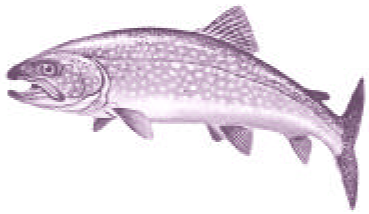
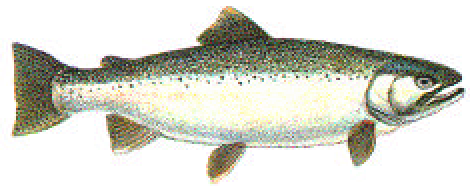

Report of the Lake Erie Coldwater Task Group

20 March 2006

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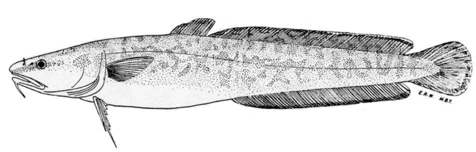
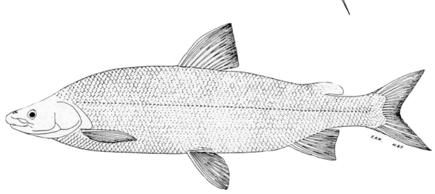
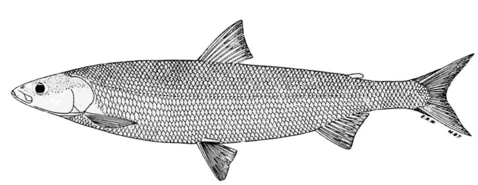
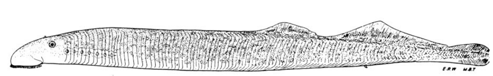
Presented to:

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.

Cover Art and Line Drawings from:

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2005 – 2006 Coldwater Task Group Charges

Charge 1: Coordinate annual standardized lake trout assessment among all eastern basin agencies and report upon the status of lake trout rehabilitation.

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

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

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.

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.

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, diet and exploitation.

Charge 7: Monitor the current status of Lake Erie lake herring. Review ecology and history of this species and assess potential for recovery

Charge 8: Improve description of diet for top coldwater predators.

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 status of that draft has not changed 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). While these two plans still serve as the working documents guiding current assessment efforts, a revision of the plan is due with the completion of the Lake Erie FCGOs (Ryan et al. 2003) identifying lake trout as the dominant predator in the profundal waters of the eastern basin. The group developed 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. A new charge concerning lake herring was added in 1999. The CWTG plans to revisit and update the Lake Trout Rehabilitation Plan beginning in 2006 and seeks to concentrate diet description activities under specific species' charges.

This report is specifically designed to address activities undertaken by the task group toward each charge in this past year and is presented verbally to the LEC at the 2006 annual meeting, held this year on 20-21 March 2006. Data have been supplied by each member agency, when available, and combined for this report, if the data conform to standard protocol. Individual agencies may still choose to report their own assessment activities under separate agency reporting processes.

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Charge 1: Coordinate annual standardized lake trout assessments among all eastern basin agencies and report upon the status of lake trout rehabilitation.

by James Markham, NYSDEC

Methods

A stratified, random design, deepwater 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 equal areas (A1-A8) using north/south-oriented 58000 series Loran C Lines of Position (LOP) bounded on the west by LOP 58435 and on the east by LOP 58955 (Figure 1.1). New York is responsible for sampling areas A1 and A2, Pennsylvania A3 and A4, and USGS/OMNR A5-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 standard eastern basin effort should be 60 standard lifts each for New York and Pennsylvania waters (2 areas each) and 120 lifts from Ontario waters (4 areas total). To date, this amount of effort has never been achieved. Areas A1 and A2 have been the most consistently sampled areas during the course of the survey 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 nets according to the sampling protocol.

Ten net panels, each 15.2 m (50 ft) long, are tied together to form 152.4-m (500-ft) gangs. Each panel consists of diamond-shaped units that have the same mesh size. Among the panels, mesh size ranges from 38 mm (1.5 in.) to 152 mm (6 in.) on a side (in 12.7-mm increments). Panels are arranged randomly in each gang. Gangs 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. NYSDEC 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 CWTG agencies except PFBC, which still uses nets made of multifilament nylon mesh, switched to standard monofilament assessment nets to sample eastern basin lake trout.

Sampling protocol requires the first gang to be set along the contour at which 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 deeper/colder water at increments of either 1.5 m depth or 0.8-km distance from the previous (shallower) gang, whichever occurs first along the transect. The fifth and deepest gang is set 15 m deeper than the shallowest net (number 1) or at a distance of 1.6 km 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 2005 by the combined agencies was 100 unbiased standard lake trout assessment lifts in the eastern basin of Lake Erie (Figure 1.2). This included 60 lifts by NYSDEC and 40 by USGS/OMNR. The PFBC was unable to sample in 2005 due to gear problems.

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

Results and Discussion

Abundance

Sampling was conducted in six of the eight standard areas in 2005 (Figure 1.1), collecting a total of 324 lake trout. Areas A1 and A2 again produced the highest catch per unit effort (CPE) values, coinciding with the areas in which stocking of yearling lake trout occurs. Lake trout catches were evenly dispersed in Ontario waters with Area A7 producing the highest CPE value.

Seventeen age-classes of lake trout ranging from age 1 to 21 were represented in the catch of known-aged fish (Table 1.1). Similar to the past four years, young cohorts (ages 2-6) were the most abundant, representing 88% of the total catch in standard assessment nets (mesh sizes 38-152 mm; Figure 1.3). Cohorts age 7 and older were only sporadically caught. Lake trout age 10 and older continue to decline in overall abundance in the Lake Erie population, decreasing from over 30% in 2001 to only 3.2% of the overall catch in 2005. Three age-21 lake trout were sampled, which were the oldest lake trout ever caught in the assessment survey.

The overall trends in area-weighted mean CPE's of lake trout caught in standard nets in the eastern basin increased slightly in 2005 to 1.91 fish/lift (Figure 1.4). This continued a general trend of increasing abundance in the overall lake trout population that has been observed since 2000 and is slightly above the time series average of 1.81 fish/lift. Overall lakewide abundance was expected to increase due to the survival and recruitment of the successful 1999 through 2004 stockings.

The relative abundance of adult (age-5 and older) lake trout caught in standard assessment gill nets was initially monitored to gauge the response of the lake trout population to sea lamprey treatments initiated in 1986. The index now serves as an important indicator of the size of the lake trout spawning stock in Lake Erie. A significant ($P < 0.05$) drop in abundance of lake trout was observed in 1998 following a 6-year (1992-1997) period of steady growth, which corresponded to the decrease in lake trout stocking numbers that began in 1992. The 2005 CPE for age-5 and older lake trout sampled in New York standard assessment nets decreased for the second consecutive year to 1.03 fish/lift, well below the series average of 1.60 fish/lift (Figure 1.5). The decrease was not expected as the successful stockings in 1999 and 2000 should have begun recruiting into the age 5+ spawning population. This may be indicative of high mortality on the older lake trout segment of the population. Overall, the adult spawning stock abundance has been below average for five of the past six years, and the four lowest indices since the adult population began to build in 1989 have occurred since 2000.

Recruitment

The relative abundance index of ages 1-3 was 0.95 fish/lift. This was the third consecutive decrease in juvenile abundance from the 14-year high experienced in 2002 (Figure 1.6). The decrease was primarily due to the low recruitment of the 2003 stocking (age 3) and below target levels of stocking in 2004 and 2005. The appearance of 14 age-1 Klondike lake trout was higher than expected given the low number of stocked yearlings (54,200). Yearling lake trout (age 1) have been sampled five of the previous six years. Age 1-3 recruitment indices are expected to remain low in the next few years due to hatchery losses to disease, resulting in no available fish for stocking in 2006 and questionable, but reduced, numbers for 2007.

A recruitment index for overall survival of stocked fish to age 2 was developed in order to show patterns in yearly recruitment. This index was calculated by dividing age-2 CPE from NYSDEC standardized gill nets by the number of fish in that year class stocked. The quotient provided an index of survival to age 2 that was corrected for stocking. This was then multiplied by 100,000 to obtain an index equal to the age 2 catch per lift per 100,000 lake trout stocked. The results show a significant decline ($P<0.001$, $r^2 = 0.80$) in recruitment to age 2 from 1986 through 1999 (Figure 1.7). Very few of the yearlings stocked from 1994 through 1998 survived to age 2 in 1995 through 1999. The index began to increase in 2000 as survival of stocked lake trout increased and recruited to the fishing gear at age 2, likely due to a combination of different stocking methods, increases in lake trout stocking size, and decreases in the adult lake trout population. The age-2 lake trout recruitment index rose slightly in 2005 to an index of 0.27, which is equal to the time-series average (Figure 1.7). The increase was mostly due to the good recruitment of Klondike strain lake trout, which were abundant despite low stocking densities.

Strains

Similar to the last four years, six different lake trout strains were found in the 285 fish caught with hatchery-implanted coded-wire tags (CWTs) or fin-clips (Table 1.2). The majority of the lake trout remain Superior and Finger Lakes strain fish, which have been the most numerous stocked strains over the last six years. The Klondike (KL) strain, only stocked the past two years, was the only other strain type that occurred in any significant numbers in the 2005 survey. Lewis Lake (LL), Lake Ontario (LO), and Lake Erie (LE) strains comprised minor contributions to the Lake Erie stock. The Lake Erie strain was stocked in 1993 through 1996 from a broodstock of mixed strains previously stocked into Lake Erie. The broodstock was developed from the Finger Lakes, Superior, Lewis Lake, and/or the Lake Ontario strains (which is also a mixed-stock strain to complicate the matter).

The Superior strain continues to be the most prevalent strain in the younger cohorts. However, it is absent from returns at older ages. Returns at ages 4-6 are artificially high due to the size-at-stocking paired planting study which resulted in a 2x return rate for the larger-sized SUP strain fish (Einhouse et al. 2006). The Finger Lakes strain continues to show the most consistent returns with lake trout being caught from each year of stocking through age 12, and then at some of its older stockings (ages 20 and 21). Overall, there were poor returns from all strains over age 7.

Returns of the new Klondike (KL) strain of lake trout have been promising for the first two years. Return rates at age 2 were four times higher for the KL's (38.0/100,000 stocked) than the Finger Lakes (FL) strain (8.8/100,000; Table 1.3). Return rates of KL's at age 1 (25.8/100,000 stocked) were substantially higher than returns of age 1 Superior (SUP) strain lake trout in 2002 (15/100,000 stocked) which were part of a large:small paired stocking study with 2:1 returns of larger fish. Growth of Klondike strain lake trout has been comparable to other lean lake trout strains through age 2. Future surveys will continue to monitor the progress of these fish, and compare their growth, maturity, and wounding rates to the currently stocked lean lake trout strains.

Survival

Cohort analysis estimates of annual survival (S) were calculated by strain and year class using a three-year running average of CPE with ages 4 through 10 (Table 1.4). A running average was used due to the high year-to-year variability in catches. Mean overall adult survival estimates were highest for the Lake Ontario (LO) strain (0.81) and lowest for the Lewis Lakes (LL) strain (0.59). Survival rates for the Lake Erie (LE) strain were also high (0.79), but this was based upon two year classes with relatively poor returns. The Finger Lakes (FL) and Superior (SUP) strains, the most stocked lake trout strains in Lake Erie, had overall mean survival estimates of 0.76 and 0.71, respectively. Survival estimates prior to 1986 are low due to the effects of a large sea lamprey population. Survival of the 1987-1991 year classes were comparably higher as the sea lamprey population declined 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 again. Mean overall survival estimates for all strains were above the Strategic Plan's target goal of 60% or higher (Lake Trout Task Group 1985) except for the LL strain. However, three out of five survival estimates prior to lamprey control (1983-85) were below the target goal, indicating the importance of lamprey control on the adult lake trout population.

Growth and Condition

Mean lengths-at-age and mean weights-at-age of sampled eastern basin lake trout remain consistent with averages from the previous five years (2000-2004) through age 8 (Figures 1.8 and 1.9). Deviations in older ages are due to low sample sizes. Overall growth of lake trout in Lake Erie continues to be some of the best in the Great Lakes basin.

Mean coefficients of condition, K, (Everhart and Youngs 1981) were calculated for age 3 and age 5 lake trout by sex to determine time series changes in body condition. Overall condition coefficients for both age 3 and age 5 lake trout remain above 1.0, indicating that Lake Erie lake trout are, on average, heavy for their length (Figure 1.10). Condition coefficients for age-3 lake trout declined from 1985 through 1990, increased to 1997, and then stabilized. Average age-3 male condition remains consistently higher than age-3 female condition. Condition coefficients for age-5 lake trout exhibited an increasing trend from 1993-1999. Female condition has since stabilized while male condition has declined but remains well above the standard (1.0).

Maturity

Seventy-four mature females ranging in age from 4 through 21 were sampled in standard assessment gill nets in 2005, generating a mean age of mature females of 6.03 years old (Figure 1.11). This is the fourth consecutive year that mature female lake trout have not met or exceeded the target mean age established in the Strategic Plan of 7.5 years (Lake Trout Task Group 1985) and is reflective of the low abundance of female lake trout older than age 7 present in the Lake Erie population. The plan's objective assumes that adult females would need at least two spawning years to contribute to the production of detectable, natural reproduction. Female lake trout in Lake Erie reach 100% maturation by age 5 (Einhouse et al. 2006).

Natural Reproduction

Despite more than 20 years of stocking, no naturally reproduced lake trout have been documented in Lake Erie. One potentially wild fish was caught in eastern basin coldwater gill net surveys in 2005, making a total of 28 potentially wild lake trout recorded over the past five years. Otoliths continue to be collected from lake trout without CWT's or fin-clips and will be used for future stock discrimination studies.

A GIS project is being conducted by the USGS (Sandusky) and Ohio Division of Wildlife to determine potential lake trout spawning sites within Lake Erie. The goal of this exercise is 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. In addition, a proposal was submitted to the GLFC for funding to further examine the sites identified in the GIS-phase of this exercise using side-scan sonar (in those sites not already examined), RoxAnn sonar, underwater video imaging, and diving to fully examine substrate type (i.e., bedrock, boulder, cobble) and interstice depth. The type and extent of future work will depend on funding.

Lake Trout Population Model

The CWTG has assisted the Forage Task Group (FTG) in the past by providing a Lake Trout Population Model (LTPM) to estimate the lake trout population in Lake Erie. The LTPM is a simple spreadsheet model initially created in the late 1980's and uses stocked numbers of lake trout and annual mortality to generate an estimated adult (age 5+) population. The population estimates are used in FTG bioenergetics models and to gauge the progress of Lake Erie lake trout rehabilitation efforts. The model starts with a known number of yearling equivalents for each cohort and then annually applies an appropriate survival rate to that cohort as it passes through the fishery up to age 20+. Applied mortality rates were derived mostly from past standard assessment data. Several adjustments to be model were made through the years to account for poor juvenile survival and increased mortality due to sea lampreys. Initial versions of the model matched observations seen in annual coldwater gill nets surveys conducted by the NYSDEC with an increasing lake trout population with high survival. However, runs of the original model in the late 1990's depict a departure between the model and annual surveys with the model showing a high, increasing lake trout population while surveys indicated a dropping population. Concerns over the LTPM to predict lake trout numbers were evident in the initial 1991 version of the bioenergetics model (Einhouse et al. 1999).

The Lake Erie CWTG has been updating and revising the LTPM over the past year, incorporating new information on strain performance, survival, sea lamprey mortality, longevity, and stocking into the model. The most recent working version of the LTPM separates each lake trout strain to accommodate strain-specific mortality, lamprey mortality, and stocking. The individual strains are then combined to provide an overall estimate of the adult (ages 5+) lake trout population. Unlike previous versions, the model now follows the general trend of the survey data and computes mortality estimates that are near levels measured from survey data. While the absolute numbers in the model are probably not comparable to the actual Lake Erie lake trout population, the model does provide a good tool for predicting trends into the future under various management and population scenarios. The 2006 model estimates the adult population of age 5 and older (using the new model) at around 38,000 fish, about 40% of what it was a decade ago when the lake trout population was at its peak. 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.

Population projections were made using the model to determine the effects of stocking and sea lamprey mortality. Model runs indicated that both stocking and lamprey control are major influences on the Lake Erie lake trout population. Under the scenario of low sea lamprey mortality (i.e. good lamprey control), the model shows that the lake trout population will increase over the next decade (Figure 1.12a). However, very little overall gains will be accomplished at recent stocking rates of 120K yearlings/year. Increasing stocking rates to 160K or 200K yearlings/year beginning in 2007 will increase the population much faster, and actually reach population levels seen in the early 1990's by 2016. If sea lamprey mortality continues at its current level (i.e. moderate lamprey control), then model runs show that the lake trout population will only expand by increasing stocking to 200K (Figure 1.12b). Lower stocking rates (120 – 160K) at moderate lamprey control will do little more than keep the adult lake trout population at its current level.

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Table 1.1. Number, sex, mean length and weight, by age class, of lake trout collected in gill nets (all gear types) from eastern basin Lake Erie, August, 2005.

AGE	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (g)
1	Combined	14	208	86
2	Male	14	364	502
	Female	6	361	533
3	Male	23	549	1917
	Female	4	511	1527
4	Male	88	647	3364
	Female	31	653	3395
5	Male	6	726	4123
	Female	22	720	4699
6	Male	27	710	4531
	Female	23	719	4785
7	Male	4	777	5852
	Female	1	752	4780
8	Male	3	749	5661
	Female	1	780	6340
9	Male	3	745	4960
	Female	0	---	---
10	Male	1	785	5480
	Female	1	815	6380
11	Male	0	---	---
	Female	2	804	7180
12	Male	1	850	6960
	Female	0	---	---
13	Male	0	---	---
	Female	1	809	7423
14	Male	0	---	---
	Female	2	745	5660
15	Male	1	860	7100
	Female	1	835	7730
16	Male	0	---	---
	Female	0	---	---
17	Male	0	---	---
	Female	0	---	---
18	Male	0	---	---
	Female	0	---	---
19	Male	0	---	---
	Female	0	---	---
20	Male	1	871	7260
	Female	0	---	---
21	Male	2	897	7805
	Female	1	832	6000

Table 1.2. Number of lake trout per stocking strain by age collected in gill nets from eastern basin waters of Lake Erie, August 2005. Stocking strain codes are: FL = Finger Lakes, LE = Lake Erie, LL = Lewis Lake, LO = Lake Ontario, SUP = Superior, KL = Klondike. Shaded cells indicate ages strain was stocked.

Age	**FL**	**LE**	**LL**	**LO**	**SUP**	**KL**
1						14
2	7					12
3	27					
4	30				90	
5	12				16	
6	4		7		40	
7					5	
8	3				1	
9	1		1		1	
10	1	1				
11	1	1				
12	1					
13				1		
14			1	1		
15				2		
16						
17						
18						
19						
20	1					
21	3					
Total	**91**	**2**	**9**	**4**	**153**	**26**

Table 1.3. Number, mean total length (mm TL), mean weight (g), stocking number, and return rate of known age lake trout by age class and strain collected in gill nets (all gear types) from eastern basin waters of Lake Erie, August 2005. KL = Klondike strain (humper); FL = Finger Lakes strain (lean)

AGE	STRAIN	SEX	NUMBER	MEAN LENGTH (mm TL)	MEAN WEIGHT (g)	NUMBER STOCKED (yearlings)	RETURN RATE (#/100,000)
1	KL	Combined	14	208	86	54,200	25.8
2	FL	Combined	7	358	513	80,000	8.8
	KL	Combined	12	368	522	31,600	38.0

Table 1.4. 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, 1985-2005. Three-year running averages of CPE from ages 4-10 were used due to year-to-year variability in catches. Shaded cells indicate survival estimates that fall below the 0.60 target rate.

	STRAIN				
Year Class	**LE**	**LO**	**LL**	**SUP**	**FL**
1983				0.687	
1984				0.619	0.502
1985				0.543	0.594
1986				0.678	
1987				0.712	0.928
1988		0.784		0.726	0.818
1989		0.852		0.914	0.945
1990		0.840		0.789	0.634
1991		0.763	0.616		
1992	0.719		0.568		
1993	0.857				0.850
1994					
1995					
1996					0.780
Mean	**0.788**	**0.810**	**0.592**	**0.709**	**0.756**

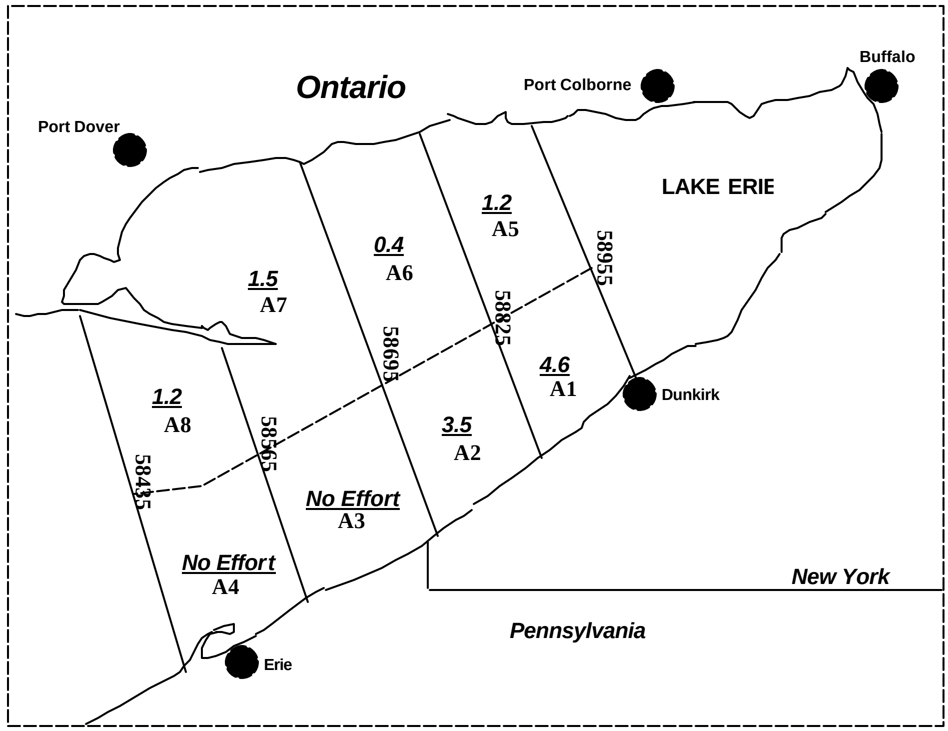


Figure 1.1. Standard sampling areas (A1-A8) used for assessment of lake trout in the eastern basin of Lake Erie. The numbers in each area represent 2005 CPE (number/lift) for total lake trout catch within that area.

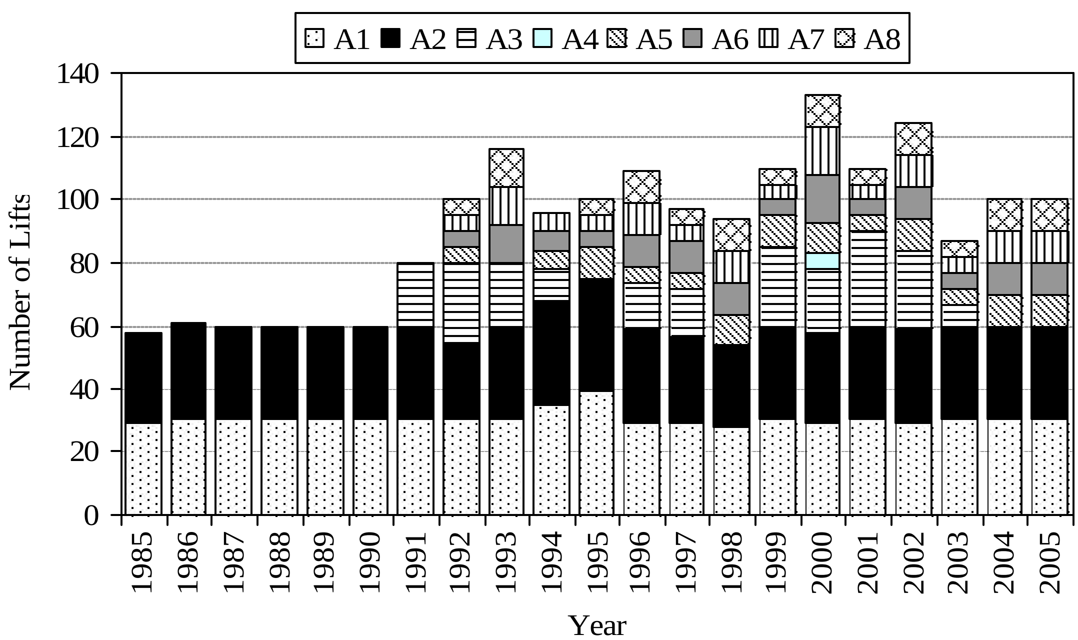


Figure 1.2. Number of coldwater assessment gill net lifts by area in the Eastern Basin of Lake Erie, 1985-2005.

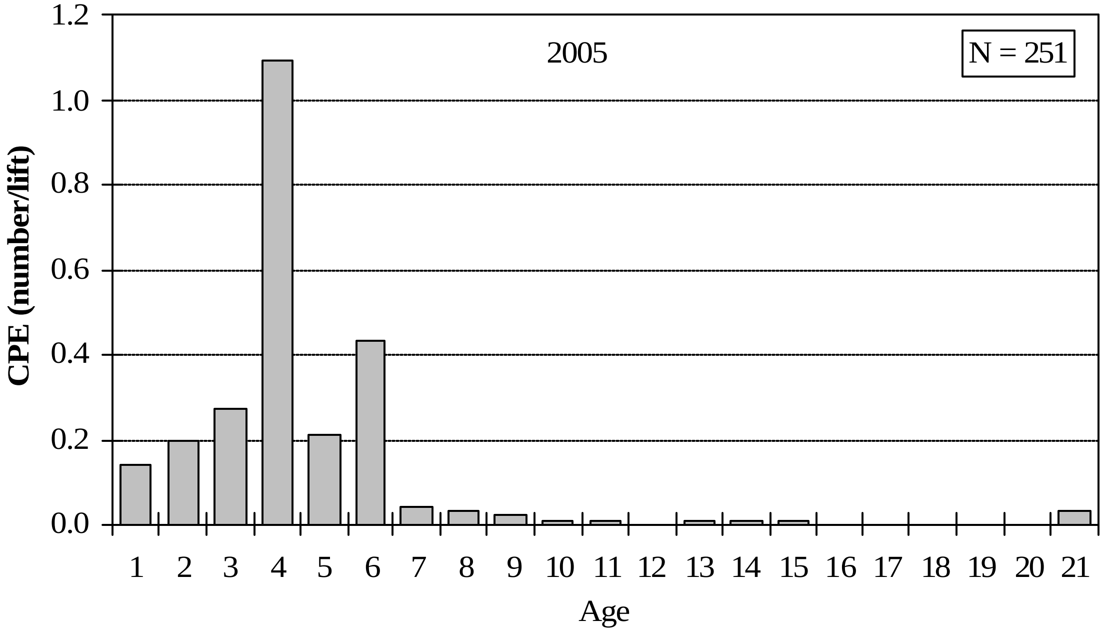


Figure 1.3. Relative abundance at age of lake trout collected from standard assessment gill nets fished in the eastern basin of Lake Erie, August 2005.

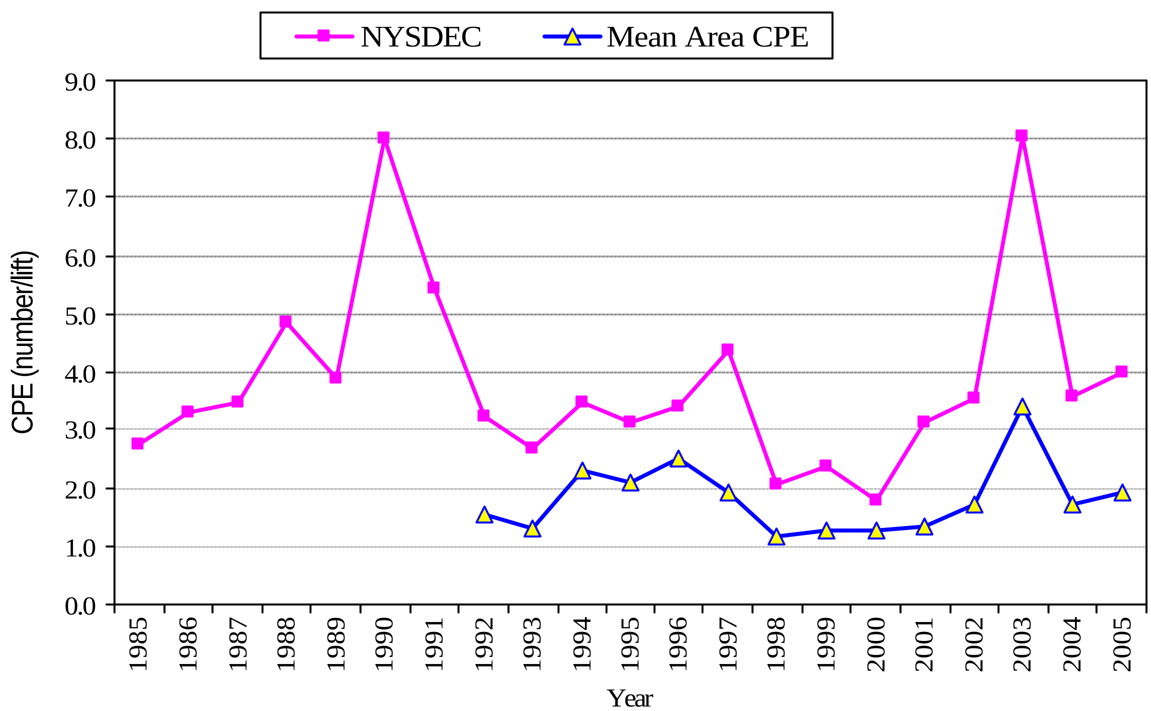


Figure 1.4. Mean CPE (number fish/lift) weighted by area for lake trout caught in standardized gill nets assessment surveys from the eastern basin of Lake Erie, 1992-2005. The NYSDEC series from 1985-2005 is also shown for reference to a longer time-series.

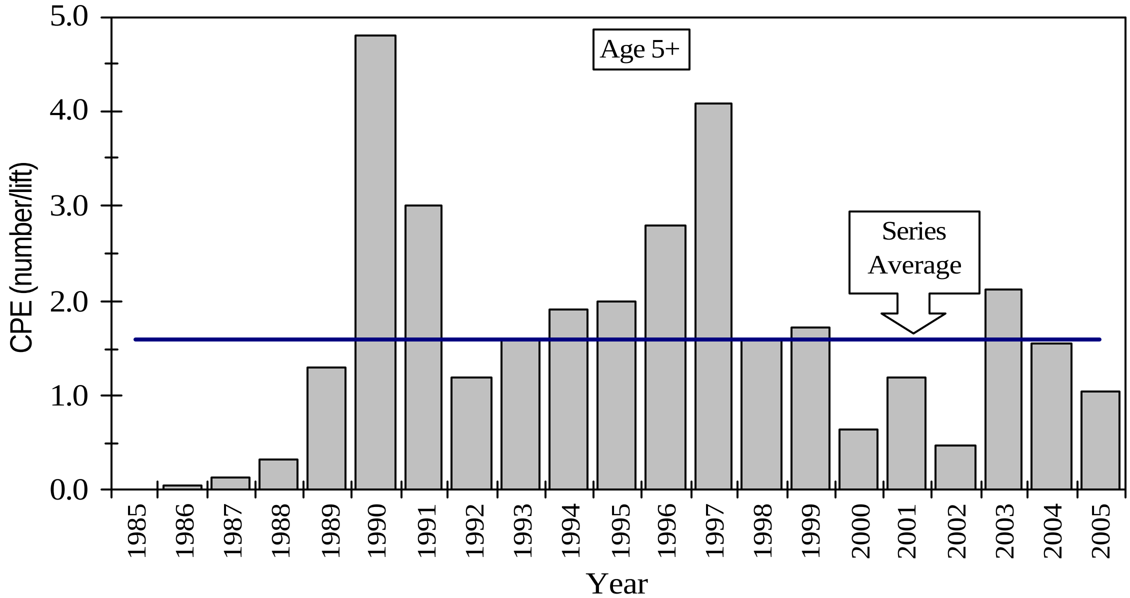


Figure 1.5. Relative abundance (number fish/lift) of age 5 and older lake trout sampled in standard gill net surveys from the New York waters of Lake Erie, August, 1985-2005.

Figure 1.6. Relative abundance (number fish/lift) of juvenile (ages 1-3) lake trout collected in standard assessment gill net surveys in the New York waters of Lake Erie, August, 1985-2005.

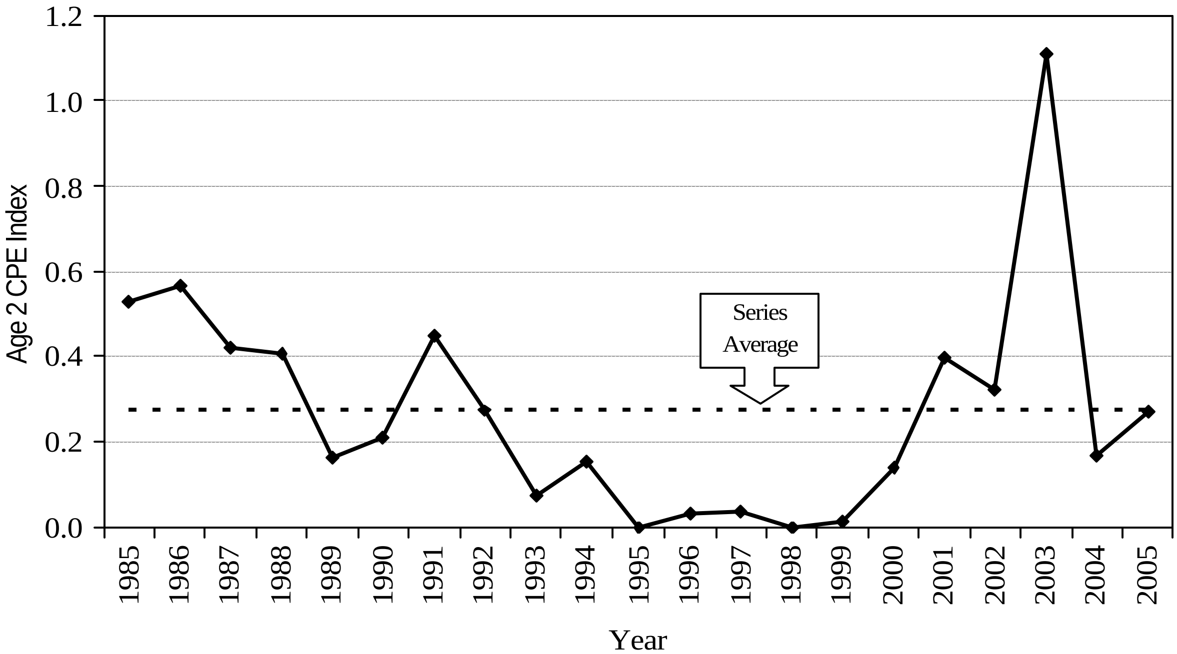


Figure 1.7. Index of age 2 recruitment of lake trout caught in standard assessment gill nets from New York waters of Lake Erie, August, 1985-2005. The index is calculated by dividing the age-2 CPE by the stocking rate for each cohort, and then multiplying by 100,000. The final index is equal to the number of age-2 fish caught per lift for every 100,000 yearling lake trout stocked.

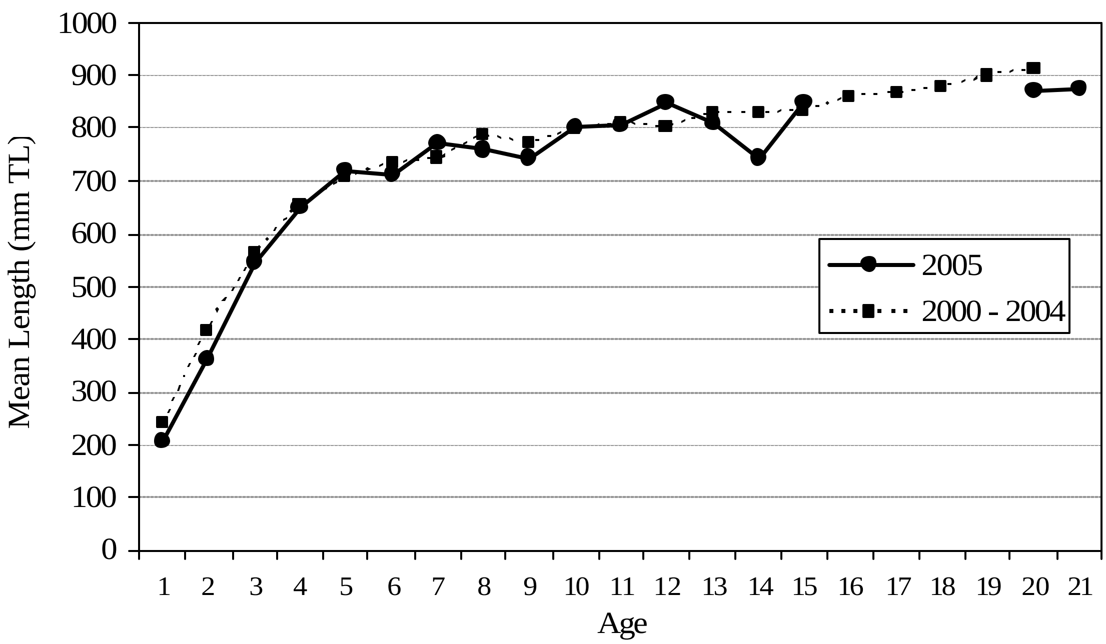


Figure 1.8. Mean length-at-age of lake trout collected in gill nets from the eastern basin of Lake Erie, August, 2005. The previous 5-year averages (2000-2004) from New York are shown for current growth rate comparison.

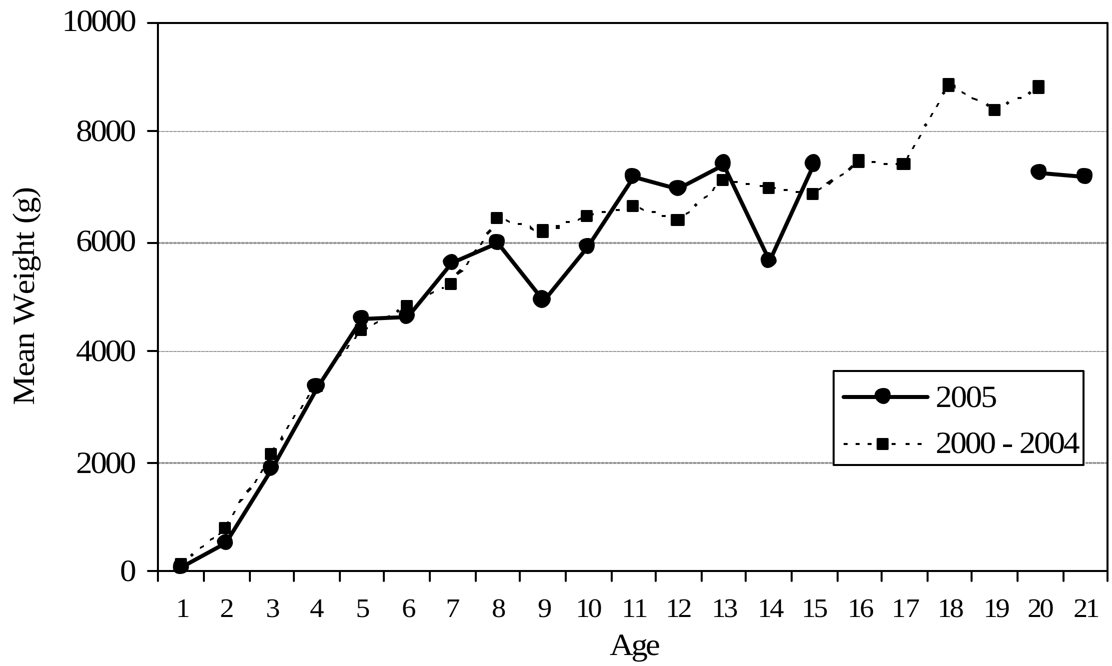
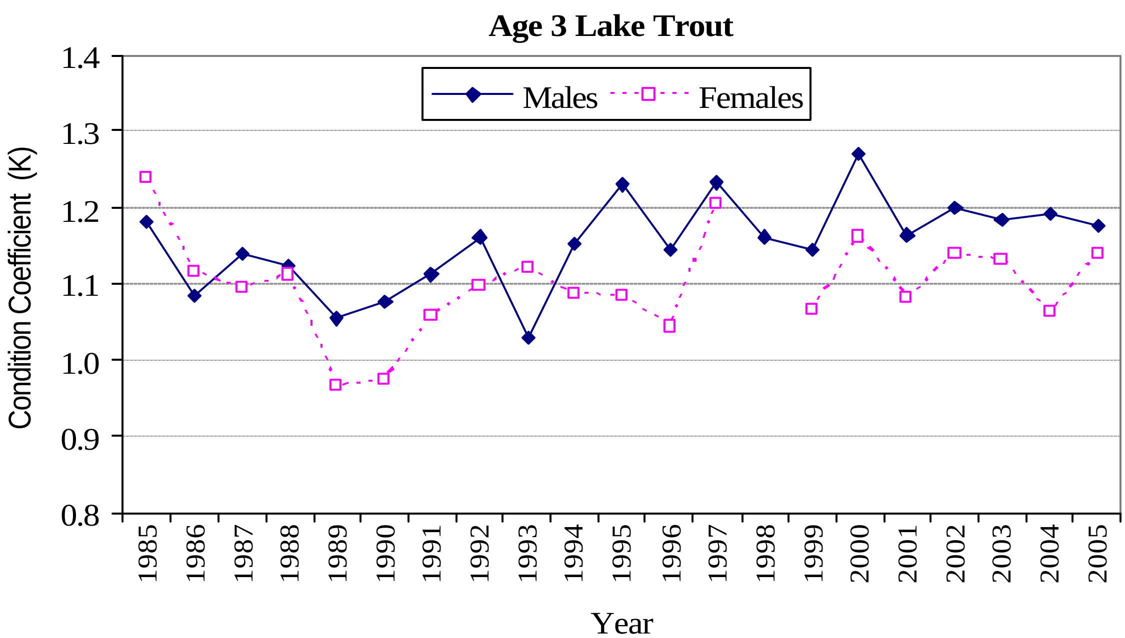


Figure 1.9. Mean weight-at-age of lake trout collected in gill nets from the eastern basin of Lake Erie, August, 2005. The previous 5-year averages (2000-2004) from New York are shown for current growth rate comparison.



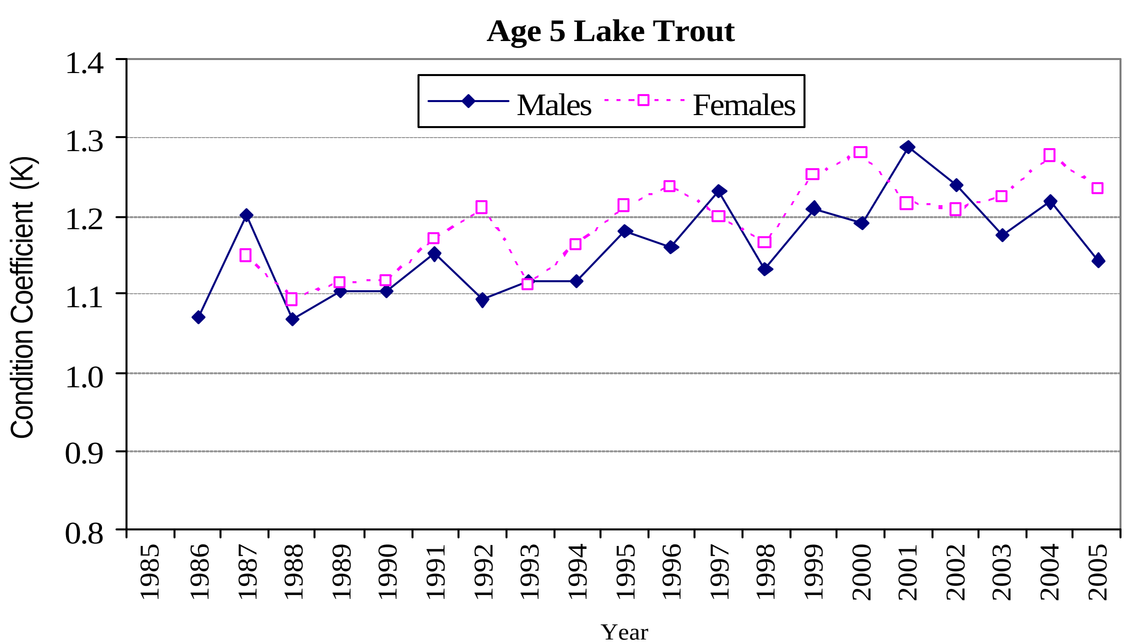


Figure 1.10. Mean coefficients of condition (K) for age-3 lake trout (top) and age-5 lake trout (bottom), by sex, collected in NYSDEC gill net assessment surveys, August, 1985-2005.

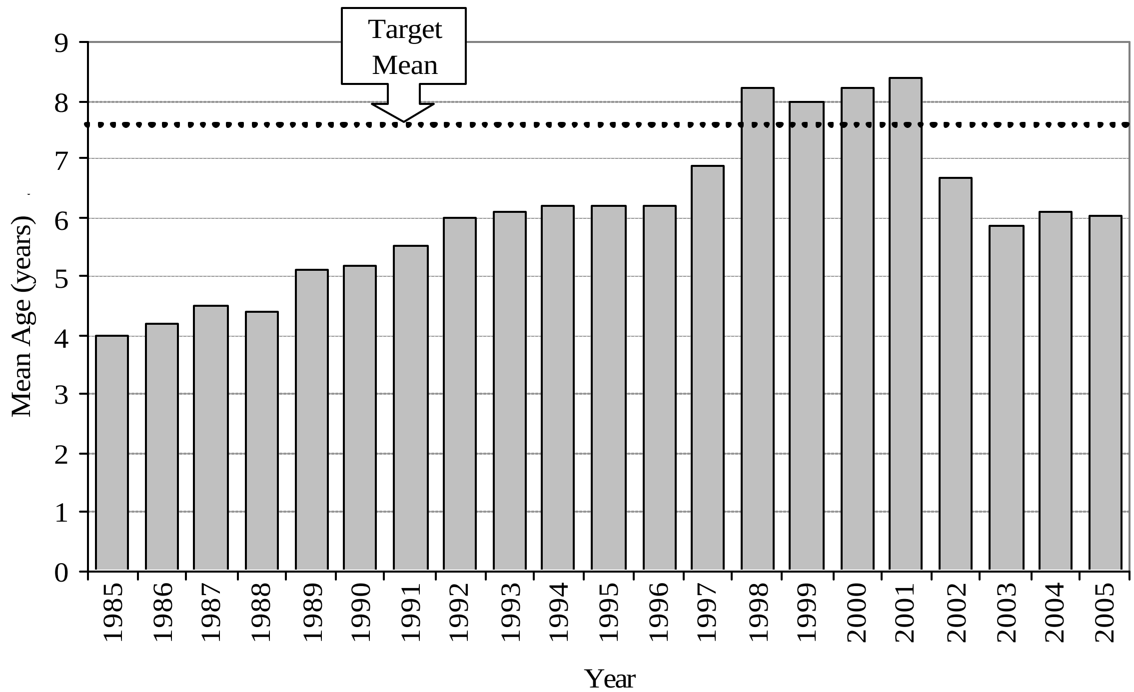


Figure 1.11. Mean age of mature female lake trout sampled in standard assessment gill net surveys in the eastern basin of Lake Erie, 1985-2005. The target mean age is 7.5 years.

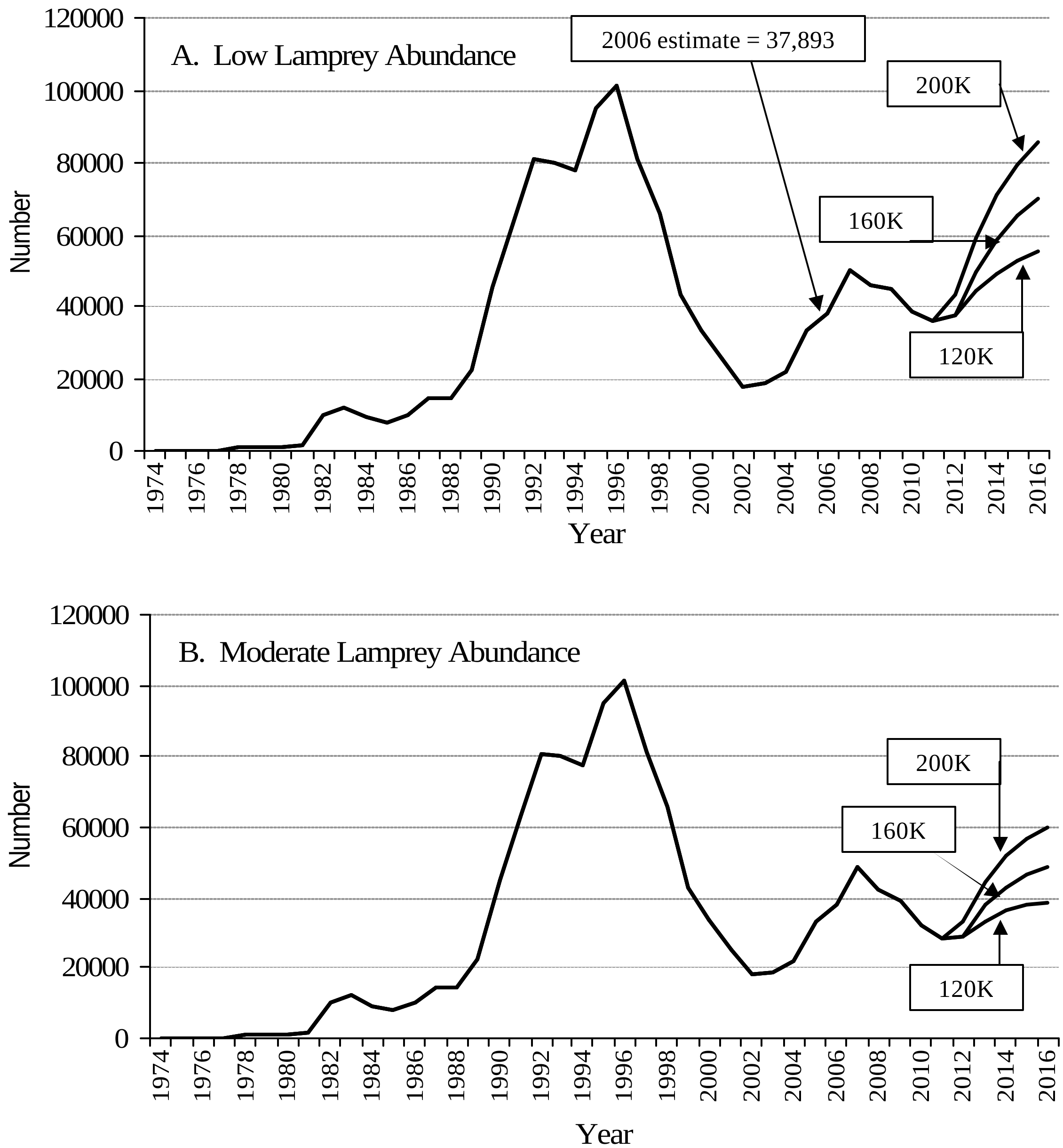


Figure 1-12. Projections of the Lake Erie adult (age 5+) lake trout population using the Lake Trout Population Model (LTPM), 1974-2016. Figure A is a projection of the adult lake trout population using low lamprey mortality (low abundance) and stocking rates varying from 120K, 160K, and 200K yearlings per year beginning in 2007. Figure B is a projection of the adult lake trout population using moderate lamprey mortality (moderate abundance) and stocking rates varying from 120K, 160K, and 200K yearlings per year beginning in 2007. The model estimates the current (2006) population at 37,893 adult lake trout.

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

By Andy Cook, OMNR and Kevin Kayle, ODW

Commercial Harvest

The total harvest of Lake Erie whitefish in 2005 was 326,836 pounds (Figure 2.1). Ontario accounted for the majority (99% or 321,660 lbs.) of the catch in 2005, while Ohio harvested 1% (4,613 lbs.), and Pennsylvania's harvest remained low (563 lbs.). Ontario's overall harvest decreased 48%, while Ohio's harvest decreased by 56% from 2004. Pennsylvania's harvest increased over six-fold from the minimal 91-pound harvest in 2004.

The majority (99%) of Ontario's 2005 whitefish harvest was taken in gill nets. The remainder was caught in smelt trawls and trap nets. The largest fraction of Ontario's whitefish harvest (70%) was taken in the central basin mostly during the spring (OE 2), followed by OE 1 (22%) in the fall and to a lesser extent in the spring. The remainder came from OE 3 (1%) and OE 4 (1%) during spring and fall, and OE 5 (5%) mostly in July. Ohio's whitefish fishery harvested 36% from March to June, but the majority (64%) was taken during October and November. Pennsylvania's harvest was distributed throughout the year, with 94% landed from May to October.

Ontario's 2005 annual targeted catch rates appear generally lower since 2000 with some differences between quota zones 1, 2 and 3 (Figure 2.2). Ohio's commercial trap net catch rates have declined from 2001, with 2005 representing the lowest in the series since 1996 (Figure 2.3). In contrast, catch rates in Pennsylvania's smaller commercial trap net fishery showed improvement over recent years (Figure 2.3).

Ontario's targeted gill net catch rates in the west basin differ between months, but describe a declining trend during the month of October (Figure 2.4). Interpretation of these catch rates is difficult due to fluctuations in targeted whitefish effort associated with reduced walleye quota during the Coordinated Percid Management Strategy (Figure 2.5). The majority of Ontario's targeted whitefish harvest in the west basin occurred in November (45,760 lbs.), during the peak whitefish spawning season in Lake Erie (Figure 2.6). The landed weight of roe from the 2005 whitefish fishery was 4,830 pounds with an approximate landed value of CAN$2.50/lb. Ontario's west basin fall fishery was likely dominated by age-4 fish, based on estimated harvest age composition derived from comparable mesh sizes of survey gear (Figure 2.7). The few Ontario commercial whitefish samples obtained described the 2001 year class (age 4) as dominant in central (OE 2) and east basin (OE 4) fisheries, with a range of ages up to 21 years (Figure 2.8). Whitefish are generally fully recruited to the whitefish gill net fishery by age 5, but may dominate the harvest at age 4 when year classes are relatively strong. Incidental harvest of whitefish from Ontario smelt trawls were composed primarily of age-2 fish (2003 year class).

Assessment Surveys

Whitefish gill net indices in Ontario and New York were somewhat promising in 2005 (Figures 2.9 and 2.10, respectively). New York's 2005 index surpassed the previous three years, while Ontario's west-central basin index was the highest in the series. However, Ontario's east basin index caught only three whitefish. Where survey catch rates improved, the increase can be attributed mostly to whitefish ages 2 and 4 (Figures 2.11 and 2.12). In 2005, young-of-year, and to a lesser degree, yearling lake whitefish were found in moderate numbers in Ohio central basin trawl surveys. Similar to other Lake Erie indices, whitefish caught in Ohio central basin surveys (trawl and gill net) were composed mostly of age-2 (57%) and age-4 (15%) whitefish with a range in ages up to 21 years old (Figure 2.13).

Growth and Diet

Each year, task group members monitor the condition of whitefish seen in assessment surveys using Fulton's coefficient of condition, K (Bagenal and Tesch 1978, Busacker et al. 1990), calculated as:

$$K=10000*\text{weight (in grams)} / \text{length (in mm)}^{3},$$

with K=1.0 as the fitness index metric for comparison purposes. In 2005, Ontario lake whitefish condition (ages 4 and older) remained near, but above, historic 1927-1929 averages for each sex (Van Oosten and Hile 1947; Figure 2.14). Ohio surveys showed that whitefish condition was good (mean K = 1.036, standard deviation=0.173) and was generally increasing with the size and age of whitefish (Figure 2.15). Whitefish condition seen in Ohio surveys tended to approach a maximum with larger size.

Whitefish diet information available in Ohio surveys showed the breadth of whitefish diets. The diets of young-of-the-year, yearling, and age-2 and older whitefish collected from the central basin are described according to mean percent of diet items by dry weight (Figure 2.16). Chironomid larvae, chironomid pupae, isopods, and sphaeriid clams were the most significant prey items in all age groups of whitefish. Tricopterans, leptodorans, and other invertebrates contributed to the juvenile whitefish diet. Yearling whitefish consumed a higher proportion of the zooplankton *Bythotrephes*. Hirudineans and gastropods contributed to the diets in older whitefish. Dreissenid mussels were prevalent in age-2 and older whitefish stomachs.

Research Efforts 2005-2006

Lake whitefish samples were collected from western Lake Erie in November and December to support a Great Lakes Fishery Trust project entitled "Does Adult Condition Affect Recruitment Potential in Lake Whitefish?" Forty-nine live reproductive fish (28 female, 21 male) were sampled for length, weight, sex, age, stomach contents, GSI, visceral fat index, stable isotope signature, and fatty acid profile of a number of tissues. Similar collections were made in Lake Superior and six locations in Lake Michigan. Preliminary results suggest Lake Erie lake whitefish are of similar condition and moisture content to those from Lake Superior and southern Lake Michigan sites and that all of these stocks are of better condition than those from northern Lake Michigan sites. Muscle energy content of lake whitefish was significantly higher in Lake Erie than at any other site, while egg energy content was lowest. Rapid growth, good condition, and high energy content of Lake Erie lake whitefish may explain why this stock continues to recruit well when compared to other Great Lakes stocks where food web changes have hampered their survival and production.

Roseman and others began a GLSC/FWS (Great Lakes Science Center/U.S. Fish and Wildlife Service) project in 2005 to quantify and characterize lake whitefish reproductive habitat in the Detroit River. Objectives include identifying spawning/incubation areas and associated physical characteristics; quantifying relative egg abundance and survival, assessing egg viability and physiological condition, predation of lake whitefish eggs, spawning stock characteristics (age, size, fecundity, genotype) and developing a geographic database of spawning sites using a geographic information system. Information gained from this study will support the development of comprehensive models of spawning and nursery habitats in the Huron-Erie corridor. A spawning-ready male lake whitefish was collected from the upper Amherstberg Channel in November 2005. Eggs believed to be lake whitefish eggs were collected in December, 2005, in the Detroit River at Hole-in-the-Wall west of Amherstberg, the Trenton Channel, and at the upstream end of the Amherstberg Channel. DNA analysis was planned for some of the eggs and while others were put in incubators for hatching.

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Bagenal, T.B. and F.W. Tesch. 1978. Age and growth. Pages 101-136 *in:* T.B. Bagenal, editor. Methods for assessment of fish production in fresh waters, 3rd edition. Blackwell Scientific Publications. Oxford, England.

Busacker, G. P., I. R. Adelman, and E. M. Goolish. 1990. Growth. Pages 363-387 *in*: C. B. Schreck and P. B. Moyle, editors. Methods for fish biology. American Fisheries Society. Bethesda, Maryland.

Van Oosten, J. and Hile, R. 1947. Age and growth of the lake whitefish, *Coregonus clupeaformis* (Mitchill), in Lake Erie. Trans. Am. Fish. Soc. 77: 178-249.

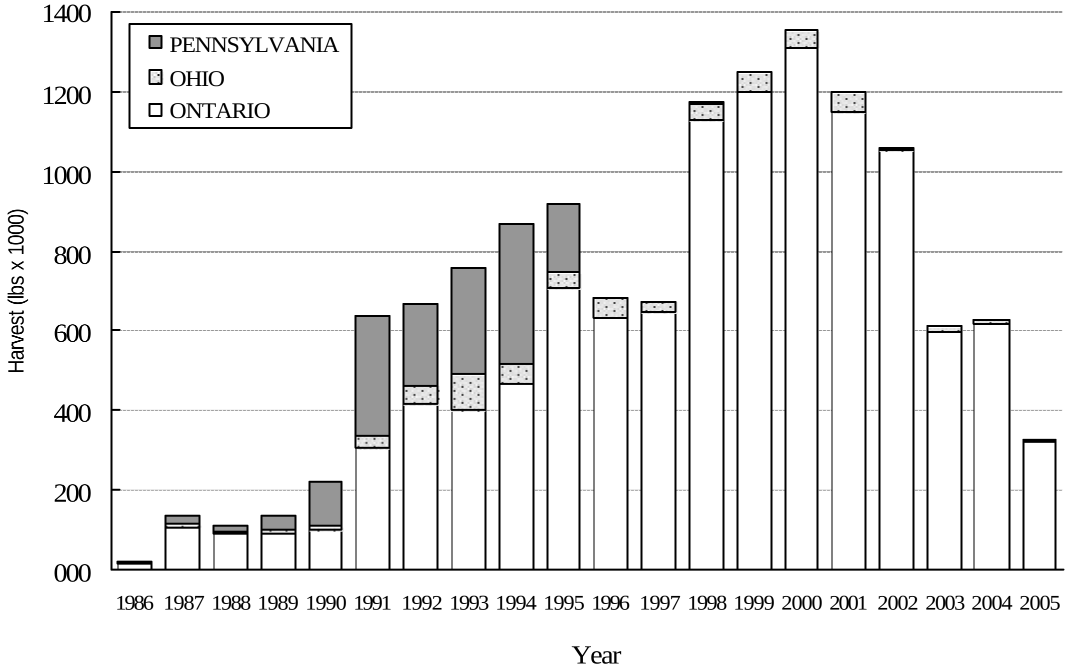


Figure 2.1. Total Lake Erie commercial whitefish harvest from 1986-2005 by jurisdiction. Note: Pennsylvania ceased gill netting in 1996.

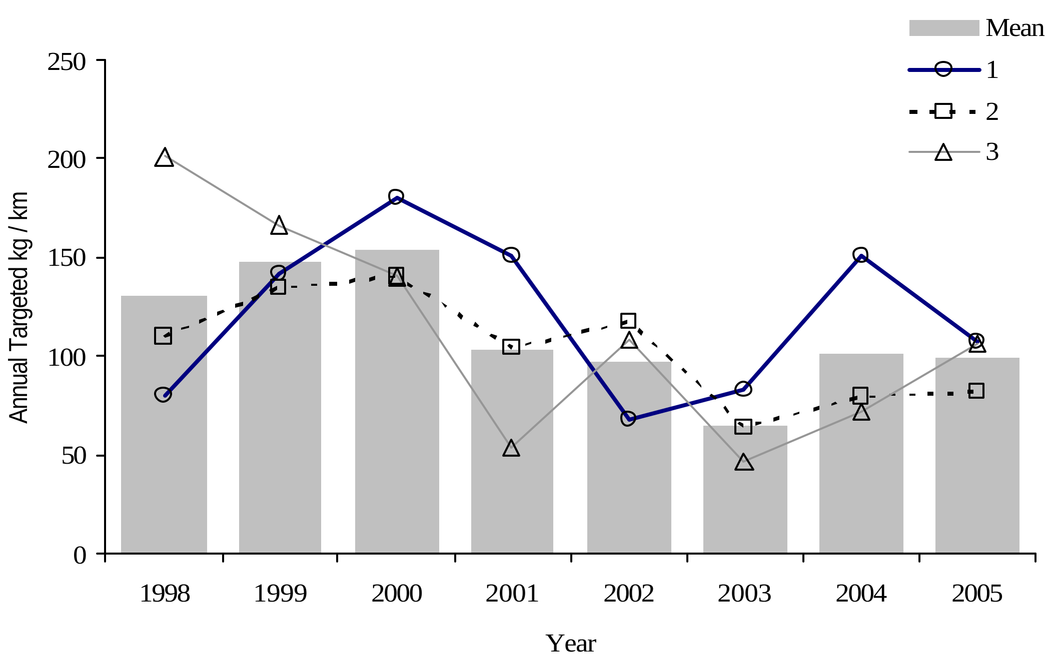


Figure 2.2. Ontario annual commercial large mesh gill net catch rates targeting lake whitefish by quota zone, 1998-2005. Bars represent the unweighted averages of catch rates by quota zone.

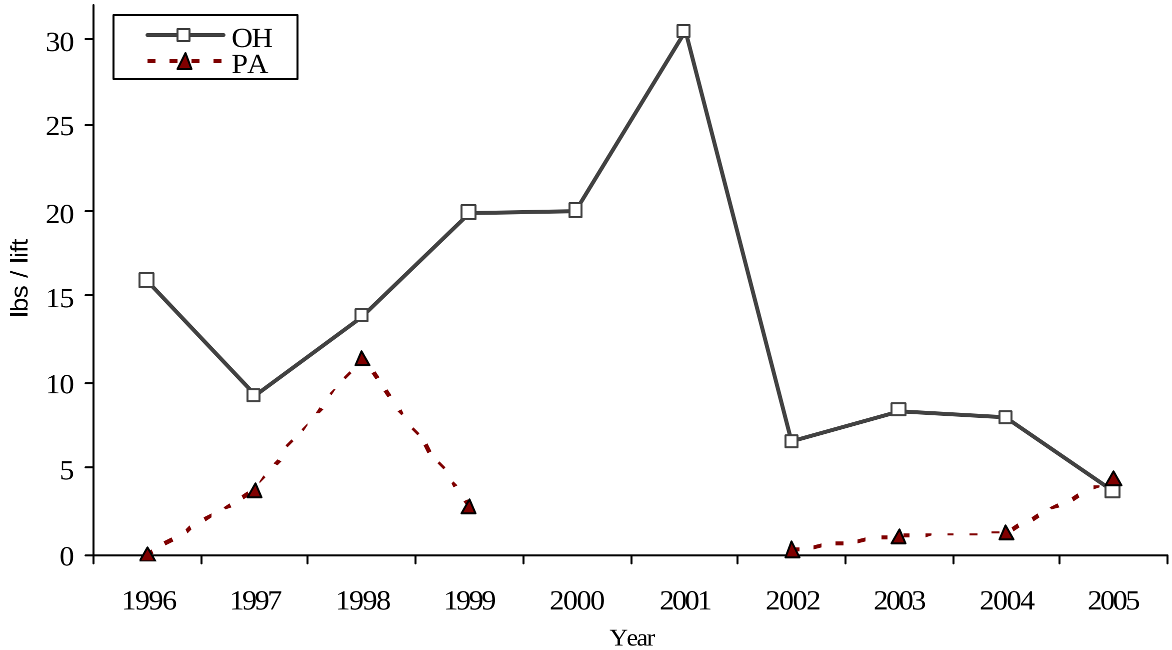


Figure 2.3. Ohio and Pennsylvania lake whitefish commercial trap net catch rates (pounds per lift), 1996-2005.

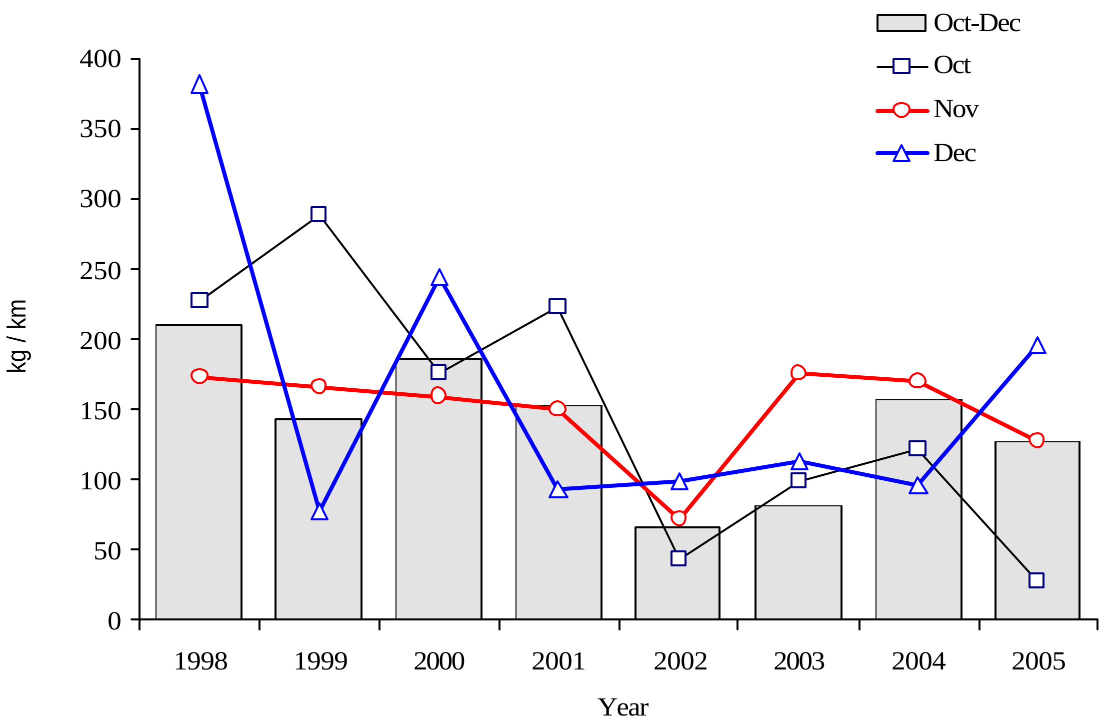


Figure 2.4. Targeted large mesh gill net catch rate (kg / km) for lake whitefish in the west basin of Lake Erie for October, November, December, and pooled (Oct.–Dec.), 1998–2005.

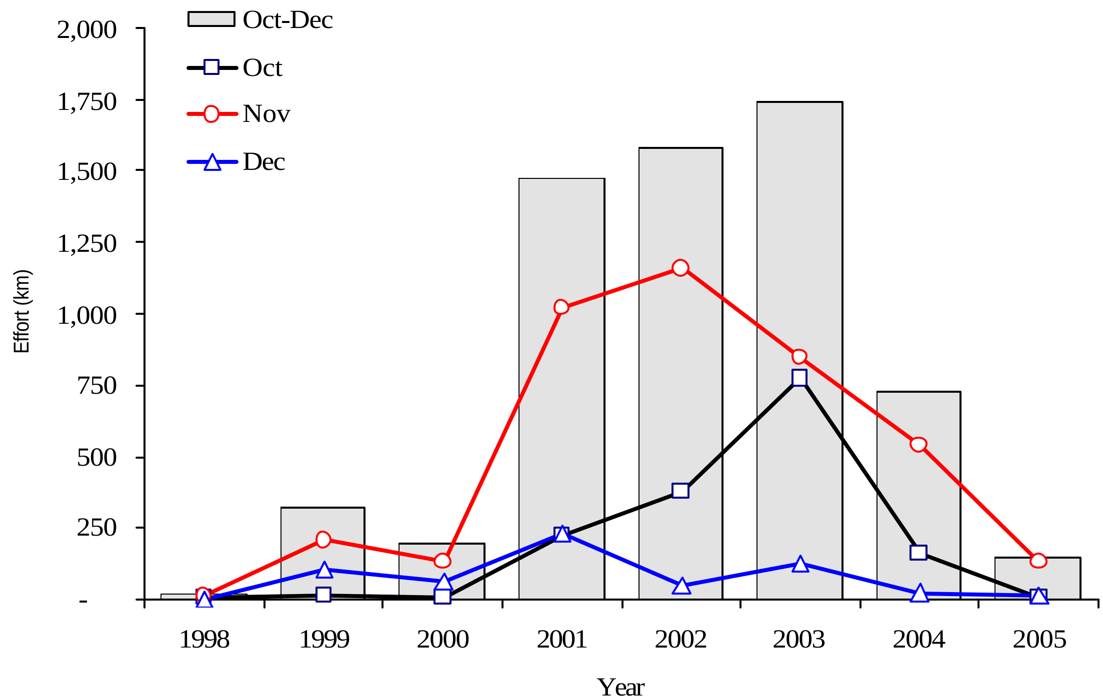


Figure 2.5. Targeted large mesh gill net effort (km) for lake whitefish in the west basin of Lake Erie for October, November, December, and pooled (Oct.–Dec.), 1998–2005.

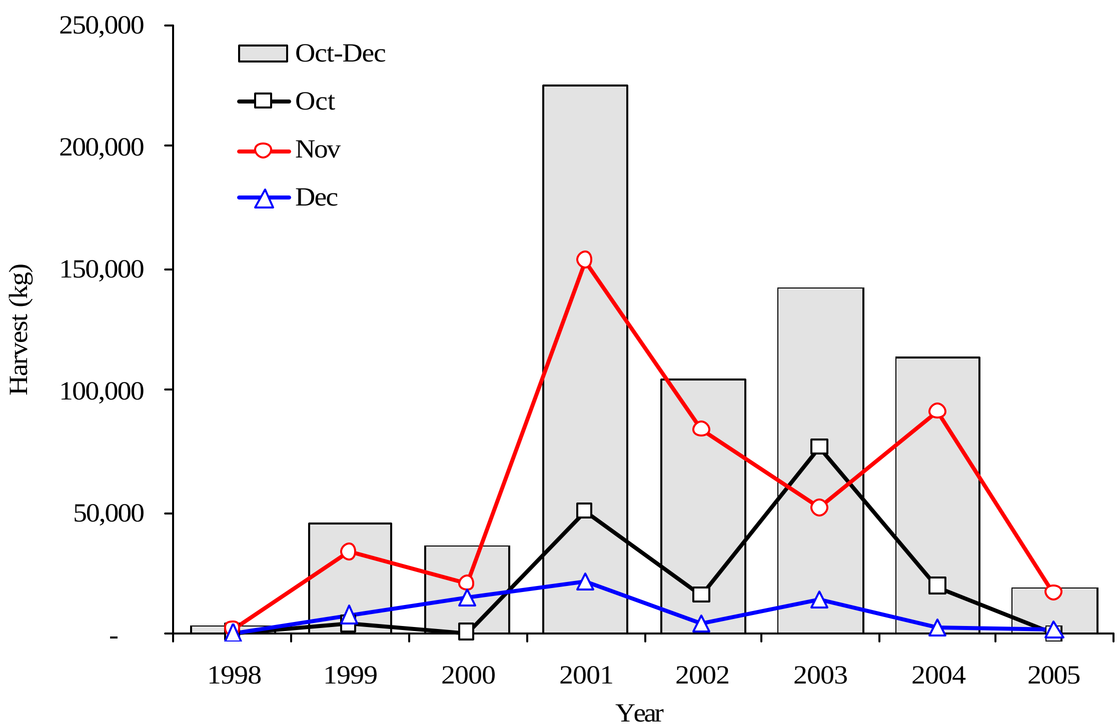


Figure 2.6. Targeted large mesh gill net harvest (kg) for lake whitefish in the west basin of Lake Erie for October, November, December, and pooled (Oct.–Dec.), 1998–2005.

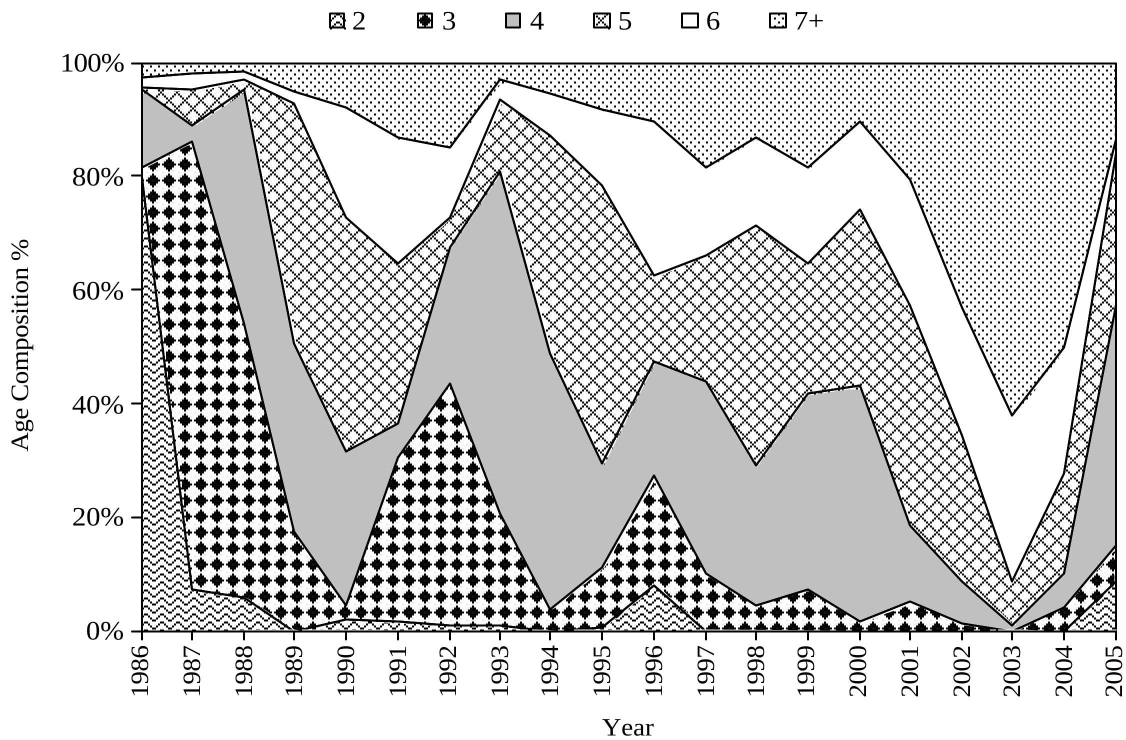


Figure 2.7. Ontario fall commercial whitefish harvest age composition in statistical district 1, 1986-2005 (Effort with gill nets >=3 inches, with whitefish in catch from October to December). Age composition in 2005 estimated from survey age composition in mesh sizes comparable to the fall OE1 fishery. Scale ages used for aging.

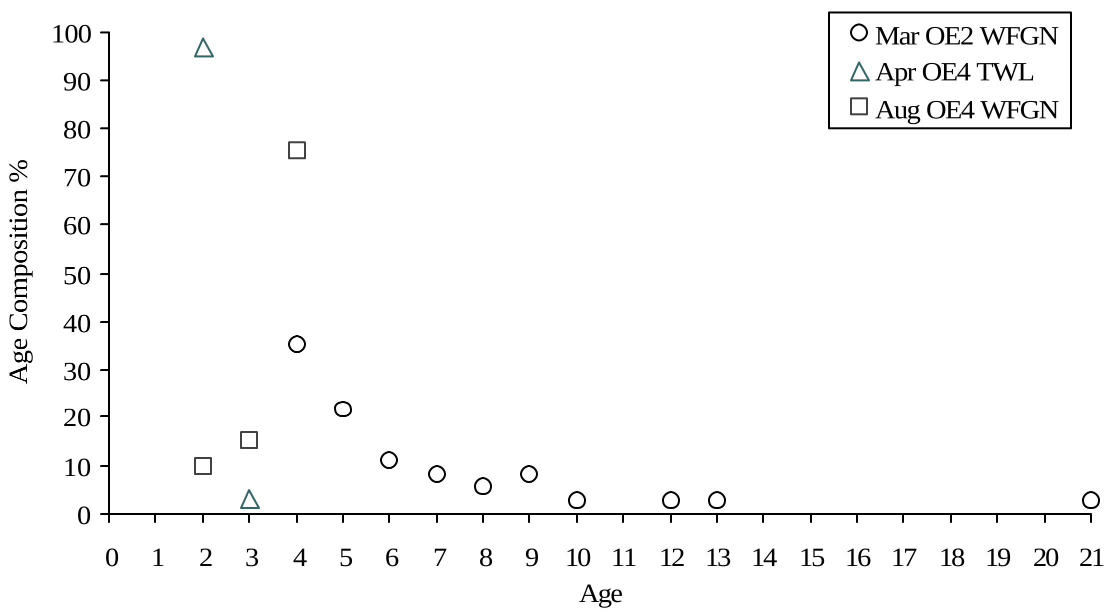


Figure 2.8. Age composition of lake whitefish caught commercially in Ontario waters of Lake Erie in 2005. Samples were obtained from the gillnet fishery targeting whitefish in statistical district OE2 in March (March OE2 WFGN), OE4 in August (Aug OE4 WFGN) and incidental whitefish from the smelt trawl fishery in OE 4 during April, 2005. Scales and otoliths were used for aging commercial whitefish samples.

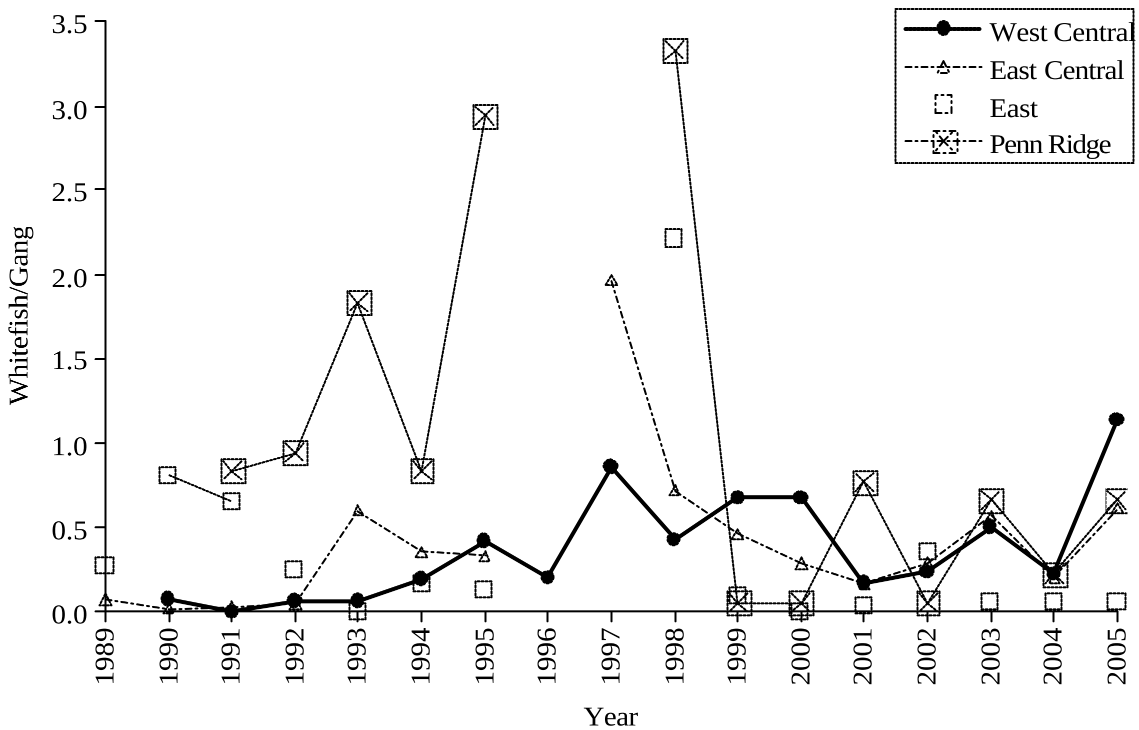


Figure 2.9. Catch rate (number per gang) of lake whitefish from Ontario partnership index gill netting by basin, Lake Erie, 1989-2005. West central basin was not surveyed in 1989. East central basin was not surveyed in 1996. East basin was not surveyed in 1996 and 1997; and few sites were fished in 1995. Pennsylvania Ridge not surveyed in 1989, 1990, 1996, and 1997. Includes canned (suspended) nets, excludes thermocline sets. Rates standardized to equal effort among mesh sizes.

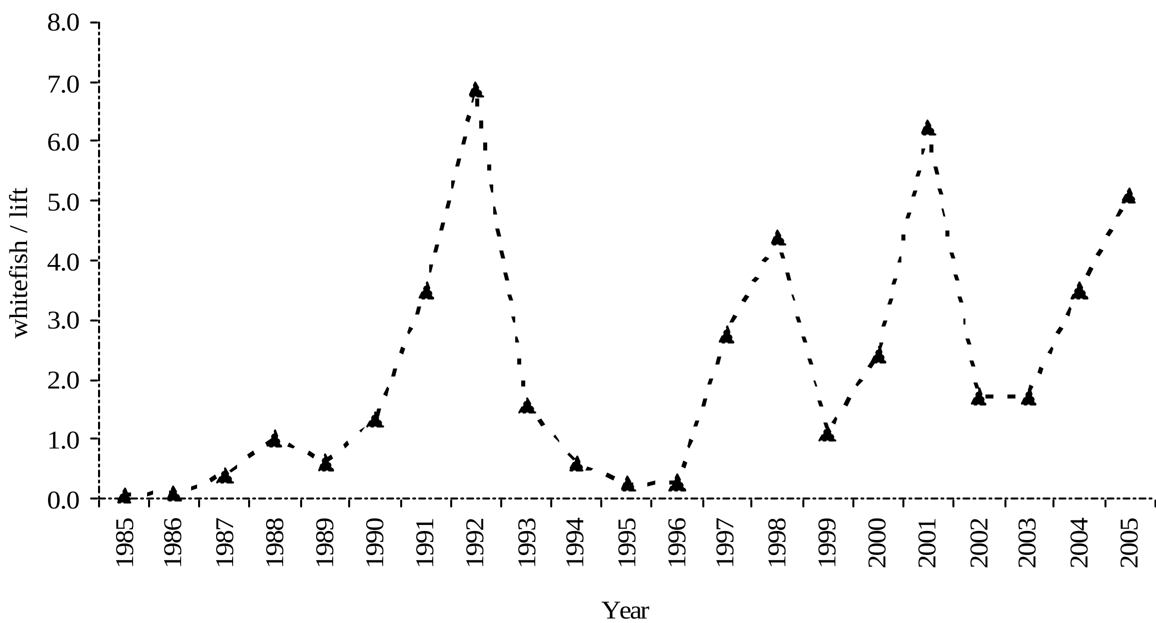


Figure 2.10. Catch per effort (number fish/lift) of lake whitefish caught in standard assessment gill nets from New York waters of Lake Erie, August 1985-2005.

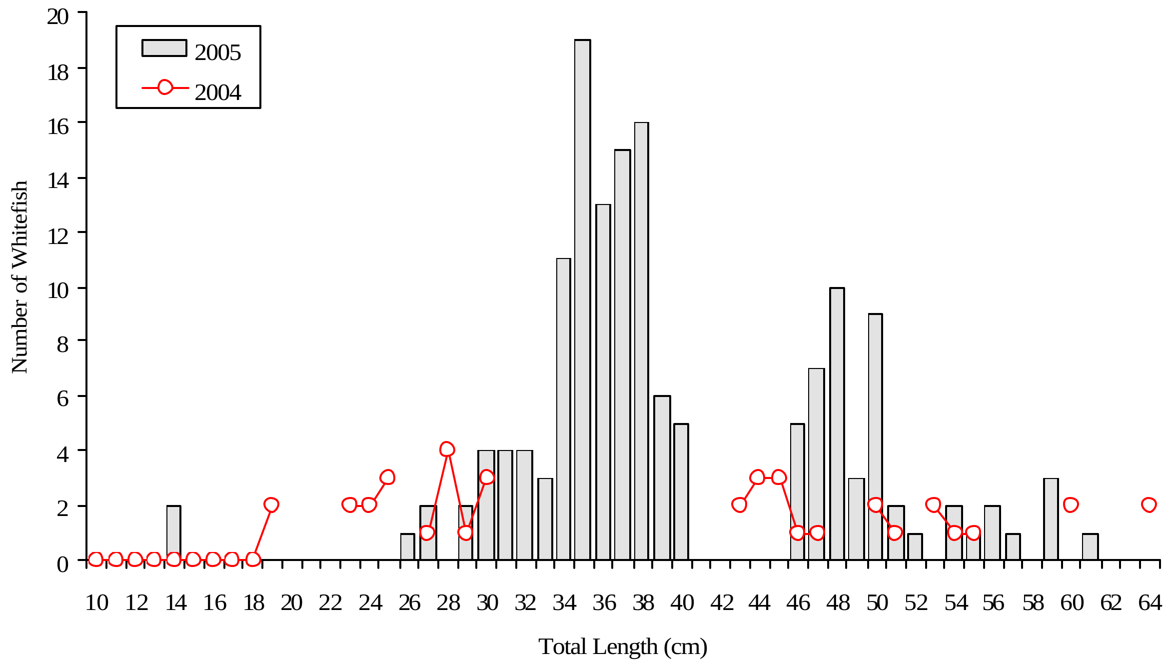


Figure 2.11. Length frequency distributions of lake whitefish collected during Ontario lakewide Partnership index fishing in 2004 and 2005. Rates standardized to equal effort among mesh sizes.

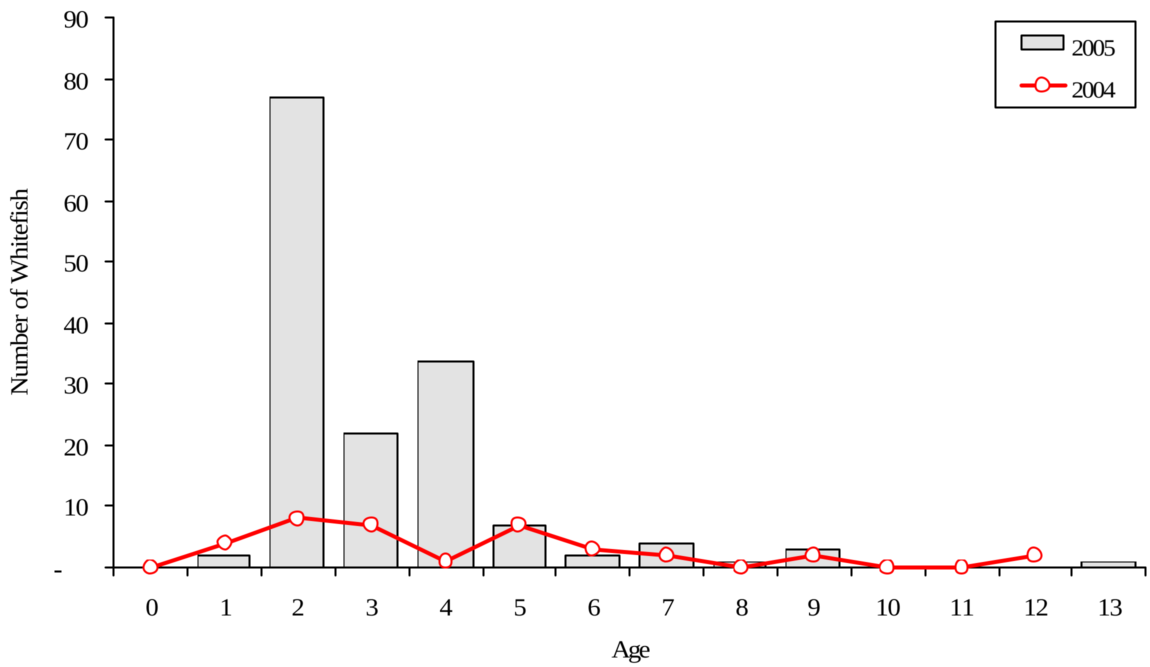


Figure 2.12. Age-frequency distributions of lake whitefish collected during Ontario lakewide Partnership surveys in 2004 and 2005. Rates standardized to equal effort among mesh sizes.

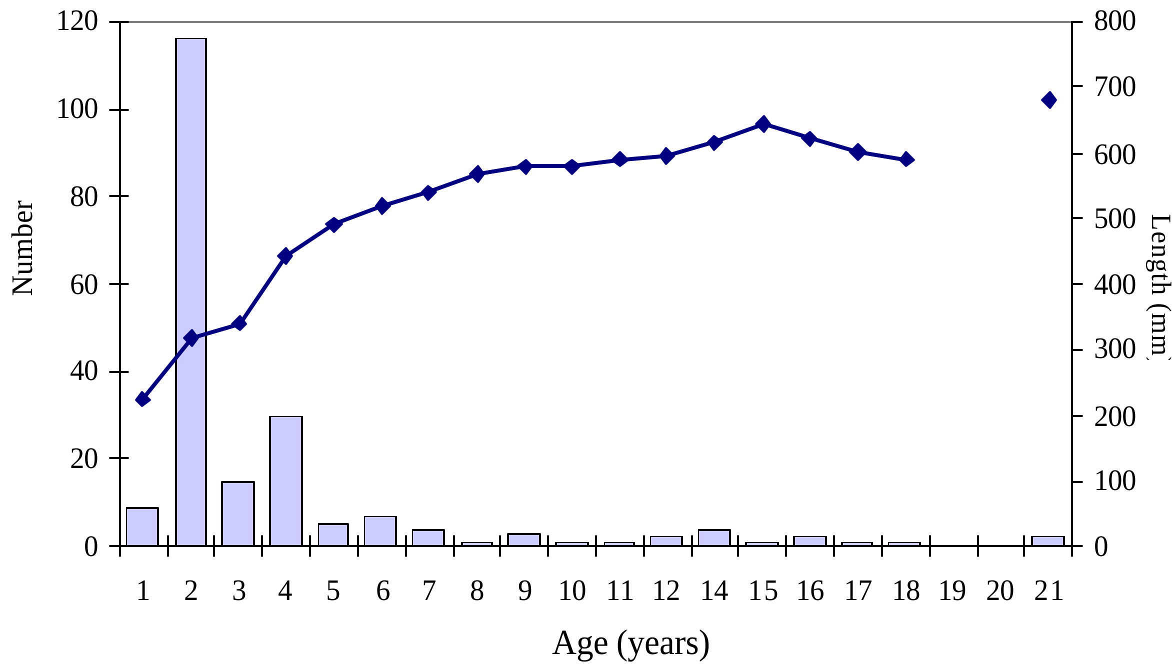


Figure 2.13. Age-frequency distributions (bars) and mean length-at-age (line) of lake whitefish collected during Ohio trawl and gill net assessment surveys in the central basin of Lake Erie, May-October 2005.

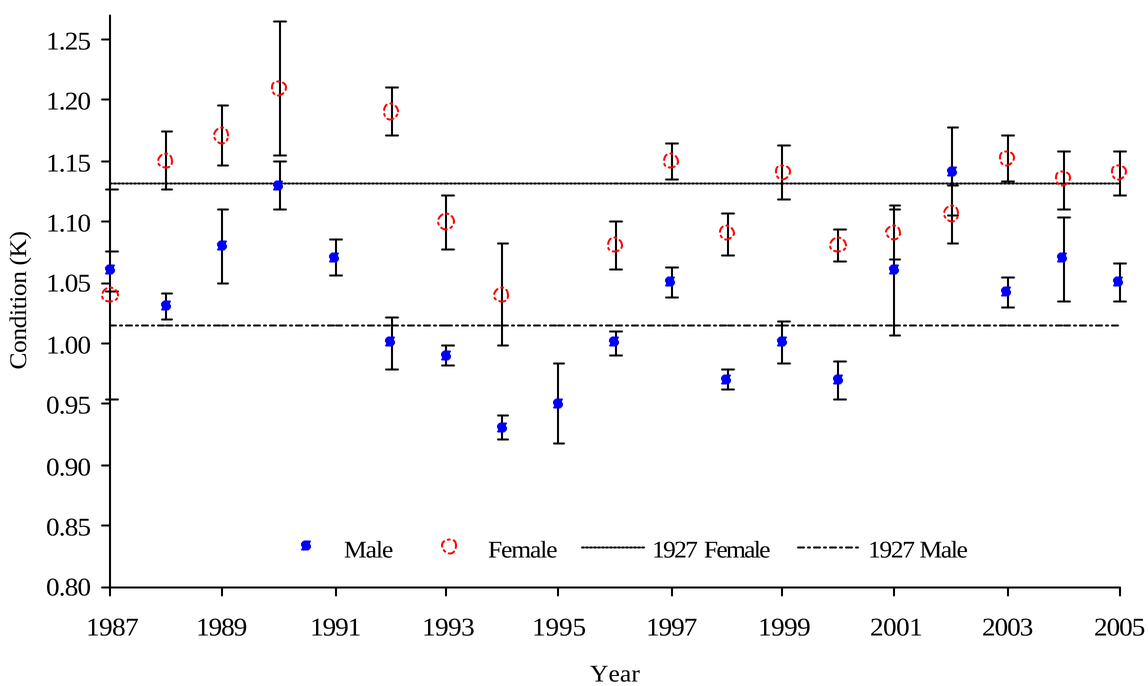


Figure 2.14. Mean condition factor of lake whitefish by sex from 1987-2005 with one standard error. Data includes whitefish ages 4 and older collected from Ontario commercial fish, Partnership, and whitefish index samples from October to December. Spent and ripe whitefish were excluded. Historic mean condition (1927–1929), presented as dashed lines, was calculated from Van Oosten and Hile (1947).

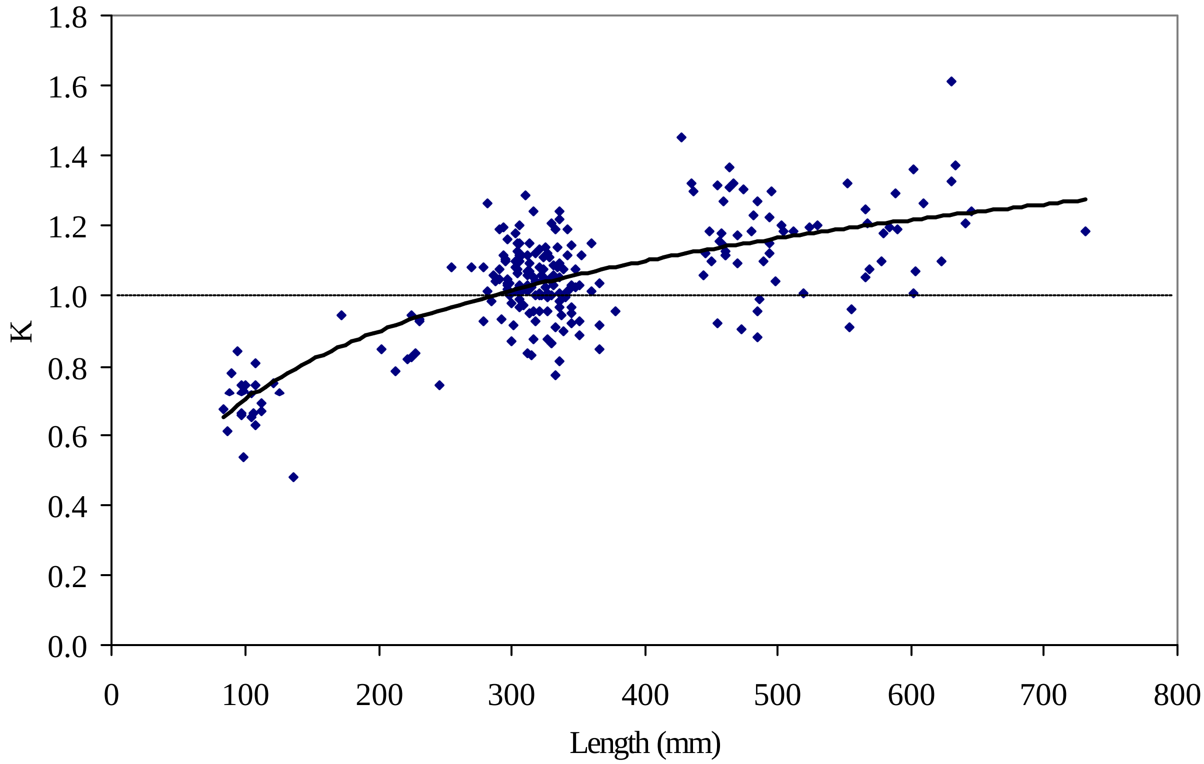
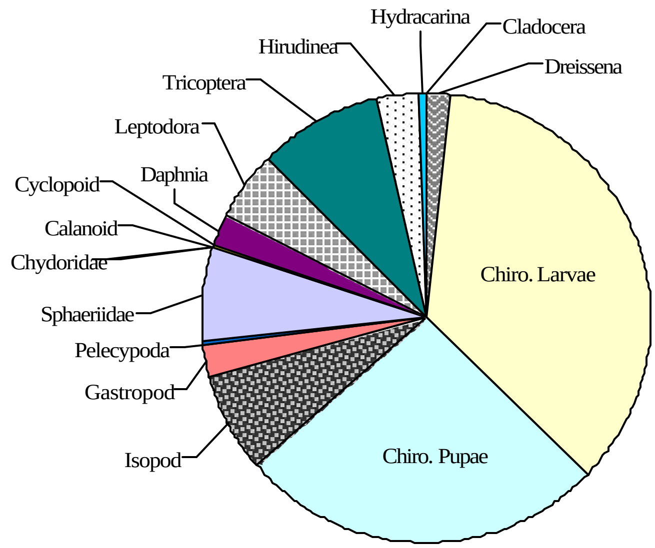
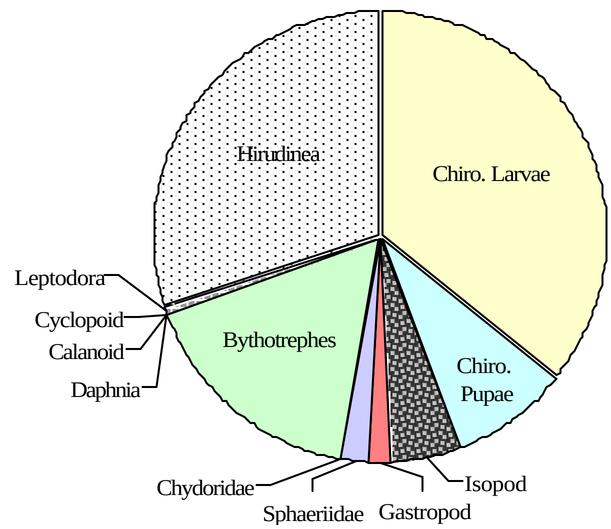


Figure 2.15. Condition (K) factor of lake whitefish sampled during Ohio Division of Wildlife trawl and gill net assessment surveys in the central basin of Lake Erie, May-October 2005. The horizontal K line is at K=1.0; mean of values was 1.036. The fitted line is a logarithmic trend line using least-squares methods.

Young-of-Year N=22
August & October



Yearling N=6
June, August & October



Ages 2 and Older N=118
June, August &
October

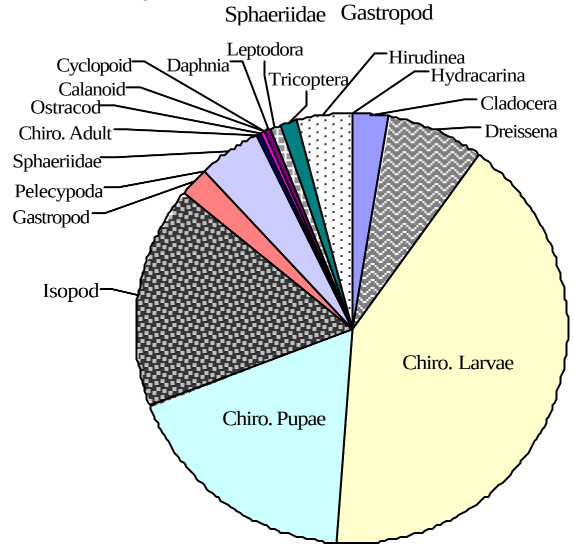


Figure 2.16 Stomach contents (mean % dry weight) of lake whitefish young-of-year (top), yearling (middle), and ages two and older (bottom), collected from Lake Erie's central basin by the Ohio Division of Wildlife trawls and gill nets from May to October, 2005.

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

By 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 (Table 3.1). Beginning in 1990, harvest began to increase, 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. 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 for the first time in recent history. As a result, the commercial harvest in Ontario increased dramatically (Table 3.1). However, this market did not continue, resulting in declining annual harvests from 2000 through 2003. The 2003 commercial harvest of 2,800 pounds of burbot was the lowest total in Lake Erie since 1988. Since 2003, overall harvest has increased due to an increase in the Ontario harvest. This harvest is a result of by-catch from various fisheries. The majority of the burbot by-catch (89%) came from the lake whitefish and rainbow smelt commercial fishery.

Assessment Programs

Burbot is one of the most commonly caught species in annual eastern basin coldwater gill net assessment surveys. In 2005, CPE and biomass per lift in Ontario and New York waters decreased from levels recorded in 2004 (Figures 3.1 and 3.2). Burbot were not assessed in Pennsylvania waters in 2004 or 2005. The catch of burbot in assessment surveys increased from 1993 through 2000 in all jurisdictions, but most dramatically in Ontario waters. Of the three jurisdictions, Ontario waters have yielded the highest catches since 1996. In general, New York waters exhibited a slower, but steady increase in catch per lift during 1993-2004. Between 2000 and 2003, the catch in Pennsylvania decreased to levels recorded in the late 1990s. Average total length and average mass of burbot increased in 2005 from 2004 levels, continuing an increasing trend in size since the late 1990s (Figures 3.3 and 3.4).

Burbot is one of the target species in the OMNR Partnership gill net assessment surveys conducted annually since 1989 in Canadian waters during the months of September and October. Burbot catches continues to be very low in the central basin (Figure 3.5). Burbot catches increased in the eastern basin and Pennsylvania Ridge area from 1992 to 1998, with a four-fold increase in catch occurring between 1995 and 1998. Catches in the Pennsylvania Ridge area showed an alternating pattern from 1999 through 2004, with the highest CUE recorded in 2003. This pattern did not continue in 2005; instead the CUE dropped to a number similar to the catches of the early 1990s. The catches in the east basin has generally been declining from a high in 1998. In 2005, the highest CUE observed was 1.68 fish/set in the east basin.

Burbot declined in all areas and in both assessment programs in 2005. In some areas this decline has been observed for two years. The cause is unknown, but one possible explanation would be a higher mortality in each of the two last years from sea lamprey. There has been a combination of higher sea lamprey abundance and lower number of adult lake trout, which are the preferred lamprey targets. Burbot are highly susceptible to sea lamprey wounding and die at a higher rate (Swink and Fredericks 2000). Data indicates that lamprey abundance has increased and wounding rates on lake trout are high (see

Charge 4 section of this report). Since lake trout abundance has declined recently, the sea lamprey may be targeting other coldwater fish species like burbot.

Age Structure and Growth

Two technicians from OMNR examined otoliths and determined age for 148 burbot caught in the Partnership gill net assessment in 2005 (Figure 3.6). Ages determined by the two readers ranged from 2-16 and 2-18. Mean age in the sample, as measured by the two technicians, was 8.8 years and 10.2 years, respectively. As expected, there was considerable variance between the two technicians, particularly for otoliths collected from older (i.e., $\geq$ 8 years old) specimens. Females and males exhibited a logarithmic relationship between total length and age, with females slightly longer than males over most of the range.

Diet

Burbot diets are covered in Charge 8 of this report.

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

Swink, W.D. and Fredericks, K.T. 2000. Mortality of burbot from sea lamprey attack and initial analyses of burbot blood. Pages 147-154 *in:* Burbot biology, ecology and management. Edited by V.L. Paragamian and D.W. Willis. Fisheries Management Section of the American Fisheries Society, Spokane, Washington.

Table 3.1. Commercial harvest of burbot (thousands of pounds) in Lake Erie by jurisdiction, 1980-2005.

Year	New York	Pennsylvania	Ohio	Ontario	Total
1980	0.0	2.0	0.0	0.0	2.0
1981	0.0	2.0	0.0	0.0	2.0
1982	0.0	0.0	0.0	0.0	0.0
1983	0.0	2.0	0.0	6.0	8.0
1984	0.0	1.0	0.0	1.0	2.0
1985	0.0	1.0	0.0	1.0	2.0
1986	0.0	3.0	0.0	2.0	5.0
1987	0.0	0.0	0.0	4.0	4.0
1988	0.0	1.0	0.0	0.0	1.0
1989	0.0	4.0	0.0	0.8	4.8
1990	0.0	15.5	0.0	1.7	17.2
1991	0.0	33.4	0.0	1.2	34.6
1992	0.7	22.2	0.0	5.9	28.8
1993	2.6	4.2	0.0	3.1	9.9
1994	3.0	12.1	0.0	6.8	21.9
1995	1.9	30.9	1.2	8.9	42.9
1996	3.4	2.3	1.2	8.6	15.4
1997	2.9	8.9	1.7	7.4	20.9
1998	0.2	9.0	1.5	9.9	20.5
1999	1.0	7.9	1.1	394.8	404.8
2000	0.1	3.5	0.1	30.1	33.8
2001	0.4	4.4	0.0	6.5	11.2
2002	0.9	5.2	0.1	3.4	9.5
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	10.0	13.3

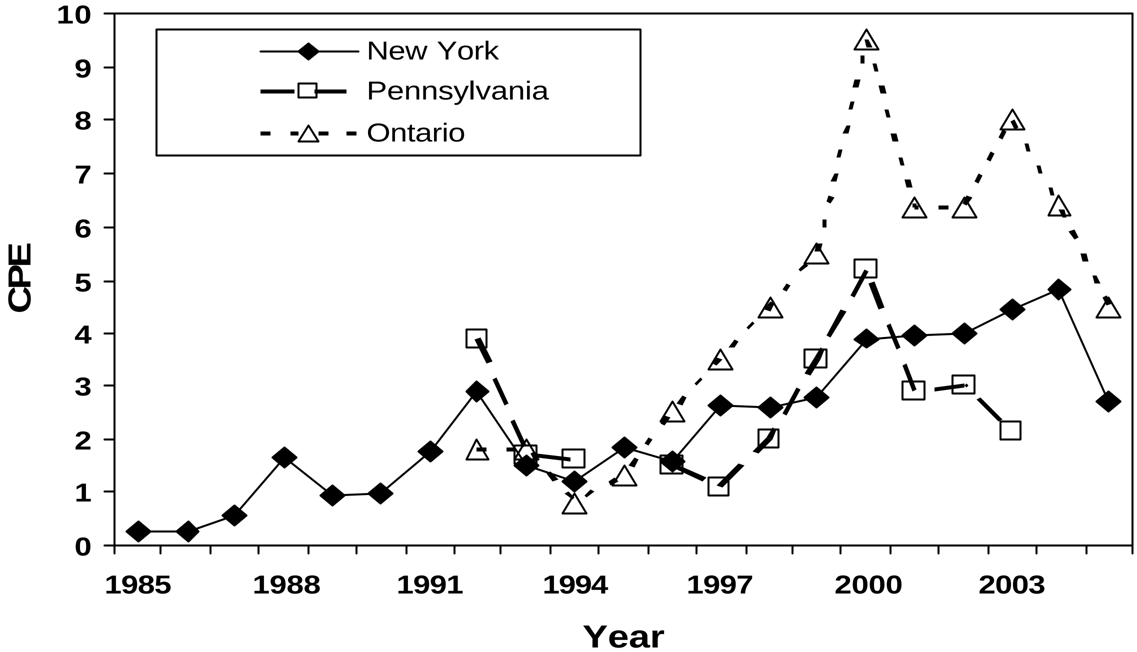


Figure 3.1. Average burbot catch rate (number of fish/lift) from summer gill net assessment by jurisdiction, 1985-2005.

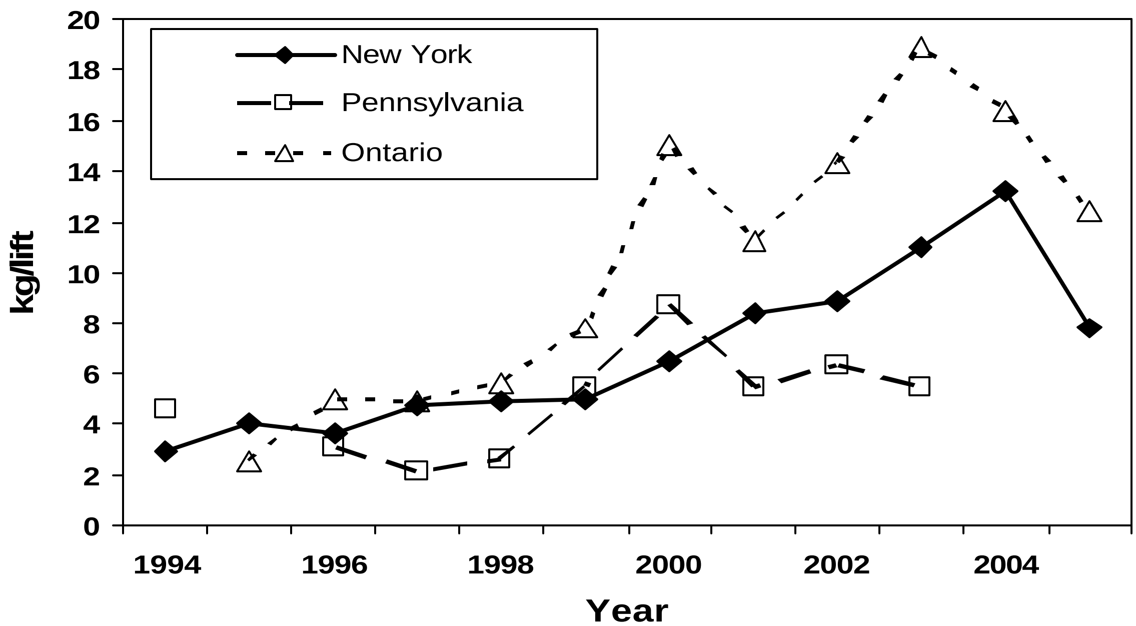


Figure 3.2. Average burbot biomass (kg/lift) from summer gill net assessment by jurisdiction, 1994-2005.

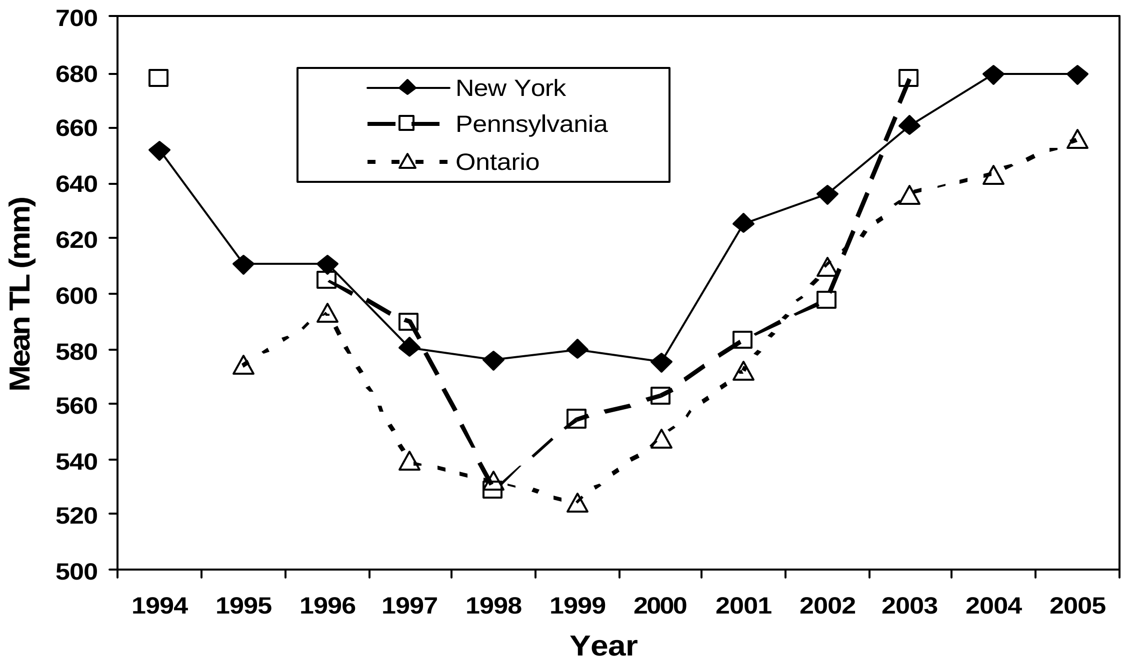


Figure 3.3. Average total length (TL) of burbot caught in summer gill net assessments by jurisdiction during 1994-2005.

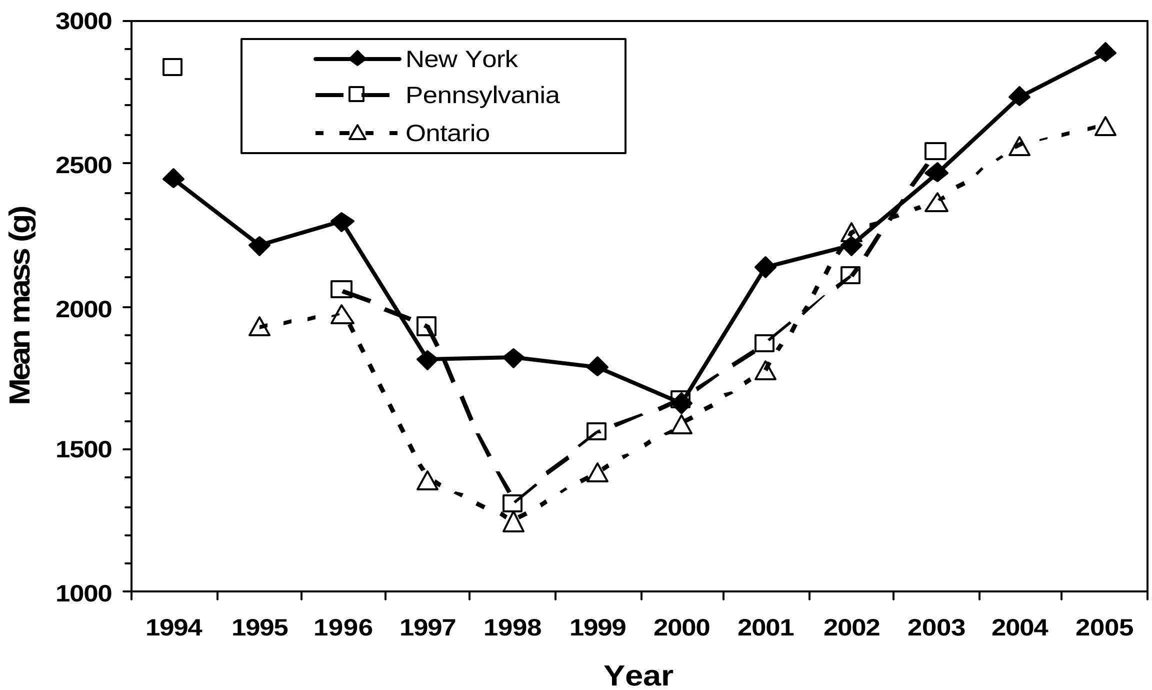


Figure 3.4. Average weight of burbot caught in summer gill net assessments by jurisdiction during 1994-2005.

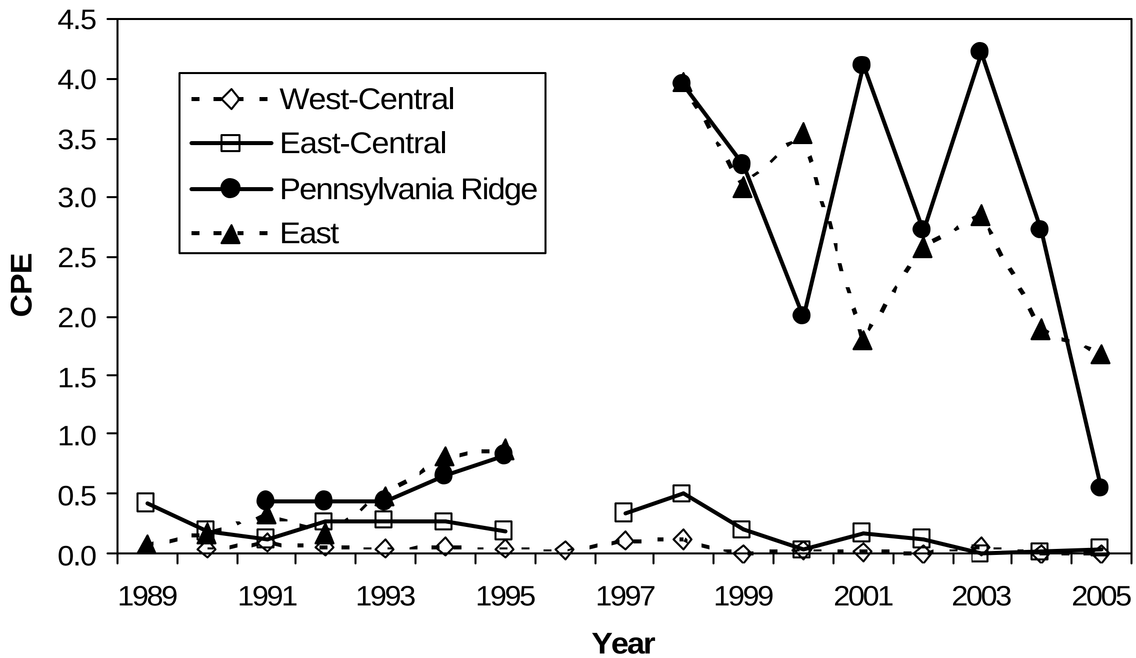
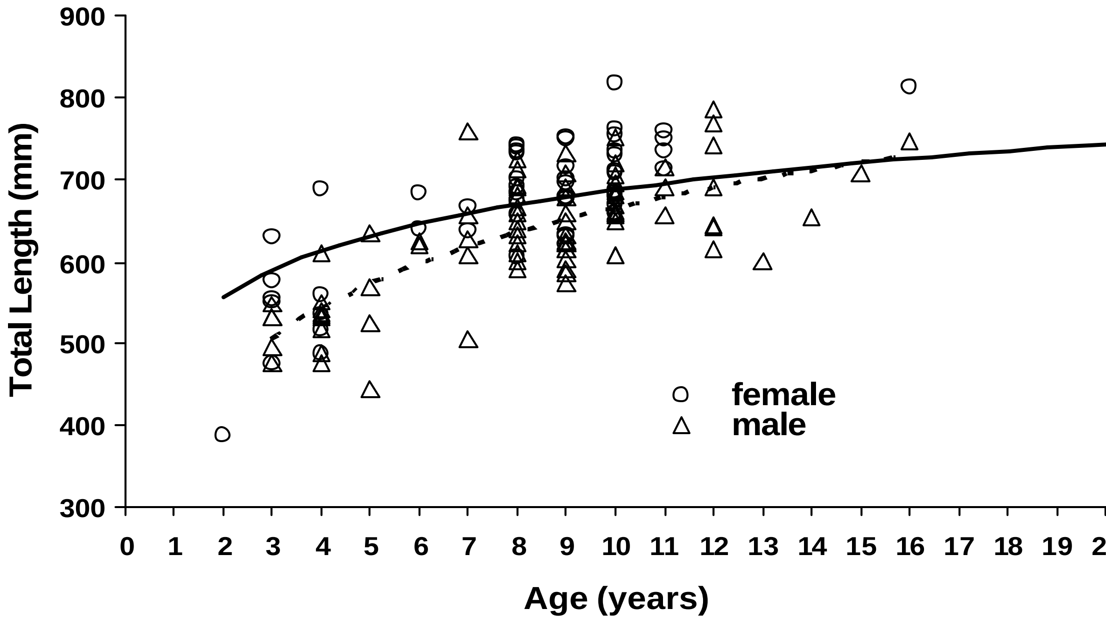
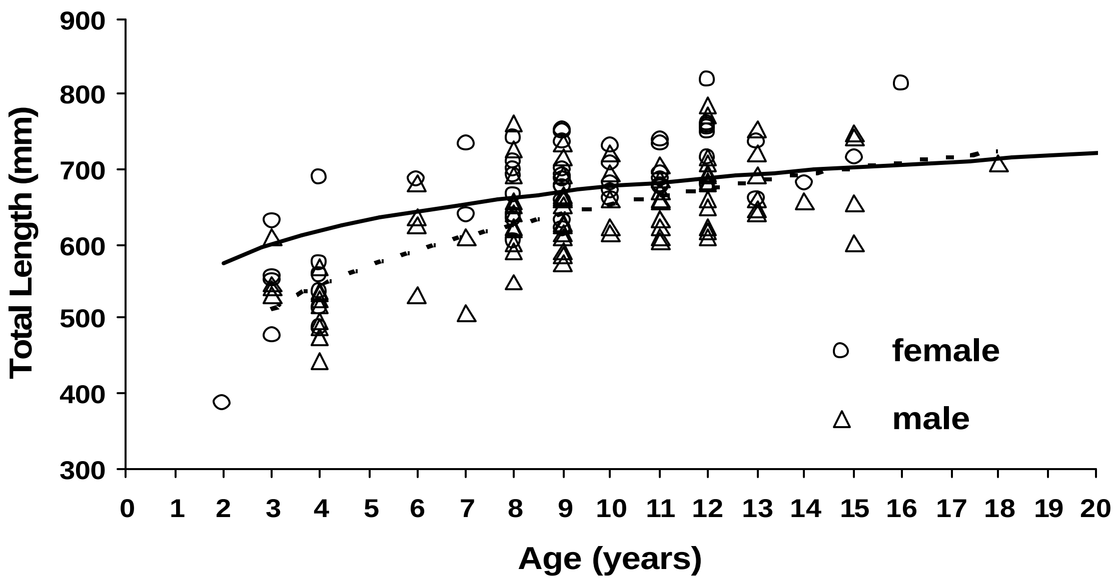


Figure 3.5. Burbot CPE (number of fish/set) by basin from the Ontario Partnership surveys 1989–2005 (includes canned and bottom gill nets, all mesh sizes, except thermocline sets).



(A)



(B)

Figure 3.6. Relationship between age (years) as measured by two technicians (A, B) and total length (mm) of 148 burbot caught in OMNR partnership gill net survey in 2005. Females (solid lines) and males (dashed lines) exhibited logarithmic relationships between total length and age.

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.

By Michael Fodale (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 implement Integrated Management of Sea Lampreys (IMSL) in Lake Erie including quantitative selection of streams for treatment implementation of alternative control methods. The Lake Erie Cold Water Task Group has provided the forum for the discussion of concerns about wounding and lake trout mortality.

2005 Lake Trout Wounding Rates

Observed A1-A3 wounding on lake trout greater than 21 inches total length increased substantially from 7.9 wounds per 100 fish in 2004 to 17.0 wounds/100 fish in 2005 (Figure 4.1). Wounding rates are 3.4 times above the target rate of 5 wounds per 100 fish (Lake Trout Task Group 1985) and are comparable to the 1997-2001 time period when rates hovered around 20 wounds per 100 fish due to relaxed lamprey control measures. Lake trout greater than 29 inches received the most fresh wounds (Table 4.1) followed by fish in the 25-29 inch range. There were no wounds found on lake trout less than 21 inches.

Fresh A1 wounds are considered indicators of the attack rate for the current year at the time of sampling (August). A1 wounding in 2005 was 0.03 wounds per adult lake trout greater than 21 inches, still above the series average of 0.02 wounds/fish (Figure 4.2). With the exception of 2002, where no A1 wounds were observed, this rate has remained steady since 2000. Half of the A1 attacks occurred on lake trout greater than 29 inches and two on fish in the 25-29 inch range (Table 4.1). Lampreys were still attached to two lake trout brought aboard the R/V ARGO, and one lake trout was presumed to be near death as very little blood remained in its body cavity.

The past year's cumulative attacks are indicated by A4 wounds. The 2005 A4 wounding rate increased for the third consecutive year to 56.0 wounds per 100 fish for lake trout greater than 21 inches (Figure 4.3). This is the highest A4 wounding rate in the time series including the pre-treatment years, and nearly three times the series average of 19.2 wounds/100 fish. Similar to past surveys, the majority of the A4 wounds were found on fish greater than 25 inches in total length (Table 4.1).

Although A4 wounding rates are not considered to be a major factor for determining sea lamprey abundance, their sharp rise to unprecedented levels has to be of concern, knowing that at least 60% of smaller and 43% of larger lake trout do not survive an attack (Swink 2003). Seventy-five of the 200 lake trout greater than 21 inches sampled had at least one A4 wound (37.5%) while 27 (13.5%) had 2 or more. Based on A4 wounds alone and assuming that 43% of the lake trout died from an attack, an additional 59 lake trout greater than 21 inches died from lamprey attacks that would have been sampled this year. These additional fish would have raised the total CPE from 4.0 lake trout/lift to 5.0 fish/lift, a population increase of 25%.

One factor that needs to be studied more closely in determining actual trends in lamprey abundance is the influence of lake trout strain. Superior strain lake trout, shown to have higher lamprey mortality compared to the Finger Lakes strain (Schneider et al. 1996) due to their environmental preferences (Swink 2003), have been stocked with more frequency in Lake Erie the past six years and are now comprising the majority of the lake trout population. These fish are just moving into the larger size categories that are preferred by adult lampreys (Swink 1991), possibly creating an apparent increase in wounding due to the greater availability of optimal prey in more accessible locations. On the other hand, the decrease in burbot abundance that was observed (see Charge 3) is indicative of a high abundance of lampreys due to high mortality rates (63-80% from Swink 2003).

2005 Actions

Control efforts continued by GLFC agents during 2005 with lampricide treatments of Delaware Creek and Raccoon Creek. Assessments were conducted in five streams (4 U.S., 1 Canada) to rank them for possible lampricide treatment in 2006. Another 17 streams (11 U.S., 6 Canada) and an area offshore of one U.S. tributary were surveyed to search for new or to monitor existing populations. Larval surveys seeking upstream recruitment above the washed out barrier at Daniels Park on the Chagrin River did not find any sea lamprey.

The estimated number of spawning-phase sea lampreys increased substantially from 3,800 in 2004 to 17,475 in 2005 (Figure 4.4). This estimate has large confidence intervals due to several factors, including the loss of the Big Creek trap. A total of 585 spawning-phase sea lampreys were trapped in four tributaries (2 U.S., 2 Canada) during 2005, an increase of about 191% when compared to 2004 catches.

A study of paired quantitative assessment sampling and catch-per-unit-effort sampling was conducted in five streams (4 U.S., 1 Canada) as part of a larger three-year project to test a potentially more efficient sampling method for an alternative model of stream selection for lampricide treatments. This is a GLFC-sponsored research project with Dr. Michael Jones of Michigan State University as the principle investigator.

2006 Plans

Sea lamprey management plans for Lake Erie during 2006 include lampricide treatment of three U.S. (Conneaut Cr., Crooked Cr. and Grand R.) and two Canadian streams (Big Cr. and Young's Cr.) and are based on a comparison of cost-per-transformer kill estimates for all Great Lakes streams that were quantitatively assessed during 2005. Three of the treatments are being conducted as geographic effic iencies to the control program and in response to increased wounding observations in the lake. Larval assessments are planned on 15 streams (8 U.S., 7 Canada). Two of these streams (1 U.S., 1 Canada) will be ranked for potential lampricide treatment in 2007. An estimate of the lake-wide spawner abundance will be conducted during 2006. Adult assessment traps likely will be operated on four streams (2 U.S., 2 Canada) and an estimate of the lake-wide spawner abundance will be conducted during 2006. Work will continue with researchers on the comparison of quantitative assessment sampling and catch-per-unit-effort sampling in developing an alternative stream selection model for lampricide treatments.

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.

Schneider, C.P., R.W. Owens, R.A. Bergstedt, and R. O'Gorman. 1996. Predation by sea lamprey (*Petromyzon marinus*) on lake trout (*Salvelinus namaycush*) in southern Lake Ontario, 1982-1992. Canadian Journal of Fisheries and Aquatic Sciences 53(9): 1921-1932.

Swink, W.D. 1991. Host-size selection by parasitic sea lampreys. Transactions of the American Fisheries Society 120: 637-643.

Swink, W.D. 2003. Host selection and lethality of attacks by sea lampreys (*Petromyzon marinus*) in laboratory studies. Journal of Great Lakes Research 29 (Supplement 1): 307-319.

Table 4.1. Frequency of sea lamprey wounds observed on several standard length groups of lake trout collected from standard mesh gill nets in New York waters of Lake Erie, August 2005.

Size Class Total Length (in.)	Sample Size	No. fish with fresh wounds	Wound Classification A1	A2	A3	A4	% with A1-A3 wounds	No. A1-A3 Wounds per 100 fish
17 - 21	9	0	0	0	0	0	0	0
21 - 25	59	4	1	1	2	16	6.8	6.8
25 - 29	118	20	2	7	13	75	16.9	18.6
>29	23	5	3	2	3	21	21.7	34.8
>21	200	29	6	10	18	112	14.5	17.0

Table 4.2. Larval sea lamprey assessments of Canadian Lake Erie tributaries during 2005 and plans for 2006.

Stream	**History**	**Surveyed in 2005**	**Survey Type**	**Results**	**Plans for 2006**
Canada					
Sixteenmile Creek	Negative	Yes	Evaluation	Negative	None
Kettle Creek	Negative	No			Detection
East Creek	Positive	No			Evaluation
Silver Creek	Positive	Yes	Evaluation	Positive	None
Big Otter Creek	Positive	Yes	Evaluation	Positive	*Quantitative*
South Otter Creek	Positive	Yes	Evaluation	Negative	None
Clear Creek	Positive	No			Evaluation
Big Creek	Positive	Yes	*Quantitative*	Positive	Treatment Evaluation
Young's Creek	Positive	Yes	Evaluation	Positive	Treatment Evaluation
Hay Creek	Negative	Yes	Detection	Negative	None
Grand River	Positive	No			Evaluation

[1]*Quantitative survey* – conducted to estimate larval population and larvae expected to metamorphose in the following year. Projected treatment cost is divided by the metamorphosed sea lamprey estimate to provide a ranking against other Great Lakes tributaries for lampricide treatment.
[2]*Evaluation survey* – conducted to determine requirement for quantitative assessment.
[3]*Detection survey* – conducted to determine larval presence or absence in streams with no history of sea lamprey infestation.
[4]*Distribution survey* – conducted to determine instream geographic distribution or to determine lampricide treatment application points.
[5]*Treatment Evaluation survey* – conducted to determine if the relative abundance of survivors from a lampricide treatment is large enough to warrant a Quantitative survey.

Table 4.3. Larval sea lamprey assessments of U.S. Lake Erie tributaries during 2005 and plans for 2006.

Stream	History	Surveyed in 2005	Survey Type	Results	Plans for 2006
Eighteenmile Creek	Negative	Yes	Detection	Negative	None
Delaware Creek	Positive	Yes	Distribution	Negative	None
Cattaraugus Creek	Positive	Yes	*Quantitative*	Positive	*Quantitative*
Canadaway Creek	Positive	Yes	Evaluation	Positive	None
Walnut Creek	Negative	Yes	Detection	Negative	Detection
Crooked Creek	Positive	Yes	*Quantitative*	Positive	Distribution
Raccoon Creek	Positive	Yes	Distribution	Negative	None
Turkey Creek	Negative	No			Detection
Conneaut Creek	Positive	Yes	*Quantitative*	Positive	Distribution
Cowles Creek	Negative	Yes	Detection	Negative	None
Wheeler Creek	Positive	Yes	Evaluation	Negative	None
Grand River	Positive	Yes	*Quantitative*	Positive	Distribution
Chagrin River	Negative	Yes	Detection	None	Detection
Rocky River	Negative	No			Detection
Black River	Negative	Yes	Evaluation	Positive	None
Pine River	Negative	Yes	Evaluation	Negative	None

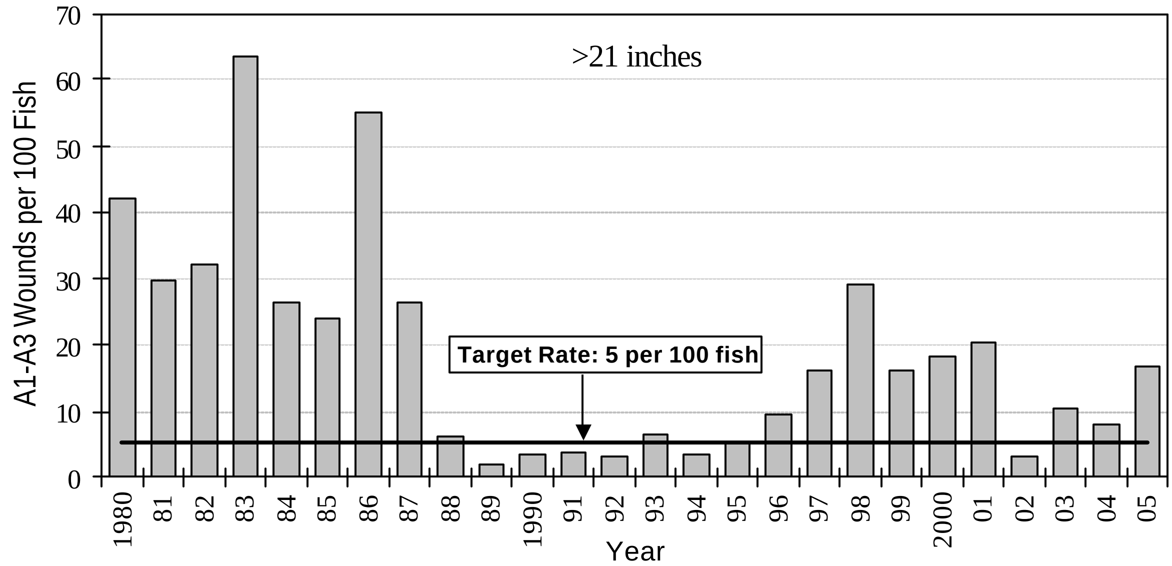


Figure 4.1. Number of fresh (A1-A3) sea lamprey wounds per 100 adult lake trout greater than 21 inches sampled in standard assessment gill nets from New York waters of Lake Erie, August - September, 1980-2005. The Strategic Plan target rate is 5%.

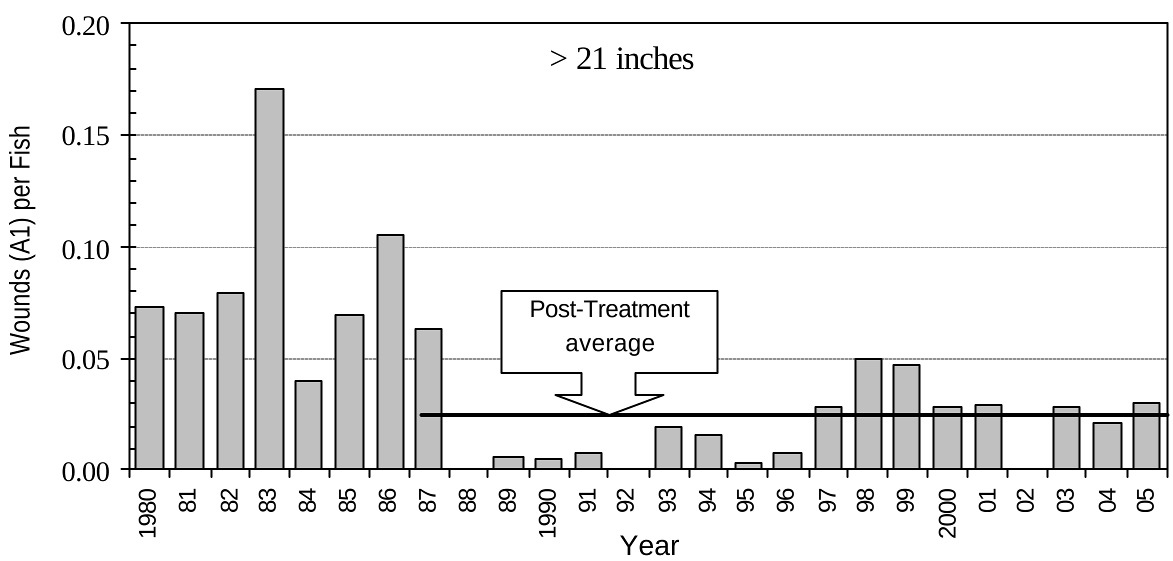


Figure 4.2. Number of fresh (A1) sea lamprey wounds observed per adult lake trout greater than 21 inches sampled in standard assessment gill nets from New York waters of Lake Erie, August - September, 1980-2005. The post-treatment average includes 1987 through 2005.

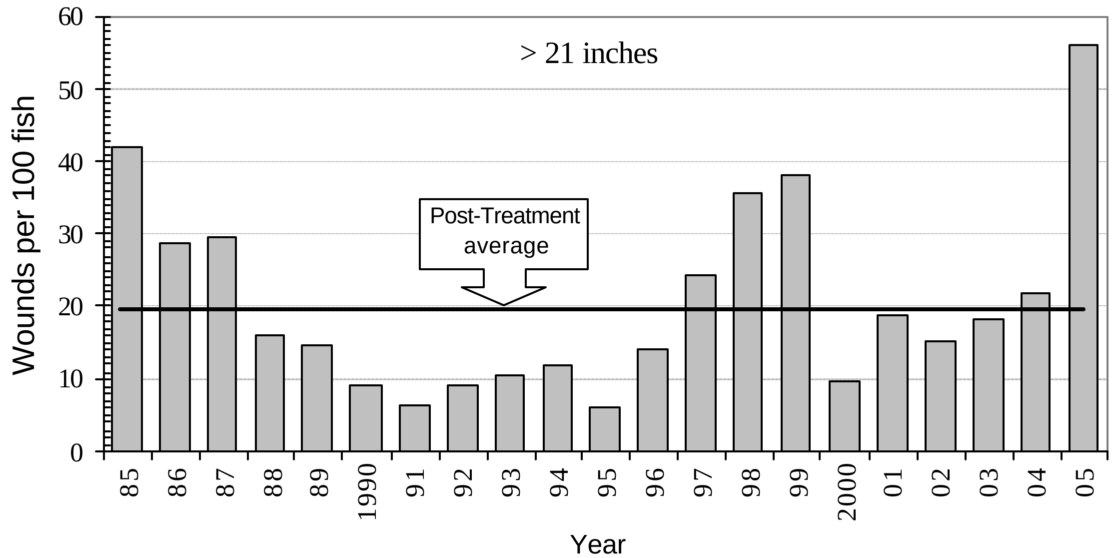


Figure 4.3. Number of healed (A4) sea lamprey wounds observed per 100 adult lake trout greater than 21 inches sampled in standard assessment gill nets from New York waters of Lake Erie, August, 1985-2005. The post-treatment average includes 1987 through 2005.

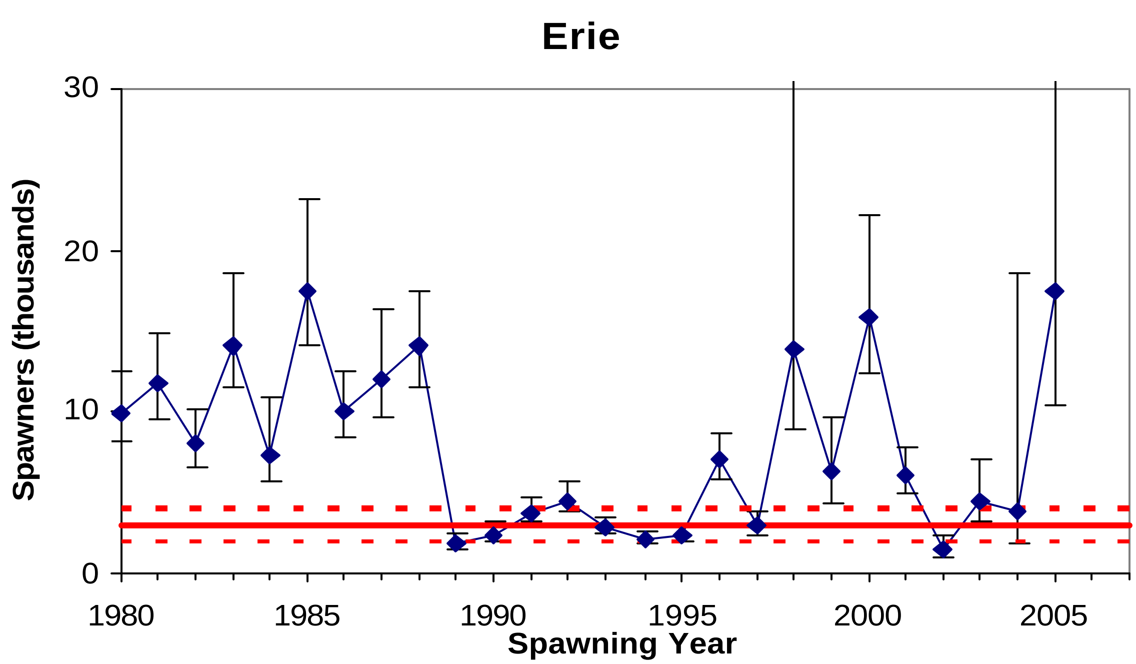


Figure 4.4. Lake-wide estimate of spawning-phase sea lampreys with 95% confidence limits in Lake Erie, 1980-2005 (Solid line indicates spawner abundance target level).

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.

By Chuck Murray (PFBC) and James Markham (NYSDEC)

Lake Trout Stockings

The current lake trout stocking goal (160,000 yearlings) was not met for the second consecutive year (Table 5.1; Figure 5.1). The shortage was due to a power outage at the Allegheny National Fish Hatchery (ANFH) on 26 April 2005 that killed an estimated 235,000 yearling lake trout, about 45% of the production at the facility. Because the hatchery was already short of fish due to losses from disease during the winter, the actual stocking of 54,200 yearling Klondike (KL) strain lake trout was over 100,000 fish short of the targeted goal. These fish were all stocked in over 70 feet of water northwest of Barcelona on 10 May 2005 using the R/V ARGO. No lake trout were stocked in Pennsylvania waters for the third consecutive year. All yearling lake trout were adipose fin-clipped and coded-wire tagged prior to stocking. Further problems were incurred at the ANFH in July 2005 when Infectious Pancreatic Necrosis (IPN) was detected, forcing the complete depopulation and sterilization of the hatchery. Surplus Finger Lakes (FL) strain fall fingerling lake trout (58,400) from the Bath (NY) State Fish Hatchery were shore stocked in Barcelona on 3 November 2005 to compensate for the complete loss of the 2006 stocking. These fish were dorsal fin-clipped only. Hatchery stockings from ANFH are scheduled to resume in 2007 although the numbers of lake trout that will be available are still in question.

Evaluation of five years of paired plantings of yearling lake trout to compare survival and growth rates of large versus small size at stocking was continued in 2005. The plantings began in 2000. In general, the results of the first three years of stocking using Superior (SUP) strain fish have favored the larger stocked fish at a ratio of 2:1 (Einhouse et al. 2005). However, returns of lake trout appear to be more mixed as the fish get older, with returns virtually equal at age 6 for the 2000 stocking and at age 4 for the 2002 stocking (Figure 5.2 a-c). Returns at age 5 were still significantly higher for the larger stocked fish (chi-square: $p<0.05$) from the 2001 stocking, which had the lowest overall returns of the first three stockings. Results of the last two years of the paired plantings using FL strain fish with overall smaller stocking sizes are inconclusive at this time, mostly due to poor returns from either of these stockings. Large lake trout from the 2003 stocking have had fewer returns at age 2 and age 3 compared to the small or medium-sized stockings (Figure 5.2d). Large and small FL lake trout stocked in 2004 have had equal returns thus far at age 1 and 2, but returns of Klondike strain lake trout, which were stocked at a lesser density (40K vs. 31.6K) than the FL strain, were over twice as high (Figure 5.2e). Significant differences in mean length were not apparent by age 4 for any of the paired plantings.

Stocking of Other Salmonids

In 2005, over 2 million yearling trout and salmon were stocked in Lake Erie, including rainbow trout/steelhead, brown trout and lake trout (Figure 5.3). Total salmonid stocking decreased 3.5% from 2004 and 8.9% from the long-term average (1989-2005). Annual summaries for each species stocked within individual state and provincial areas are summarized in Table 5.1.

All riparian agencies presently stock rainbow trout in the Lake Erie watershed. Rainbow trout / steelhead accounted for nearly 94% of all salmonids stocked in 2005. A total of 1,976,973 yearling rainbow trout were stocked in 2005, representing a 1% decrease from 2004. Steelhead stocking in 2005 was 11% higher than the long-term average, primarily a result of the increased prominence of this species in jurisdictional fisheries over that last decade. The majority of rainbow trout stocked in Lake Erie are planted in Pennsylvania (60%), followed by Ohio (20%), New York (14%), Michigan (3%) and Ontario (3%). Details on strain composition and stocking location are covered extensively under Charge 6 of this report.

Brown trout stocking in Lake Erie totaled 72,923 yearlings in 2005. This total represents about a 16% decrease from 2004 and the long-term average. This was the second most frequently stocked salmonid and was 3.5 % of all salmonids stocked. About half (51%) of the brown trout stocked in Lake Erie were in New York waters, and the other half (49%) were stocked in Pennsylvania waters. No other agencies reported stocking brown trout in Lake Erie in 2005.

Of the 35,483 brown trout stocked in Pennsylvania waters, most (84%) were stocked for the opening day of trout season for a put-and-take fishery. The remaining brown trout stocked in Pennsylvania waters to Lake Erie were stocked by cooperative sportsmen's groups for the purpose of providing a modest lake-run brown trout tributary fishery. Reductions in brown trout stocking in Pennsylvania waters (-30%) were primarily a result of decreased brown trout stocking effort by the Pennsylvania cooperative groups.

The NYSDEC brown trout stocking efforts have remained stable in recent years. A total of 37,440 brown trout were stocked in Lake Erie waters in 2005, up about 4% from 2004. 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.

References

Einhouse, D.W., J.L. Markham, D.L. Zeller, R.C. Zimar, B.J. Beckwith, and M.L. Wilkinson. 2005. NYSDEC Lake Erie Unit 2004 annual report to the Lake Erie Committee. New York State Department of Environmental Conservation, Albany, New York, USA.

Table 5.1. Summary of salmonid stockings in numbers of yearling equivalents, Lake Erie, 1990-2005.

	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/ Steelhead	Total
ONT.	--	--	--	--	31,530	31,530
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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**

(continued)

Table 5.1. (Continued) Summary of salmonid stockings in number of yearling equivalents, 1990-2005.

	Lake Trout	Coho	Chinook	Brown Trout	Rainbow/ Steelhead	Total
ONT.	--	--	--	--	61,000	61,000
NYSDEC	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
NYSDEC	143,320		--		310,300	453,620
PFBC	40,000	100,000	--	20,780	835,931	996,711
ODNR			--		238,467	238,467
MDNR			--		69,234	69,234
1999 Total	**183,320**	**100,000**	**0**	**20,780**	**1,539,167**	**1,843,267**
ONT.	--	--	--	--	10,787	10,787
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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
NYSDEC	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**

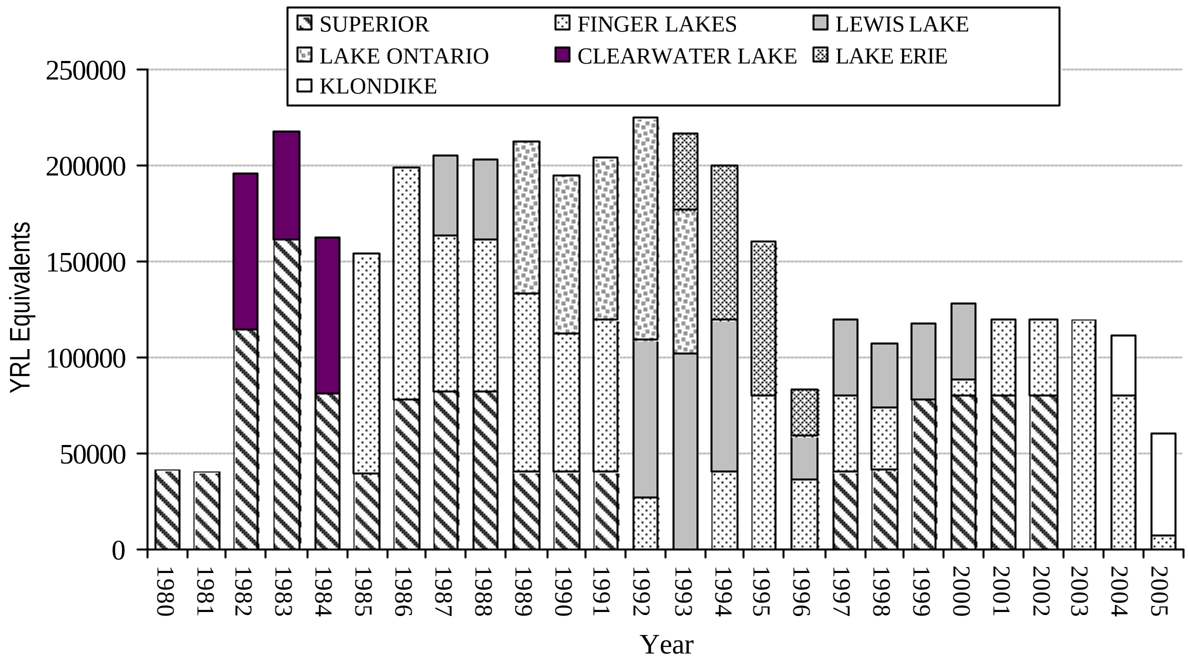


Figure 5.1. Yearling lake trout stocked in U.S. waters of the eastern basin of Lake Erie, 1980-2004, by strain in Yearling (YRL) Equivalents. The stocking goal is 120,000 yearlings per year.

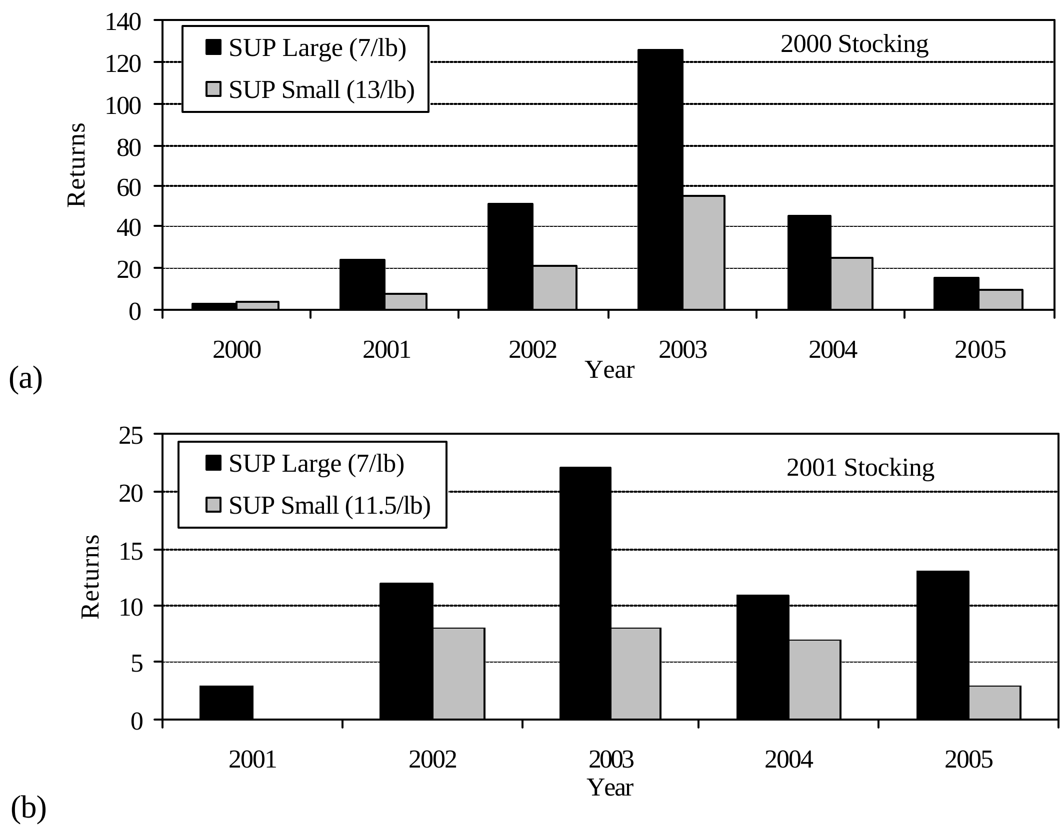
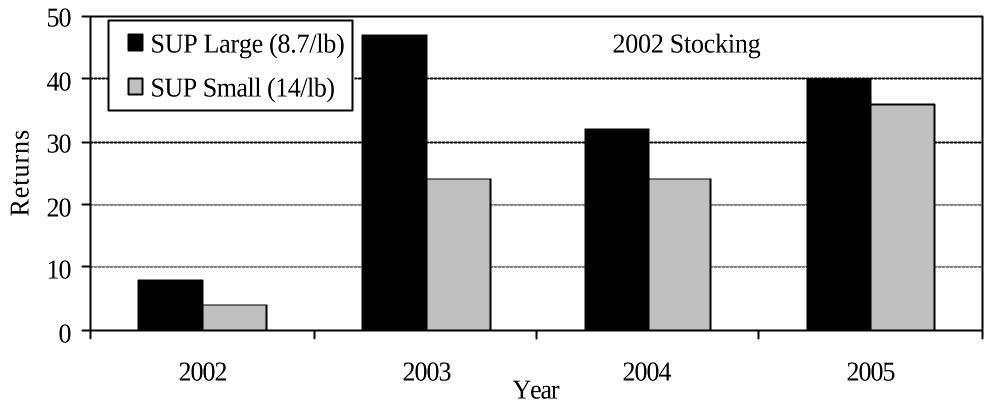
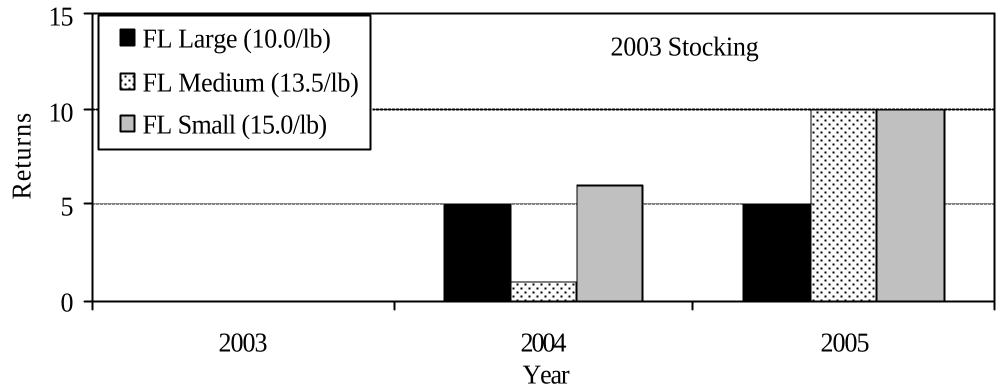


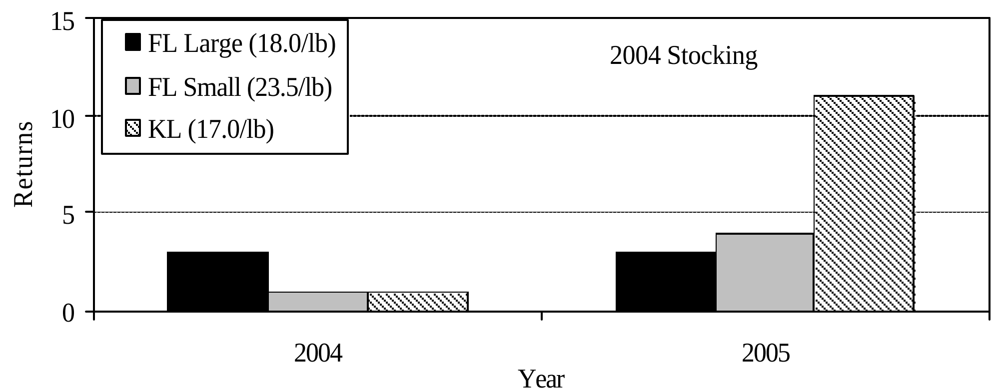
Figure 5.2. Returns of tagged yearling lake trout stocked in 2000(a) and 2001(b) for a stocking comparison study in New York waters of Lake Erie; later years follow on next page.



(c)



(d)



(e)

Figure 5.2 (continued). Returns of tagged yearling lake trout stocked in 2002 (c), 2003 (d) and 2004 (e) for a stocking comparison study in New York waters of Lake Erie. Strain key: SUP=Superior, FL=Finger Lakes and KL=Klondike.

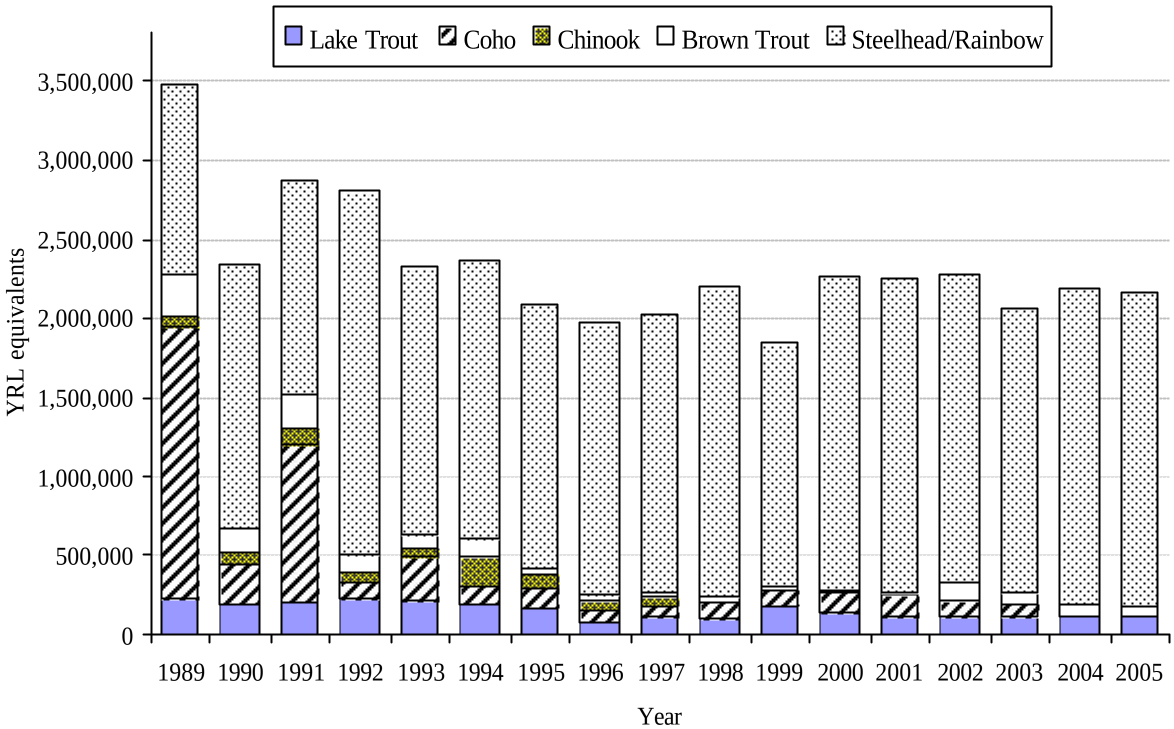


Figure 5.3. Annual stocking of all salmonid species in Lake Erie by all riparian agencies, 1989-2005. Numbers of stocked fish are represented in yearling (YRL) equivalents.

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.

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

Stocking

All jurisdictions stocked steelhead (lake-run rainbow trout) in 2005 (Table 6.1). Nearly all (99.7%) rainbow trout stocked in Lake Erie originated from naturalized Great Lakes strains. Two naturalized Lake Erie strains (Trout & Godfrey Runs, Pennsylvania, and Mill Creek, Ontario) accounted for 61% of the strain composition, followed by a Lake Michigan (Little Manistee River) strain with 23%, and three Lake Ontario strains (Ganaraska River, Ontario; Chambers Creek, WA strain Salmon River, New York; and Skamania from the Salmon River, New York) that comprised 16% of the stocking numbers; about 0.3% of the stocked rainbow trout were of domestic origin (captive broodstock).

All steelhead were stocked in the spring as yearlings; 2005 stockings were initiated in March and continued into May. New York steelhead yearlings averaged about 12.4 months and 135 mm in length at stocking. Pennsylvania steelhead smolts averaged about 15.4 months and 157 mm in length at stocking. Ohio steelhead smolts averaged about 15 months and 169 mm at stocking.

Approximately 5% of all rainbow trout stocked in 2005 were fin clipped. Michigan continued using a standard right pectoral (RP) clip for all yearling plants. Ontario completed left pectoral (LP) clips of all steelhead stocked in Lake Erie tributaries for the third consecutive year. New York implemented adipose and left ventral (ADLV) fin clips on 15,000 Skamania-strain steelhead that were stocked in Cattaraugus Creek. Summary data for fish marked from 1999-2005 are summarized in Table 6.2. No coordinated interagency effort was made to implement fin clips and monitor return data on steelhead.

Assessment of Natural Reproduction

A comprehensive, multi-year stream electrofishing survey cataloging New York's Lake Erie tributaries for steelhead reproduction potential began in fall 2002. Candidate streams for the survey include all of the New York tributaries known to have adult steelhead runs in the fall through spring. Six different tributaries, five of which were in the Cattaraugus Creek watershed, were sampled between 19 September and 19 October 2005. Juvenile steelhead were found in all six of the sampled streams, but three of the streams (Derby Brook, Coon Brook, Grannis Creek) had moderate to above average potential for production. Derby Brook, initially assessed in 2004, was sampled more extensively in 2005 and was found to be one of the best streams surveyed thus far. Similar to past surveys (Einhouse et al. 2005; Culligan et al. 2003), deep riffle areas with large rocks or woody debris appear to be an essential habitat type for juvenile trout in marginal trout streams. Trout are generally absent in marginal streams without this habitat. However, in higher quality streams such as Derby Brook, most of the juvenile and yearling trout occupy the pools, with less numbers of juvenile trout in the riffles.

Of the 24 streams that have been sampled for potential YOY steelhead production in the past four years, 10 have shown at least moderate potential for producing wild steelhead trout (Einhouse et al. 2006). Three streams, Spooner Creek, Derby Brook, and Little Chautauqua Creek, have shown a higher potential for producing wild fish. Results from this survey will be used to develop a comprehensive map of steelhead spawning waters in New York Lake Erie tributaries and may also be used to target areas for stream improvement projects.

Ohio has initiated a program to catalog streams with steelhead natural reproduction into digital maps with GIS layers. Future work may find cooperative ventures between the member agencies to develop a master set of maps of high quality watersheds for documenting and monitoring production and contribution of wild steelhead smolts.

Exploitation

Most agencies provide some measure of open lake summer harvest by boat anglers (Table 6.3). Annual open lake creel surveys are conducted by Michigan, Ohio, Pennsylvania and New York. The Ontario Ministry of Natural Resources conducts angler surveys on an intermittent basis across their wide jurisdiction along the Lake Erie shoreline. OMNR was not able to provide complete sport harvest estimates for steelhead in 2005; however, surveys conducted from the Wheatley Harbour area estimate harvest in that nearby Central Basin area during the 2005 survey season (May-August).

Although harvest by boat anglers represents only a portion of the total estimated harvest, it remains the only annual estimate of steelhead harvest by most Lake Erie agencies, and it can be used as a relative measure of total harvest. Harvest in most jurisdictions has decreased since the record high observed in 2002. The reported estimated harvest from the summer open-water boat angler fishery in 2005 was 19,402 steelhead. Nearly all (95%) of the reported harvest was concentrated in Central Basin waters of Ohio (53%), Ontario (32%), and Pennsylvania (9%). Approximately 5% of the total recorded open lake harvest was in the eastern basin in New York (3%) and Pennsylvania (2%). In conjunction with harvest, catch rates have also declined from 2004 (Figure 6.1); down in Ohio (-32%), Ontario (-6%) and Pennsylvania (-56%). The 2005 catch rates by open lake boat anglers in New York waters were not available for this report.

Previous creel surveys confirm that the majority of the steelhead angling activity takes place in the tributaries, as fish move from the lake into the streams during spawning runs. This was confirmed through tributary creel surveys conducted in Pennsylvania and New York tributaries to Lake Erie in 2003 (Murray and Shields 2004 and Markham 2006) and 2004 (Markham 2006).

The Lake Erie tributaries provide the core of the steelhead fishery. The only annual sources of information on the Lake Erie tributary steelhead fishery are angler diary programs that are administered in New York and Pennsylvania. Angler effort for steelhead in tributaries remains high; New York anglers increased 36% from 2003-2004 to 2004-2005 surveys to an estimated total of 263,545 angler hours generated from 104,207 trips (Markham 2006). Anglers in Pennsylvania's 2003-2004 tributary creel survey (Murray and Shields 2004) generated 595,584 angler hours and 141,134 trips seeking steelhead; an approximate three-fold increase over surveys taken a decade earlier.

Since 2000, Lake Erie steelhead anglers have experienced a period of exceptionally high catch rates. Trends in angler diary catch rates by steelhead anglers in Pennsylvania and New York waters reached historical highs during 2001 in Pennsylvania and in 2004 in New York. There was an 18% decrease in Pennsylvania diarists' average angler catch rates in 2005 compared to 2004. However, the 2005 catch rate (0.82 fish/hr) remained well above the Pennsylvania long-term average of 0.59 fish/hr (Figure 6.2). New York tributary creel surveys in 2004-2005 saw a decline in catch rates from 0.63 fish/hr to 0.55 fish/hr (Markham 2006). Exceptional release rates of greater than 75% in 2003 and 2004 tributary surveys (Murray and Shields 2004 and Markham 2006) help sustain the fishery and create more fishing opportunities.

Age and Growth

Recent interagency research regarding the summer diets of steelhead has been completed (see charge 8, this report, and Clapsadl et al. 2005). Additional activities completed during that diet study included gathering steelhead length, weight and age information from anglers and fish houses. During the past year, this field data has been collated, and ages determined from scales and otoliths taken during the diet study. We, therefore, can produce lakewide information regarding steelhead age and growth from that June-October 2004 data.

From the aging of hard parts collected (scales and otoliths), we can see that the majority of fish caught by anglers during the summer 2004 diet project were ages 2, 3 and 4 (Table 6.4); with age 3 being the most numerous, followed by ages 2 and 4. Ages reported here describe the number of summers steelhead have resided in the lake, assuming the plus group. Fish were aged from age 1 though age 7. Ohio and Pennsylvania anglers caught a higher proportion of age-2 steelhead than fishers in other jurisdictional waters, while Ontario anglers caught a higher proportion of age-4 steelhead. Mean lengths-at-age were: age 1= 413 mm; age 2= 570 mm; age 3= 640 mm; age4= 687 mm; and age 5= 732 mm. There was considerable overlap of ages in 25 mm length bins over 650 mm (Figure 6.4). A significant length-weight regression was derived for steelhead from the summer 2004 data (Figure 6.5): log10(wt[g])= -4.170788+2.721708*log10(len[mm]).

In examining steelhead conditions, some problems were noted in the data source; many lengths were recorded in (fractions of) inches and weights in pounds then converted to mm and g, respectively. This would have the effect of clumping the data and cause loss of precision in condition (K) calculations. Nevertheless, complete data from all agencies including the "clumped" data resulted in the same mean condition as data taken with more precision (mean K=1.14). Overall steelhead condition was good; most K values for individual fish were above the K=1.0 baseline (Figure 6.6). There was noted a gradual increase, peak, then decline as steelhead length increased, approaching the value of K=1.0 for the largest steelhead. Again some of the line fit at either end of the length spectrum may be skewed due to the data estimation and conversion. More work in this arena should be completed using larger sample sizes and using more precise techniques than field estimates of (fractions of) inches and pounds.

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Murray, C., and M. Shields. 2004. Creel analysis and economic impact of Pennsylvania's Lake Erie tributary fisheries in Erie County, Pennsylvania, with special emphasis on landlocked steelhead trout (*Oncorhynchus mykiss*). Pennsylvania Fish and Boat Commission. Lake Erie Research Unit. Fairview, Pennsylvania, USA.

Table 6.1. Rainbow trout /steelhead stocking by jurisdiction for 2005.

Agency	Location	Strain	Fin Clips	Number	Life Stage	Yearling Equivalents	
Michigan	Flat Rock	Manistee River, L. Michigan	No	30,900	Yearling	30,900	
		Manistee River, L. Michigan	RP	30,000	Yearling	30,000	
						60,900	**Sub-Total**
Ontario	Mill Creek	Mill Creek (wild), L. Erie	RP	13,500	Yearling	13,500	
	Mill Creek	Ganaraska River, L. Ontario	RP	35,000	Yearling	35,000	
	Erieau Harbour	Ganaraska River, L. Ontario	RP	6,500	Yearling	6,500	
						55,000	**Sub-Total**
Pennsylvania	Conneaut Creek	Trout Run & Godfrey Run, L. Erie	No	75,002	Yearling	75,002	
	Crooked Creek	Trout Run & Godfrey Run, L. Erie	No	52,875	Yearling	52,875	
	Elk Creek	Trout Run & Godfrey Run, L. Erie	No	269,490	Yearling	269,490	
	Fourmile Creek	Trout Run & Godfrey Run, L. Erie	No	14,511	Yearling	14,511	
	Godfrey Run	Trout Run & Godfrey Run, L. Erie	No	71,580	Yearling	71,580	
	Presque Isle Bay	Trout Run & Godfrey Run, L. Erie	No	58,019	Yearling	58,019	
	Raccoon Creek	Trout Run & Godfrey Run, L. Erie	No	48,355	Yearling	48,355	
	Sevenmile Creek	Trout Run & Godfrey Run, L. Erie	No	19,340	Yearling	19,340	
	Trout Run	Trout Run & Godfrey Run, L. Erie	No	161,797	Yearling	161,797	
	Twelvemile Creek	Trout Run & Godfrey Run, L. Erie	No	38,687	Yearling	38,687	
	Twentymile Creek	Trout Run & Godfrey Run, L. Erie	No	154,520	Yearling	154,520	
	Walnut Creek	Trout Run & Godfrey Run, L. Erie	No	219,070	Yearling	219,070	
						1,183,246	**Sub-Total**
Ohio	Chagrin River	Manistee River, L. Michigan	No	90,017	Yearling	90,017	
	Conneaut Creek	Manistee River, L. Michigan	No	74,042	Yearling	74,042	
	Grand River	Manistee River, L. Michigan	No	93,773	Yearling	93,773	
	Rocky River	Manistee River, L. Michigan	No	89,781	Yearling	89,781	
	Vermillion River	Manistee River, L. Michigan	No	55,214	Yearling	55,214	
						402,827	**Sub-Total**
New York	Buffalo Creek	Chambers Creek, L. Ontario	No	15,000	Yearling	15,000	
	Buffalo River	Chambers Creek, L. Ontario	No	5,000	Yearling	5,000	
	Canadaway Creek	Chambers Creek, L. Ontario	No	20,000	Yearling	20,000	
	Cattaraugus Creek	Chambers Creek, L. Ontario	No	90,000	Yearling	90,000	
	Cattaraugus Creek	Skamania, L. Ontario	ADLV	15,000	Yearling	15,000	
	Cayuga Creek	Chambers Creek, L. Ontario	No	15,000	Yearling	15,000	
	Chautauqua Creek	Chambers Creek, L. Ontario	No	40,000	Yearling	40,000	
	Dunkirk Harbor	Chambers Creek, L. Ontario	No	10,000	Yearling	10,000	
	East Br. Cazenovia Cr.	Chambers Creek, L. Ontario	No	10,000	Yearling	10,000	
	Eighteen-Mile Creek	Domestic	No	5,000	Yearling	5,000	
	Eighteen-Mile Creek	Chambers Creek, L. Ontario	No	40,000	Yearling	40,000	
	Silver Creek	Chambers Creek, L. Ontario	No	5,000	Yearling	5,000	
	Walnut Creek	Chambers Creek, L. Ontario	No	5,000	Yearling	5,000	
						275,000	**Sub-Total**
						1,976,973	**Grand Total**

Table 6.2. Steelhead fin-clip summary for Lake Erie, 1999-2005.

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

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

Table 6.3. Reported estimated harvest* of steelhead by open lake boat anglers, 1999-2005.

Year	Michigan	Ohio	Ontario	Pennsylvania	New York
1999	100	20,396	13,000	7,401	1,000
2000	100	33,524	28,200	11,011	1,000
2001	3	29,243	15,900	7,053	940
2002	70	41,357	75,000	5,229	1,600
2003	15	21,571	785	1,717	400
2004	0	10,092	18,148	2,657	896
2005	19	10,364	6,242	2,183	594

* Ontario 2003 estimate for eastern basin waters only, 2004 estimate for central basin waters only, and 2005 estimate from Wheatley Harbour surveys.

Table 6.4. Mean and standard deviation (st dev) for length-at-age (mm TL) of steelhead trout by open lake boat anglers from the interagency steelhead diet project, summer 2004.

	age	1	2	3	4	5	6	7	N
OH	mean	407	578	633	676	720	.	.	182
	st dev	38	44	41	46	42	.	.	
	N	5	65	83	27	2	0	0	
ONT	age	1	2	3	4	5	6	7	
	mean	.	525	594	677	727	680	.	37
	st dev	.	45	39	21	18	42	.	
	N	0	6	15	12	2	2	0	
PA	age	1	2	3	4	5	6	7	
	mean	451	569	666	706	.	.	813	47
	st dev	.	60	61	70	.	.	.	
	N	1	16	21	8	0	0	1	
NY	age	1	2	3	4	5	6	7	
	mean	406	523	671	755	749	.	.	35
	st dev	.	75	43	70	54	.	.	
	N	1	5	22	5	2	0	0	
grand mean	age	1	2	3	4	5	6	7	
	mean	413	570	640	687	732	680	813	301
	st dev	35	51	50	52	34	42	.	
	N	7	92	142	51	6	2	1	301

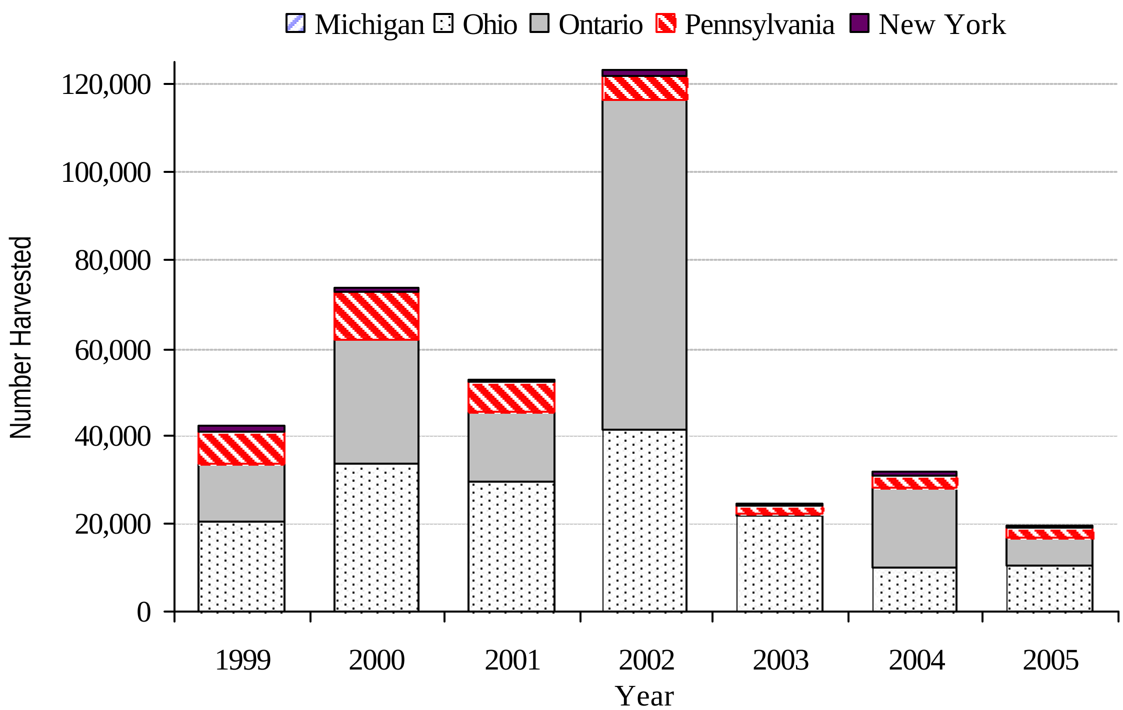

Figure 6.1. Open lake harvest of rainbow/steelhead trout by Lake Erie jurisdictions, 1999-2004. Note: 2003 Ontario data was not available.

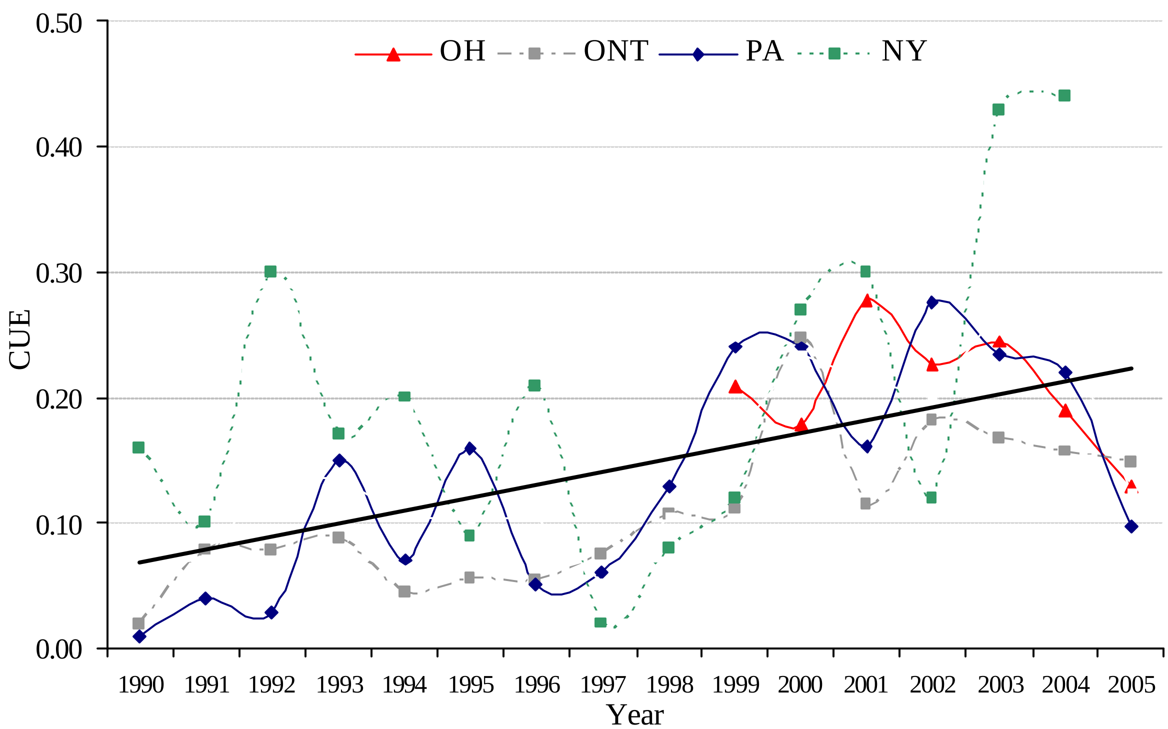

Figure 6.2. Targeted salmonid catch rates by open lake anglers in Pennsylvania, New York, Ohio, and Ontario, 1990-2005. The linear trend line indicates mean overall catch rate by year.

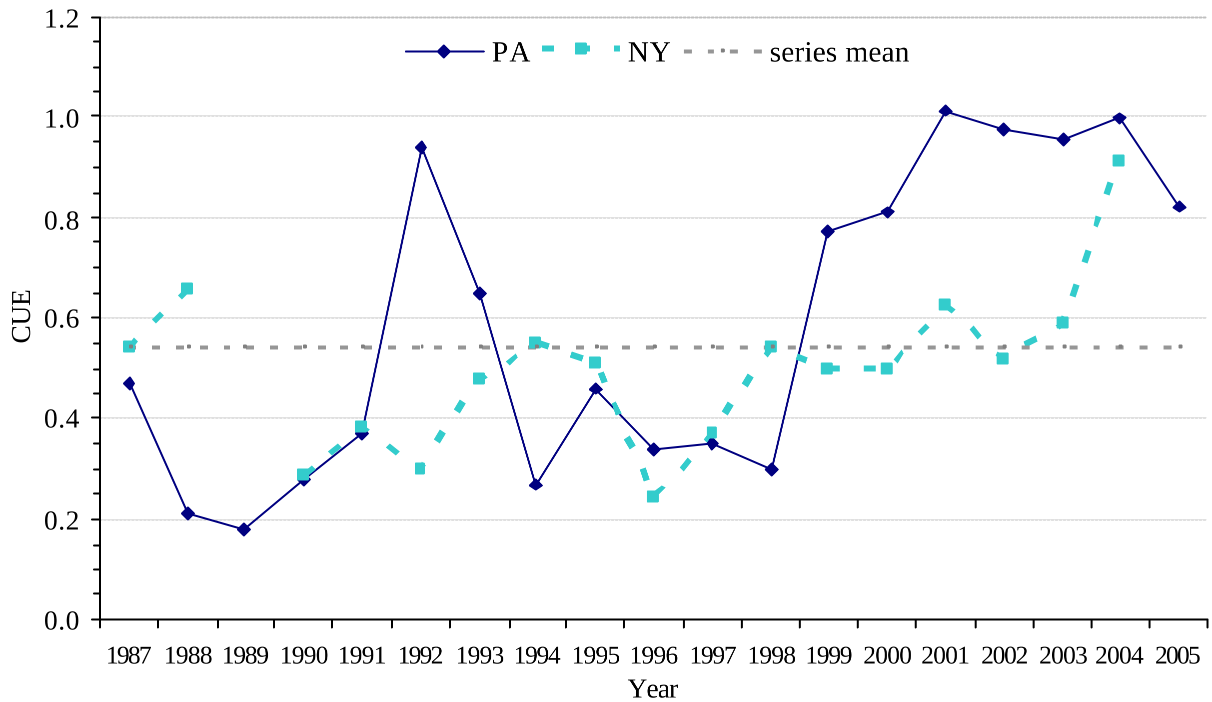

Figure 6.3. Targeted salmonid catch rates in Lake Erie tributaries by Pennsylvania and New York angler diary cooperators, 1987-2005. The dashed horizontal line indicates mean overall catch rate for all years in the series.

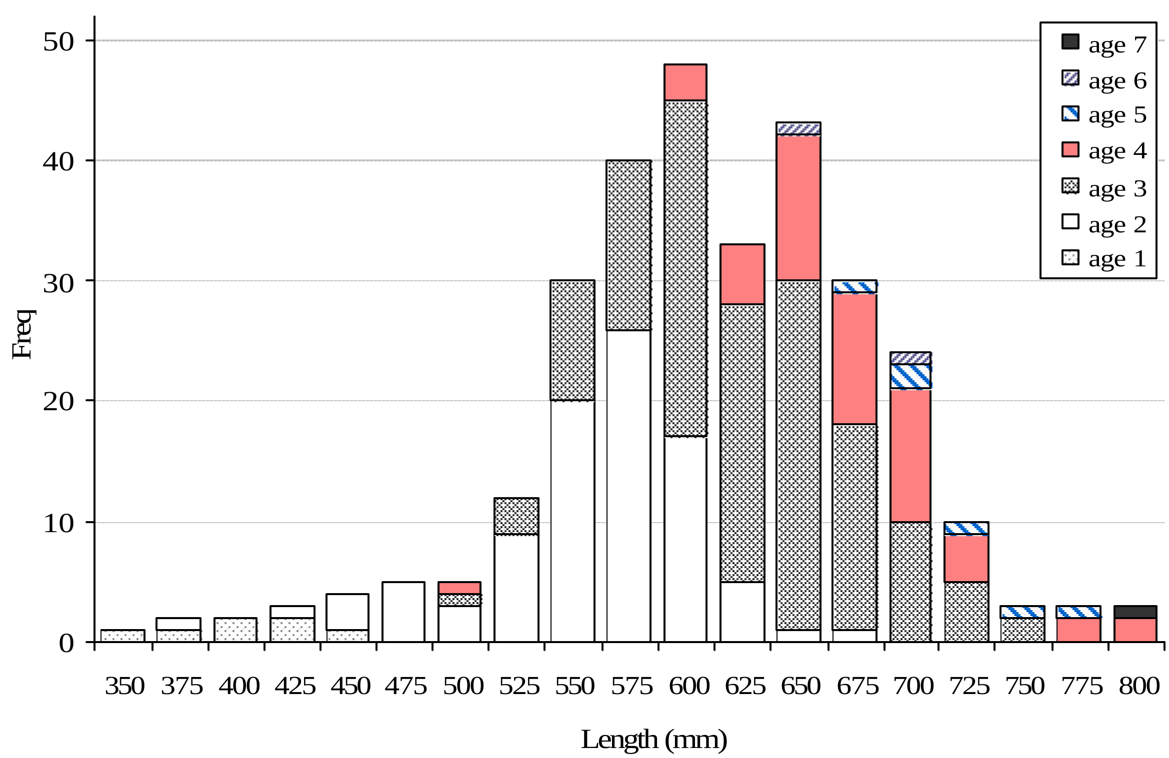

Figure 6.4. Length-frequency of steelhead aged from the summer 2004 interagency diet study.

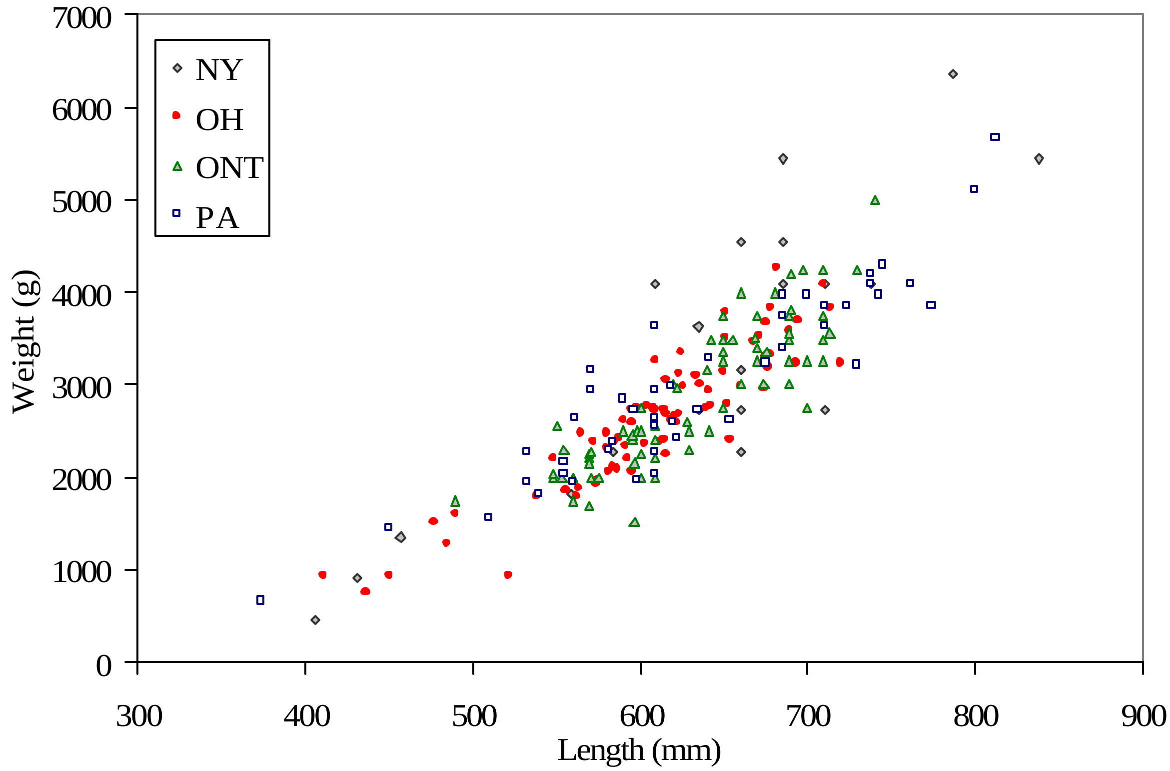

Figure 6.5. Length (mm) vs. weight (g) of steelhead surveyed in the summer 2004 diet study. The significant regression of length-weight is: log10(wt)=-4.170788+2.721708*log10(len).

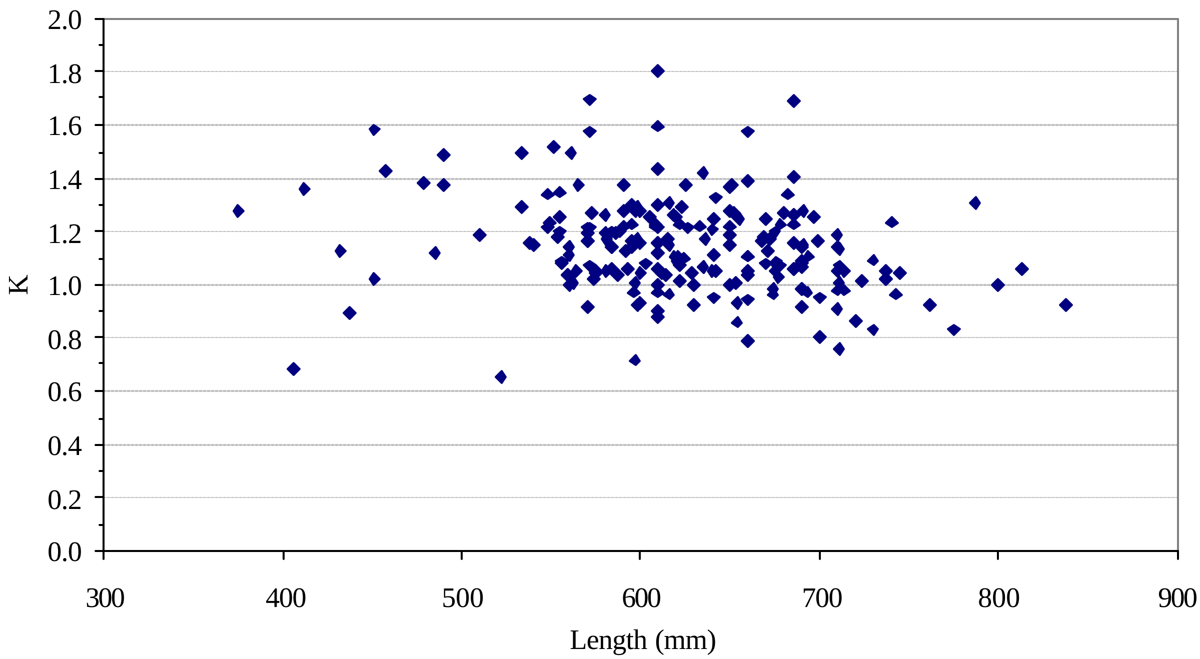

Figure 6.6. Length (mm) vs. condition (K) of steelhead surveyed in the summer 2004 interagency diet study. The mean K value was 1.14 for all steelhead measured and weighed.

Charge 7: Monitor the current status of Lake Herring. Review ecology and history of this species and assess potential for recovery.

by James Markham (NYSDEC), Tom MacDougall (OMNR), and John Fitzsimons (DFO)

Lake herring (*Coregonus artedii*) is a complex species indigenous to the Great Lakes. Herring historically supported one of the most productive fisheries in Lake Erie (Scott and Crossman 1973, Trautman 1981). Lake herring are considered extirpated from Lake Erie, although commercial fishermen report them periodically from the area of the Pennsylvania Ridge and the shoals of the western basin (Ryan et al. 1999). Their demise was mainly due to overfishing, 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). Although the population of lake herring in Lake Erie collapsed prior to the expansion of introduced rainbow smelt (*Osmerus mordax*) and alewife (*Alosa psuedoharengus*) in the 1950s, these exotic species may have prevented any recovery of herring through competition and predation. Selgeby et al. (1978) documented consumption of lake herring eggs by rainbow smelt. Evans and Loftus (1987) summarized two studies in which smelt consumed large numbers of lake herring in the larval stage.

With the recent recovery of other native coldwater species (particularly lake whitefish and burbot), and the decline in abundance of rainbow smelt, there may be an opportunity for lake herring to recover in Lake Erie. Commercial fisherman occasionally reported lake herring in the 1990's. Two large specimens (lengths of 467 mm and 367 mm) were collected from the eastern part of the central basin in 1995 and 1996, respectively. Herring were also recorded in the catch from an experimental gear study conducted south of Long Point in 1997. However, their significance was not recognized and the fish were not examined. Small numbers of lake herring have been caught in the commercial fishery of the western basin during November and December 1998. Frequency of lake herring reports increased in 1999, when commercial fishermen reported seven small herring (lengths 140-211 mm). Capture locations suggested that herring were present south of Long Point and southwest of Port Stanley. Fish were captured primarily in deep-water trawls targeting smelt. All specimens collected in the 1990s were examined at the Royal Ontario Museum (Erling Holm, unpublished data). Counts of gill rakers placed them into the range for *Coregonus artedii* (Koeltz 1929, Scott and Smith 1962). The herring collected in 1995 and 1996 were aged as 9+ and 7+, respectively. Five of the herring caught in 1999 were aged as 1+ (1998 year class), and one was aged as 2+ (1997 year class).

Two more specimens were recorded from the central basin in 2000: one from Ohio (K. Kayle, ODW, Fairport Harbor, OH, pers. comm.) and one from Ontario (L. Witzel, OMNR, Port Dover, ON., pers. comm.). Two additional specimens were recorded at Port Stanley in 2001. Three specimens were captured in yellow perch nets near Erieau during spring 2002. A fisherman from Port Dover reported capturing four herring in one day in a smelt trawl. A fisherman from Port Burwell reported one herring caught and that it had been smoked. Two more specimens were reported in 2005 as by-catch from the commercial yellow perch fishery near Kent to the southeast of Wheatley in the Central Basin. Both herring were mature females of similar length (357, 367 mm), and one of these was aged as six years old (1999 year class). OMNR biologists believe that the level of reporting has declined in recent years as herring catches become more common.

Numerous investigators have shown that alewife and smelt have negative effects on coregonid populations in the north-temperate lakes (reviewed by Ryan et al. 1999). The recent warm winters have promoted overwinter survival of alewife in eastern Lake Erie, while smelt numbers have continued to decline (L. Witzel, OMNR, Port Dover, ON, unpublished data). A major die-off of alewife was documented in winter of 2001. When alewife and smelt stocks are depressed, it creates an opportunity for coregonids and other species to have stronger year classes. There is some evidence accumulating to indicate that this has occurred for whitefish in eastern Lake Erie in 2001. Lake herring would also be favored by these conditions. The 2002-2003 winter began as an apparent El Niño warm winter, but then became one of the coldest winters of recent years. This would favor reproduction of coregonids and other native species adapted to Lake Erie's adverse winter conditions (Ryan et al. 1999).

Rehabilitation Efforts

Until recently, the possibility of rehabilitation of lake herring stocks in Lake Erie has by default relied on natural recruitment from extremely small remnant/transient stocks to rebuild the population, with almost no information on the identity and impacts of potential impediments. Although a few fish have been caught in recent years, the probability of the stock recovering on its own under current conditions appears remote. Within the last two years, there have been several different efforts which are the initial stages for re-establishment of lake herring into Lake Erie.

A workshop sponsored by the Great Lakes Restoration Act was held in July 2003 reviewing the status and impediments for lake herring 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 lake herring 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 a necessary part of most restoration efforts in many parts of the Great Lakes, but only where it will not affect an existing remnant stock. Another lake herring workshop is being 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 lake herring stock still exists in Lake Erie, lake herring specimens gathered over the past several years from Lake Erie have been shipped to USGS's Conte Anadromous Fish Laboratory for genetic analysis (microsatellite markers). Recent and museum specimen lake herring from Lake Erie and other Great Lakes, including archived Lake Erie specimens from 1955-65, 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 initial results of this research indicate that the recently caught lake herring are genetically most similar to Lake Erie specimens from 1950's and 1960's and are a surviving remnant population (Rocky Ward, USGS Wellsboro, unpublished data). However, sample sizes of the findings are still small (9) and additional testing is needed to confirm the results. The implications of these findings pose difficult management decisions for restoration efforts involving stocking with lake herring 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.

There are plans to begin disease testing of potential lake herring brood stock from other viable sources in case stocking is required for lake herring rehabilitation. Positive results for BKD from Lake Superior bloaters in 2005 have eliminated the upper Great Lakes as a potential source of lake herring brood stock or gametes. Attempts will be made to collect adult lake herring from Lake Ontario beginning in 2006 for disease screening. Negative results are required for three consecutive years before the collection of brood stock or gametes can be considered. Finger Lakes lake herring populations may be considered as well.

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Charge 8: Improve description of diet for top coldwater predators.

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

Lake Trout and Burbot

Seasonal diet information for both lake trout and burbot is not available based on current sampling protocols. Diet information was limited to fish caught during August 2005 in the coldwater gill net assessment surveys in the eastern basin of Lake Erie. Analysis of the stomach contents of lake trout and burbot revealed diets almost exclusively made of fish (>98%) in both species (Table 8.1). Rainbow smelt remained the main prey item for lake trout, occurring in 87% of the stomach samples (Figure 8.1). Round gobies were the only other prominent diet item, comprising 16% of the total lake trout diet in 2005 samples. Other prey items included emerald shiners, *Morone* species, dreissenids, and unknown fish.

Burbot diets were more diverse with nine different fish species and three invertebrate species found in stomach samples (Table 8.1). Smelt were the most common prey item found, occurring in over 50% of the non-empty burbot stomachs (Figure 8.1). Round gobies, the dominant prey item for burbot over the past two years, declined to 37% occurrence. Other minor prey items included dreissenids, yellow perch, shiners, white perch, gizzard shad, *Morone* species, drum, alewife, mayflies, and *Bythotrephes*.

The occurrence of round gobies declined in the diet of both lake trout and burbot in 2005 (Figure 8.2). Conversely, the occurrence of smelt has steadily declined in lake trout diets and dramatically declined in burbot diets since gobies first appeared in the eastern basin in 1999. Gobies had increased in lake trout diets since 2001 and in burbot since 1999, and were the main forage item for burbot in 2003 and 2004. Despite the declines seen, gobies continue to provide an alternate food source for Lake Erie's coldwater predators, relieving some dependency on the smelt resource.

Steelhead

Collection of steelhead for a lake-wide summer diet study funded by the Great Lake Fisheries Commission was completed by interjurisdictional agencies in 2004 (Clapsadl et al. 2004). The results of this study show that steelhead consume a wide variety of different fish and invertebrate species (10 species apiece), but that emerald shiners and smelt provide the majority of their diets' dry-weight biomass (Figures 8.3 and 8.4). In general, shiners became a more important diet item moving towards the west and smelt became more important moving to the east. Gobies were minor diet items except in the east where they were more prevalent. Other fish species were minor contributors to the overall diet by weight. Invertebrate species were more common in diets of central basin steelhead, but contributed very little to the diet dry-weight biomass.

Summertime steelhead diet samples were also collected by the Ohio Division of Wildlife in 2002, 2003, and 2005 in the central basin of Lake Erie. Results of these collections show that steelhead are opportunistic feeders and diets vary from year to year depending on the availability of forage species (Figure 8.5). Rainbow smelt comprised the majority of the dry weight biomass in both 2002 and 2003, but emerald shiners were the major forage item in 2005 as smelt declined. Yellow perch were noted as occasional food items in 2003, which was a strong year class for yellow perch. Other fish, insects and invertebrate species were occasional diet items and varied by year.

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Table 8.1. Frequency of occurrence of diet items from non-empty stomachs of lake trout and burbot collected in gill nets from the eastern basin of Lake Erie in August 2005.

	Lake Trout (N = 230)		Burbot (N = 201)	
Prey Species	Number	by %	Number	by %
Rainbow Smelt	199	86.5	101	50.2
Morone spp.	1	<0.1	3	1.5
Round Goby	36	15.7	75	37.3
Gizzard Shad			4	2.0
White Perch			15	7.5
Yellow Perch			6	3.0
Shiner spp.	7	3.0	11	5.5
Freshwater Drum			1	0.5
Alewife			1	0.5
Unidentified fish	10	4.3	34	16.9
Quagga/Zebra mussels	2	0.1	4	2.0
Cladoceran (B.c.=*Bythotrephes*)			1	0.5
Mayfly			1	0.5
Number of empty stomachs	79		155	

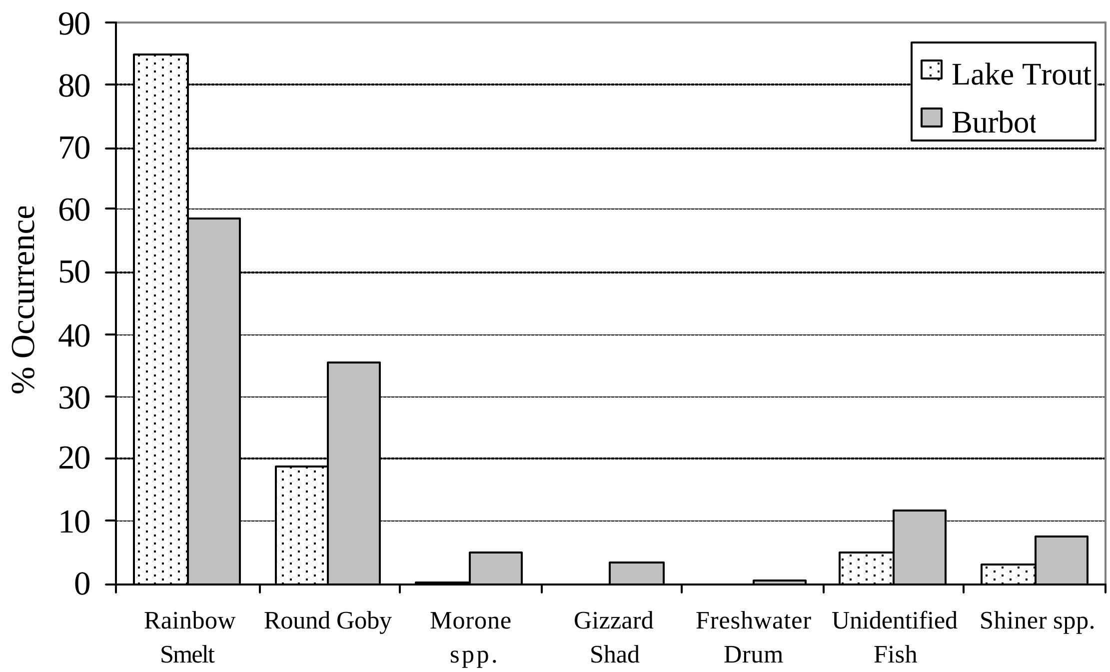

Figure 8.1. Frequency of occurrence of selected fish species in the diet of lake trout and burbot sampled in gill nets from the eastern basin of Lake Erie, August 2005.

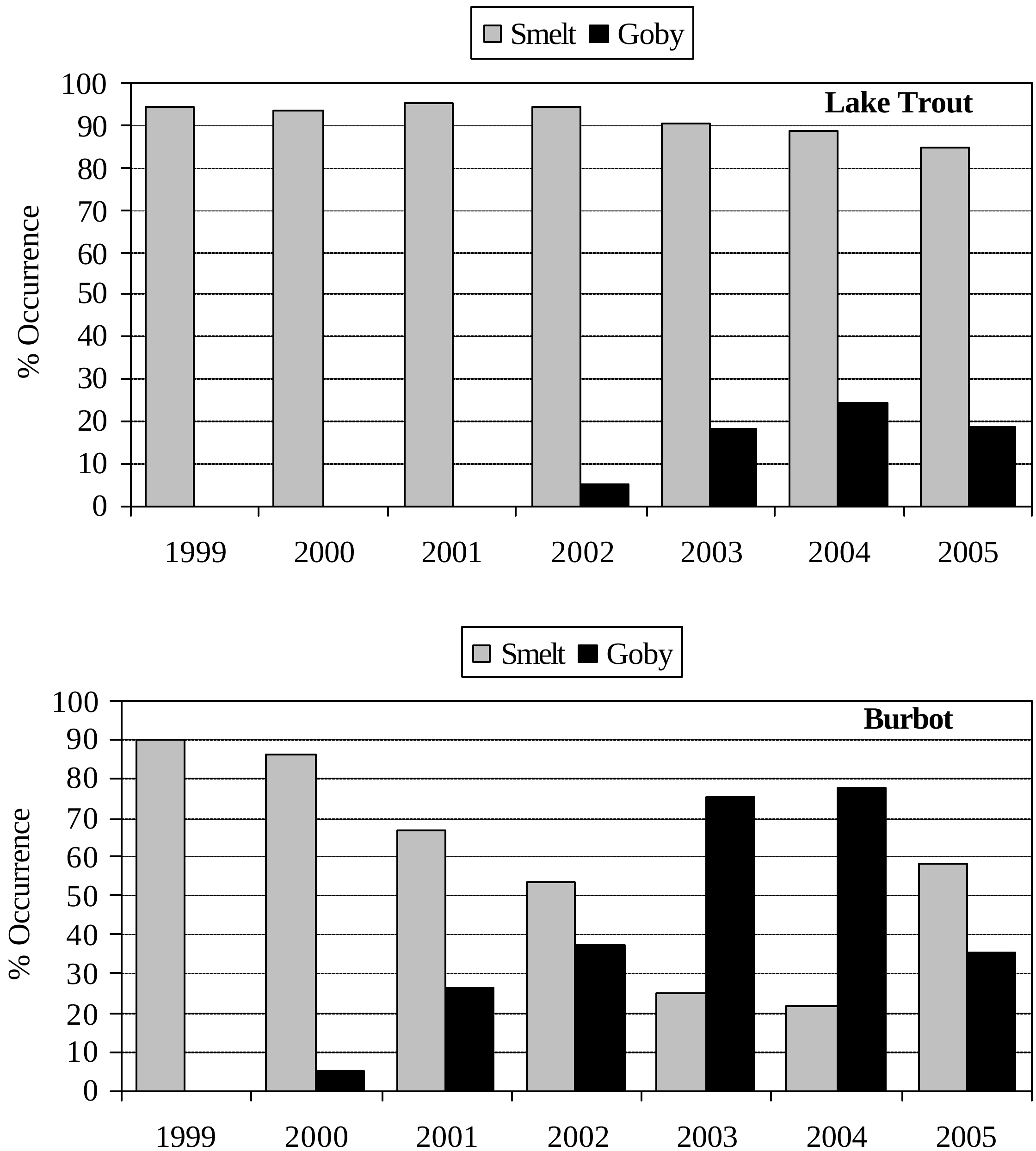

Figure 8.2. Percent occurrence of smelt and round goby in the diets of lake trout (top) and burbot (bottom) caught in NYSDEC assessment gill nets, August 1999-2005.

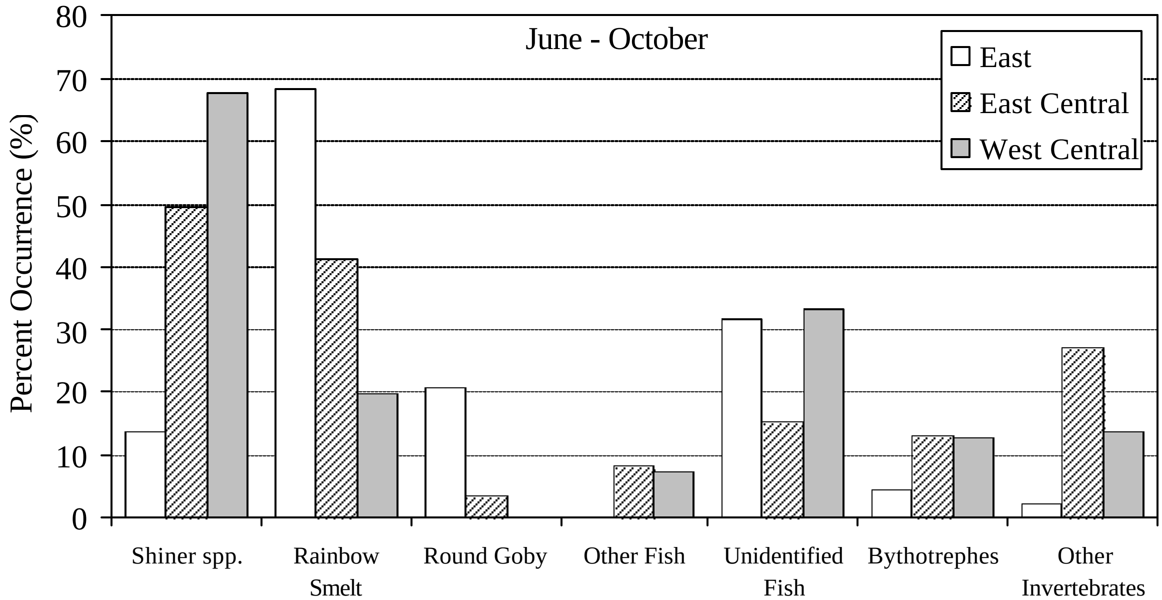

Figure 8.3. Percent occurrence of diet items found in steelhead stomachs from Lake Erie by basin, June-October 2004.

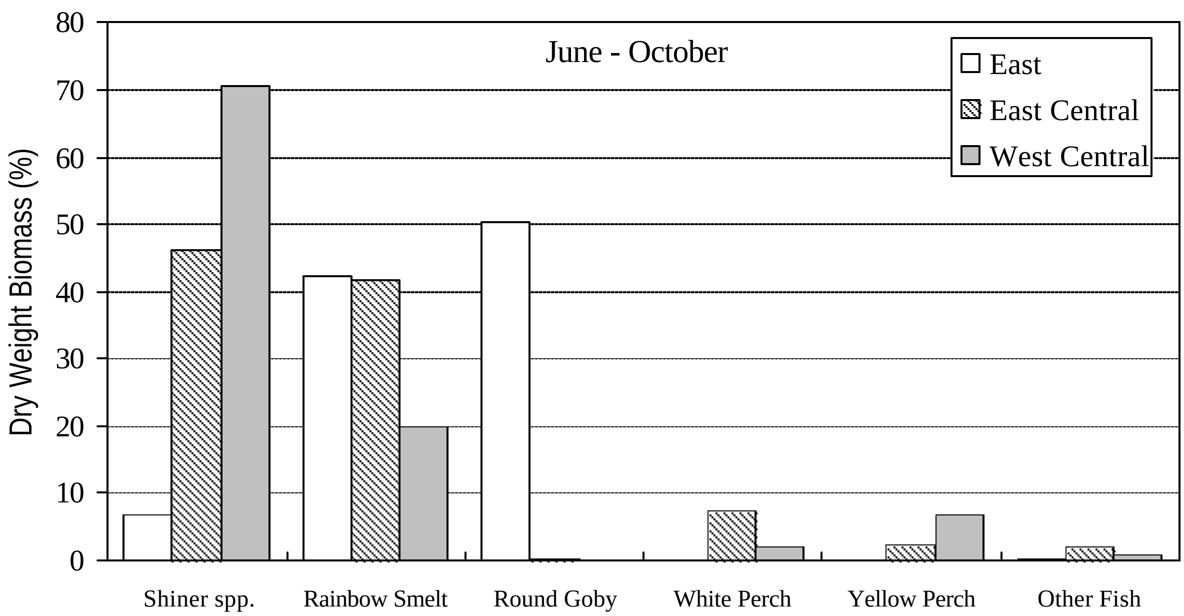

Figure 8.4. Dry weight biomass (%) of fish species found in steelhead stomachs from Lake Erie by basin, June-October 2004.

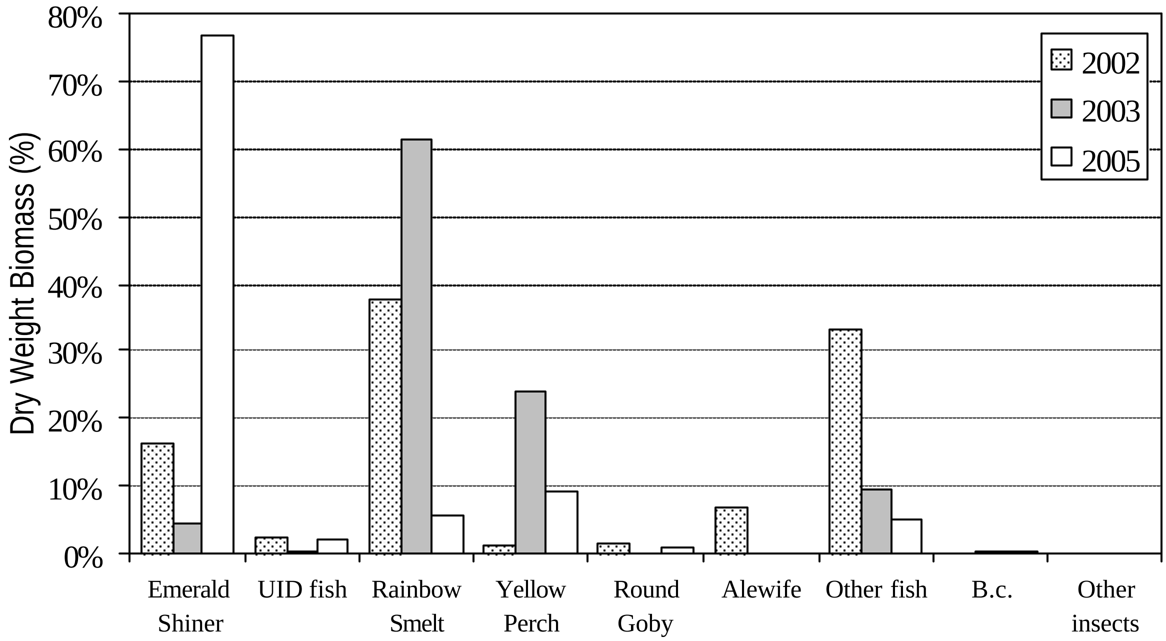

Figure 8.5. Dry weight biomass (by % of total) of diet items found in steelhead stomachs collected during the summer in Ohio's portion of the central basin of Lake Erie in 2002, 2003, and 2005. Note: UID fish is unidentified fish species from incomplete samples.