this avenue as well. The current expectation is that a reviewable draft of the plan will be completed by late 2011.

References

Evans, D. O. and Loftus, D. H. 1987. Colonization of inland lakes in the Great lakes region by rainbow smelt, Osmerus mordax: their freshwater niche and effects in indigenous species. Canadian Journal of Fisheries and Aquatic Science 44 (Suppl. 2):249-266.

Fitzsimons, J. and R. O'Gorman. 2004. Status and assessment, research, and restoration needs for lake herring in the Great Lakes. Final Report: Great Lakes Restoration Act. Great Lakes Fisheries Commission, Ann Arbor, MI, USA.

Forage Task Group. 2010. Report of the Lake Erie Forage Task Group, March 2010. Presented to the Standing Technical Committee, Lake Erie Committee of the Great Lakes Fishery Commission, Ann Arbor, Michigan, USA.

Greely, J.R. 1929. Fishes of the Erie-Niagara watershed. Pages 150-179 in: A biological survey of the Erie-Niagara System, supplemental to eighteenth annual report, 1928. J.B. Lyon Co., Albany, NY, USA.

Hartman, W.L. 1973. Effects of exploitation, environmental changes and new species on the fish habitat and resources of Lake Erie. Great Lake Fishery Commission Technical Report No. 22. 43 pp.

Oldenburg, K., M.A. Stapanian, P.A. Ryan, and E. Holm. 2007. Potential strategies for recovery of lake whitefish and lake herring stocks in eastern Lake Erie. Journal of Great Lakes Research 33(Suppl. 1):46-58.

Ryan, P.A., L.D. Witzel, J. Paine, M. Freeman, M. Hardy, S. Scholten, L. Sztramko, and R. MacGregor. 1999. Recent trends in fish populations in eastern Lake Erie in relation to changing lake trophic state and food web. pp. 241-289. In: M. Munawar, T. Edsall, and I. F. Munawar [eds.]. State of Lake Erie (SOLE) – Past, Present and Future. Ecovision World Monograph Series, Backhuys Publishers, Leiden, The Netherlands.

Scott, W.B. and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin of the Fisheries Research Board Canada 184. Ottawa, ON, Canada. 966 pp.

Selgeby, J.H., W.P. MacCuallum, and D.V. Swedberg. 1978. Predation by rainbow smelt (Osmerus mordax) on lake herring (Coregonus artedi) in western Lake Superior. Journal of the Fisheries Research Board Canada 35:1457-1463.

Trautman, M.B. 1957. The fishes of Ohio. Ohio State University Press. Columbus, Ohio, USA. 782 pp.